Chapter 1
Introduction to research problem and methodology

1.1 Introduction

The principal goal of Chapter 1 is to introduce the reader to the key characteristics of the research that is reported in the present thesis. It commences with an overview of the issues that were the catalysts for this research and a statement of the preliminary goals of the research activity that followed. During the initial research design phase, a number of questions were formulated out of my synthesis of the literature that seemed to be relevant to "the research problem". They provided the direction for the research effort, and are enumerated in the context of a brief background of how the problem was identified in the first place. The boundaries of the study are clarified with a statement concerning three related and important questions about surgical technologies that this thesis does not seek to answer. Then the two propositions that guided the overall research effort are stated. The first proposition has been investigated using the methods and assumptions of the *naturalistic* paradigm, which is the dominant paradigm of the thesis. It is important to note at this juncture that my use of a naturalistic methodology meant that, during the course of the research, new phenomena were identified, and emergent themes were explored in conjunction with additional literature, resulting in a number of outcomes that were not envisaged when the study began. The other proposition, although secondary in terms of the proportion of the thesis devoted to it, but no less important an outcome than any other, has been investigated using the methods and assumptions of the *positivist* research tradition.

Before these paradigm issues and the mixed methods and mixed methodology of this collective case study are discussed in detail, I highlight what is the theoretical and practical significance of this thesis, along with its importance, timeliness and originality. Then, during the course of my discussion on the research paradigm issues, I detail what are the ontological, epistemological, axiological, rhetorical and methodological assumptions of my thesis. In so doing, I present a synthesis, by way of a conceptual model, of the overall approach that has been employed during the research process. The conceptual model highlights the iterative nature of the research process in which data collection, data analysis, literature review and synthesis of ideas occurred in a circular and interactive way until the conclusions were drawn. The model is actually an outcome of the research process but, in keeping with my determination to structure the thesis for clarity of meaning rather than being bound to the structural conventions of one or other research paradigm, it is included in Chapter 1. The model is also indicative of Cresswell's (1994) view that the mixed methodology design is the

most complex of designs to handle. This complexity is reflected in both the size and diverse content of this chapter as it explains both the logic of the study and the rationale behind the selection of sites, informants and data types, and outlines the various approaches to, and stages of, data analysis.

The chapter continues with a justification for choosing the specific method of *collective case study* as an appropriate means of investigating the issues concerning the adoption of intra-operative artefacts within operating theatre services in New South Wales (NSW) hospitals. This is followed by a brief introductory explanation of the methods employed in the study and a statement of the limitations of the study. The chapter concludes with an overview of the content of the remaining six chapters of the thesis.

1.2 The research problem and the purpose of the study

The problem that provided the catalyst for this thesis manifested itself to me in 1991 when I was a manager of operating theatre services in a hospital in NSW. It did not emanate from any theoretical interest in technologies. Rather, the problem confronting me at the time was an operational management one concerning staffing levels. From my managerial perspective, the pre-existing inadequate staffing levels were being aggravated by the extra workload demands of the many innovations in surgical "artefact" technologies that emerged for use in general surgery during 1989-1990. By 1991, there was a realisation within many operating theatre services (OTSs) that these new surgical technologies were not only here to stay, but were likely to expand into many other specialty areas, which they did. I believed that the new technologies were placing increasing demands on my staff for two reasons in particular. First, the new technologies were diverse and complex, and increasingly dedicated to specialised functions. Secondly, the human labour needed to manage and reprocess them seemed to be greater than was required for earlier technologies. My concerns prompted me to initiate a discussion with the executive manager of the hospital about the need to recruit additional staff. He was not supportive of my request. However, the memory of a question that he posed during that conversation resurfaced during 1996 at a time when I was at the data analysis stage of an exploratory study of operating theatre nurses' perceptions of the effects of new medical technologies on their work (Johnstone 1997; 1998; 1999; 2000). He had said: *"what are you complaining about – what, with all the money we're investing in new technologies?"* This question became the trigger for me to ask, "is there actually an assumption abroad amongst health service managers that new surgical technologies employed in operating theatres should be reducing the demand for human labour and, if so, is it a valid assumption?"

One of Lincoln and Guba's (1985:226-227) defining characteristics of a research problem is that it is 'a state of affairs that begs for additional understanding'. Furthermore, they propose that 'the purpose of research inquiry is to "resolve" the problem in the sense of accumulating sufficient knowledge to lead to understanding or explanation'. Using the aforementioned question as my starting point and continuous point of reference, this has been my goal.

The present thesis, then, was borne out of my desire to investigate what are top managers' assumptions about, and expectations of, their hospitals' investments in new intra-operative artefacts. This led me to ask several other questions: What *is* the role of new intra-operative artefacts in surgical production? How, and why, are decisions made to adopt them, and what *is* the impact on the receivers of those technologies? The motivation to research these issues arose from my interest in both the quality of work life of people working in operating theatre services and the effective management of operating theatre services.

1.3 The research questions that have directed the research effort

In the previous section, I mentioned an exploratory study that I conducted in 1996 on operating theatre nurses' perceptions of the effects of new medical technologies on their work (see Chapter 2, Section 2.5.3 for an overview). The generic term, "medical technologies", was used at that time because the study was not limited to surgical technologies, but included anaesthetic, life support, and patient monitoring technologies. When I was pondering the significance of the results, I felt that the problems of increasing levels of work overload and job-related stress that the operating theatre nurses had reported, particularly in relation to surgical technologies, were sufficiently convincing to demand further study. However, I suspected that if health service managers were going to take any notice of this problem, it would not be achieved by undertaking, for example, in-depth psychological studies of employee stress. It was then that I recalled the aforementioned statement of my executive manager in 1991: "*what are you complaining about - what, with all the money we're investing in new technologies?*" At that moment, about five years after the statement was made, it dawned on me that this manager might have been assuming that the new surgical technologies should be reducing the demand for staff in operating theatre services. Over the ensuing months, I informally tested this as a possible assumption with numerous health service managers, with, *"well, that's what I would have thought"* being a common retort. I then believed that I had identified a problem that demanded investigation – indeed, that I had the embryo of a thesis.

But, of course, an embryo represents just the very beginning of life, just as this early idea represented the beginning of a twelve-month gestation of a research proposal, during which

time many ideas on how I could research the problem ran their course, and many, many potential research questions were formulated. The following five research questions represent the synthesis of those questions that are relevant to the final focus and form of the present thesis:

1. What are the dominant technical characteristics and functional goals of new intra-operative artefacts adopted between 1988 and 1998?
2. What are the benefits expected by key internal stakeholders of adopting new intra-operative artefacts?
3. What are the actual consequences for surgical production within operating theatre services of new intra-operative artefact adoption?
4. Are the consequences for surgical production within operating theatre services of new intra-operative artefact adoption congruent with expectations and, if not, why not?
5. By what processes are decisions made to adopt new intra-operative artefacts, and how are the benefits expected by key internal stakeholders of adopting them influential in these decision processes?

There are three important areas of inquiry about changes in surgical technologies that this thesis does not seek to explore. The first concerns the social costs and benefits of adopting new technologies to diagnose and/or treat certain illness conditions – issues that fall into the scope of health economics research. The second concerns the appropriateness and effectiveness of innovations in the surgical process. The study of these issues falls into the area of biomedical/clinical research using randomised controlled trials. The third relates to the role of research and development firms in new surgical artefact innovation, and their influence in the adoption and diffusion process in general. Whilst the present thesis explores the factors that influence the new technology adoption decisions of internal hospital stakeholders, it does not go out of the hospital to explore the wider innovation, adoption and diffusion issues. This is because the overarching goals of the thesis are to make contributions to organisation theory and to management practice on issues concerning new intra-operative artefact adoption within operating theatre services. However, the existing bodies of knowledge in these three areas are recognised as providing important background to the present thesis, and pertinent issues are included in my examination of health care technologies in Section 2.5.

1.4 Research propositions

There is one all-embracing research proposition from which the five research questions, listed in Section 1.3, are derived. It has been investigated using the various methods that I introduce

later in Section 1.8 and describe in detail in Chapter 4. Simply stated, the guiding dominant paradigm proposition of this research is that:

> *The characteristics of new intra-operative artefacts, the reasons for their adoption in surgical production in hospitals, the decision processes associated with their adoption, and their consequences for receiver stakeholders, cannot be explained using the set of theories and managerial perspectives, which I refer to collectively as "the techno-economic theories of production", that are typically operationalised in new technology adoption scenarios in organisations by strategies that emphasise return-on-investment.*

The secondary paradigm outcome of this study did not start as a research proposition. In fact, I did not envisage extending my quantitative data analysis to include the specific issues relating to this outcome until well into the research process. My thesis could be complete without it. However, having reached my conclusions and adjudged that they have practical significance for the Australian health care industry, a research proposition has been formulated retrospectively in the following terms:

> *that the estimated costs of the human resource component of the Australian Government's National Operating Room Service Weights for specific surgical procedures by designated Diagnostic Related Group (DRG) do not accurately reflect the volume of human labour input to their production.*

1.5 Theoretical and practical significance of the study

Erlandson, Harris, Skipper and Allen (1993:44) propose that 'the significance of [a] problem lies in its timeliness, originality, and importance, as well as its academic and practical values'. It can be readily demonstrated that the present thesis possesses all of these characteristics, as I now briefly explain.

First, its *originality*. I have already explained how my thesis topic emanated from my experiences of working in the health care industry. Moreover, so far as can be ascertained, this is the first empirical study to explore issues associated with the management of new intra-operative artefact adoption in hospitals.

In my view, the principal *academic value* of this thesis is located in a number of inter-related contributions to organisation theory, the management of hospitals, and organisation research methodologies. To the latter it provides a conceptual model of the mixed methods, mixed methodology research process employed in the present thesis that could assist future researchers in this increasingly accepted but little documented approach.

To organisation theory, it makes four theoretical contributions that were outlined in the thesis Introduction. One concerns the various categories of surgical technologies and their process relationships in surgical production. The second is my reasoned contribution to the unresolved philosophical debate concerning voluntarism and determinism as it is articulated in the socio-techno-organisational literature. The third is that which culminates in my 7x2 matrix of technological change that is subsequently used to discuss the two dimensions of *choice* and *consequence* as they relate to stakeholders' role(s) in the new surgical technology adoption decision process, and their new intra-operative artefact receiver status. The fourth relates to my explanation of new technology adoption of a specific category of medical technologies that is in stark contrast to the widely reported analyses of new technology adoption in manufacturing/business organisations.

The *importance* of these contributions is that, until now, no context-specific studies have challenged the relevance to the adoption of medical technologies in general, or *intra-operative artefacts* in particular, of existing academic explanations of the role and adoption process of new technologies. I was spurred on in my endeavour to do this by the words of Roberts and Grabowski (1996:419) who said of the numerous academic efforts to "discover" an overarching paradigm for technology, 'uniform or generalised descriptions of technology and organisational applicability, adaptability, or utility are increasingly artefacts of simpler technological eras'. Their observation is all the more cogent in view of my conclusion, in the present thesis, that current theory is inadequate to explain the work-related consequences of new intra-operative artefact adoption. The consequences I report herein are not consistent with the general expectations of health service managers, who, being schooled in management and economic theories, might be excused for applying the principles of the prevailing paradigm's *techno-economic theories of production* to their new intra-operative artefact adoption decision behaviour. However, because no formal post-acquisition evaluations of expected and actual outcomes are undertaken, the pervasive view of top managers, that new intra-operative artefacts are enhancing operating theatre services' efficiency and/or productivity, has, I propose, become a self-perpetuating myth.

The *practical value* of this thesis derives both from characteristics of its context, the Australian health care industry, and from its conclusions concerning the management of operating theatre services. During the study's timeframe, 1988 to 1998, national spending on all health care increased by approximately 0.8 percentage points of Gross Domestic Product (GDP), the greater portion of which (0.6 percentage points) occurred during the five years to 1993 (AIHW 1994). This represents an average annual rate of growth in total health

expenditure of 4.1 per cent between 1988 and 1998 (AIHW 2000). Both in Australia and overseas these rises in health care costs have been largely attributed to the growth in complexity and widespread use of health care technologies (cf. Newhouse 1988; Richardson 1990; Folland, Goodman & Stano 1993).

Most health care "artefact" technologies are located in hospitals, and yet the average annual growth rate of total *hospital* expenditure in Australia during the same period was 0.7 percentage points lower than that for all health care expenditure (AIHW 2000). This, combined with increasing technology costs and no decreases in hospital utilisation, suggests that some other hospital budget areas have experienced a decline in relative expenditure. In this connnection, there is plenty of evidence provided in the public media of the cuts or rationalisations of services and hospital staffing levels that have characterised the 1990s. Extended waiting times for treatments, especially for certain types of surgery, are a case in point (Duckett 2000).

Fiscal constraints also have a private or hidden side, because tightening health care budgets can have negative consequences for employees. For operating theatre services personnel, problems of work overload and employee stress (Johnstone 1997; 1998; 1999; 2000), for example, are not only hidden from public view, but also from the view of other personnel working within a hospital. This is because the physical barriers that prevent "outsiders" from entering, makes the OTS, categorically, a "closed work environment". However, resource allocation to the OTS is the function of top managers, many of whom are unlikely to have ever set foot inside an OTS or, otherwise, have spent insufficient time in one to gain an appreciation of the "hidden" issues that are central to the present thesis. Overall, it is both *important* and *timely* to investigate whether managers are thinking, *"we can reduce the human resource budget in operating theatre services because our investments in new surgical technologies should be reducing the human labour input requirements"*.

Furthermore, the *timeliness* and *practical value* of the thesis is also evident in my positivist paradigm conclusions concerning the possibly unreliable estimated costs of the human resources component of the (Australian) National Operating Room Service Weights (NORSWs). The NSW Department of Health supports, in principle, the NORSWs as the basis for funding its public hospital OTSs, and during the late 1990s, health services started to analyse how their historical funding for their OTSs compared to the funding they would receive using the NORSW/casemix-based approach. It is of the utmost *importance* that the data used as the basis for such calculations are sufficiently reliable to ensure the appropriateness of operating theatre services' budgets for all categories and locations of

hospitals. This thesis raises doubts about the capacity of the NORSWs to do this. No previous research has studied the total human labour input to specific procedures, so, my quantitative analysis of a small but significant sample of high volume procedures should provide the necessary impetus to a wider-scale analysis of these issues.

1.6 Research Paradigm

Case study research of the type employed in this study is located in the research paradigm variously known as qualitative research, naturalistic inquiry, the constructivist approach, post-positivist or postmodern perspective, or the interpretative approach (Cresswell 1994). I prefer to use the term, *naturalistic inquiry* (DePoy & Gitlin 1994; Erlandson et al. 1993; Stake 1995), to describe my current research for several reasons. First and foremost, this study uses a *mixed methodology* in which both qualitative and quantitative data have been collected, both qualitative and quantitative analysis methods have been employed, and both inductive and deductive reasoning have been applied at various stages of data analysis. Thus, it avoids the confusion that would likely result from describing the research methodology as *qualitative*. Secondly, the research is categorically socio-technical research which is conducted in a natural setting as opposed to a laboratory or controlled setting (Erlandson et al. 1993).

1.6.1 Naturalistic inquiry versus logical positivism

Whilst I do not plan to engage in a extensive discussion about differences between the *naturalistic paradigm* and the *traditional scientific research paradigm,* known variously as experimental, rationalistic, or positivist research, or, collectively as *logical positivism* (DePoy & Gitlin 1994:17), I believe that some discussion is necessary because it provides the basis for explaining how each has influenced my overall research strategy and been integrated into the design of the various phases of the research process.

In their discussion about the philosophical bases of naturalistic inquiry and experimental-type research, DePoy and Gitlin (1994:17) explain how the latter *logical positivist* stance is that:

> it is possible to know and understand phenomena that reside outside of ourselves, separate from the realm of subjective ideas [and] that there is a single reality that can be discovered by reducing it into its parts. [Furthermore] the relationship among these parts and the logical, structural principles that guide them can also be discovered and known through the collection and analysis of sense data, leading finally to the ability to predict phenomena from that which is already known.

Logical positivism holds that 'through incremental *deductive reasoning,* which involves theory verification and testing, "reality" can become predictable' (DePoy & Gitlin 1994:17). Its *ontological* assumption is that this reality is *objective*. Conversely, naturalistic research holds that reality is *subjective* (Cresswell 1994; Stake 1995; cf. Popper 1968:27-34; 44-48).

Cresswell (1994) synthesises the work of Firestone (1987), Guba and Lincoln (1988) and McCracken (1988) when he compares the assumptions of the two paradigms from four additional perspectives. The first of these perspectives is the *epistemological* one that is concerned with the relationship of the researcher to what (s)he is researching. Here, the logical positivist researcher is deemed to be independent from what is being researched, whilst the naturalistic researcher interacts with the study phenomenon, usually over a prolonged period of time. Consistent with Patton's (1991, cited by Cresswell 1994:179) recommendation that the researcher should 'keep his or her assumptions explicit at all times' (cf. Lawler 1991), I need to declare that this research has certain endogenous or "insider" characteristics due to my work experience as a registered nurse working in operating theatres in the various roles of clinician, educator and manager, between 1967 to 1974, and then again from 1985 to 1992 – experience that has provided the catalyst for this research and also facilitated my access to OTSs to conduct the research (as explained further in Chapter 4).

The *axiological* assumption of logical positivist research is that it is value-free and unbiased, as opposed to naturalistic research in which the researcher acknowledges his or her values and biases, as well as the value nature of the information gathered from the field. These distinctions, combined with the relationship of the researcher to that which is researched, influence the *rhetorical* assumption which concerns the choice of language used in the reporting of the research. It is for this reason that the language of choice in my study is the personal and relatively informal voice of a naturalistic researcher rather than the formal, impersonal voice that characterises logical positivist research reports. The personal voice is an acknowledgment that the researcher is a participant in the phenomena being studied, that (s)he made choices in the course of the research that will have influenced what data were collected and reported, or not collected, and that the explanation that is finally offered will be one that is unavoidably influenced to some extent by his or her own world views (Erlandson et al. 1993). Furthermore, 'each paradigm has its own appropriate rules and criteria' (Erlandson et al. 1993:xiii) and so the very terms that are used to describe naturalistic research are customarily quite different to those used to describe positivist research. Schmuttermaier (1999), for example, suggests the use of the terms, *proposition* instead of *hypothesis* (consistent with Yin 1994), and *extrapolation* instead of *generalisation*. It is

because of these rhetorical distinctions that the present thesis also refers to its human contributors as *informants* rather than *participants.* Furthermore, Erlandson et al. (1993) draw attention to the fact that naturalistic researchers refer to a *guiding* framework for their research as opposed to what positivists refer to as *designing* their research. However, in the case study methodology, Yin (1994) does not have a problem with the term, *research design,* or to the notion of *generalising* to theory. In this thesis, I defer to Yin's position.

Finally, the *methodological* perspective relates to the process of the research. Guba and Lincoln (1988:109) describe "methodology" as 'the overall strategy' of the research. The term also relates to the underlying logic, or ways of thinking about the data. It must be distinguished from "methods" which refers to types of data (ie. qualitative or quantitative), the tools employed in collecting the data (such as interviews or quantitative measurements), and the techniques for analysing the data (such as content analysis or statistical methods) (cf. Erlandson et al. 1993). Guba and Lincoln (1988) argue that methodology is linked to the ontological and epistemological assumptions of the selected research paradigm.

It is widely held that the process of logical positivist research is a *deductive* one, whilst *inductive* logic prevails in naturalistic research, and that methodologies cannot be mixed (cf. Guba & Lincoln 1988). For example, Cresswell (1994:94-95) holds the view that:

> in a [naturalistic] study, one does not begin with a theory to test or verify. Instead, consistent with the inductive model of thinking, a theory may emerge during the data collection and analysis phase of the research or be used relatively late in the research process as a basis for comparison with other theories.

However, a far more liberating approach was presented by Patton in 1988 when he argued for a "paradigm of choices" – that paradigms should not be assumed to be rigid and fixed; that they are not *prescriptive* but only *descriptive*; and that researchers should not have to choose *between* paradigms. He holds that 'different methods are appropriate for different situations' (Patton 1988:119) and that, 'wherever possible, multiple methods should be used' (Patton 1988:136). This approach has been adopted in the present thesis.

According to DePoy and Gitlin (1994), the design of a study is influenced by the assumptions of the before-mentioned five perspectives, along with both the topic and purpose of the study, and the point of entry of the researcher into the research problem. One generally held research design implication of the two paradigms is that the logical positivist researcher can design the entire research process *a priori* by choosing the concepts, variables and hypotheses before the study begins, whilst for the naturalistic researcher, the design is a dynamic, flexible one that takes shape during the research process (cf. Guba & Lincoln 1988).

Furthermore, by comparison with the logical positivist view that reality can become predictable, the naturalistic paradigm acknowledges that its data are context-bound. Concerning these distinctions, Stake (1995:41) thoughtfully observed that:

> all research depends on interpretation, but with standard quantitative designs there is an effort to limit the role of personal interpretation for that period between the time the research design is set and the time the data are collected and analysed statistically – sometimes thought of as a "value free" period. Standard [naturalistic] designs call for the persons most responsible for interpretations to be in the field, making observations, exercising subjective judgement, analysing and synthesising, all the while realising their own consciousness.

Erlandson et al. (1993:x) argue that even 'studies that are based exclusively on qualitative methods but designed in terms of positivist assumptions remain positivist studies'; however naturalistic studies, which may include quantitative and qualitative methods, are essentially different, although 'the difference has nothing whatever to do with the issues (if there be such) of qualitative versus quantitative methods'. In a similar vein, Patton (1988:131) posits that actual studies seldom 'exemplify all of the ideal characteristics of either paradigm' (cf. Cresswell 1994), and, based on his "paradigm of choices" view, nor should they be expected to be. The important thing, so far as Patton (1988:117) is concerned, is that 'the notion of competing paradigms incorrectly implies only two research options; [but] that there are no *logical* reasons why qualitative and quantitative approaches cannot be used together'.

1.6.2 Mixed methods strategy in a mixed-methodology study design

The "paradigm debate" is a long-standing one. (See, for example Popper's (1968) *The Logic of Scientific Discovery*, which was originally published in German in 1934.) A wide range of eminently well reasoned views are currently held on what constitutes "truth" and how it is discovered. Somewhere in the middle of the prevailing wide ranging views is a pragmatic school of thought that holds that 'a false dichotomy exists between qualitative and quantitative approaches and that researchers should make the most efficient use of both [approaches] in understanding social phenomena' (Cresswell 1994:176; cf. Patton 1988). This is what I have endeavoured to do, but I have discovered in the course of the research that operationalising this pragmatic position is not without its challenges at either the practical or philosophical levels. For example, when Cresswell discussed the topic of mixing methods in single studies, he highlighted how this raises the previously mentioned contentious issue of whether or not paradigms, and hence, methodologies, *must* be linked with methods. He questions (Cresswell 1994:175-176):

> if a researcher used an inductive, emerging qualitative stance in a study, does this mean that he or she must use qualitative data collection approaches such as observations and interviews? Alternatively, should a deductive, theory-driven study in the quantitative paradigm always be linked with quantitative data collection procedures such as surveys and experiments? [Furthermore] can aspects of the design process other than methods – such as the introduction to a study, the literature and theory, the purpose statement, and research questions – also be drawn from different paradigms in a single study?

In the course of his response to these questions, he noted that, as late as 1989, mixed-methods research designs were 'largely uncharted territory' (Cresswell 1994:176 citing Greene et al. 1989), and that it was not possible, at the time he was writing, to formulate a comprehensive set of guidelines concerning these issues. Hassard's (1993) four paradigm organisational research "experiment" produced some useful conclusions. He did not approach the question using the positivist/constructivist dichotomy. Rather, he used Burrell and Morgan's (1979) 'four paradigms for organisational analysis' (Hassard 1993:89), and concluded that:

> [P]aradigm heterodoxy holds many benefits for organisational analysis. Multiple paradigm research, if operationalised successfully, may allow us to learn the languages and practices of a wide range of academic communities and in turn to develop analytical skills representative of their forms of life. Through refining such a poly-paradigm methodology we may be able to realise epistemological variety in our studies of organisation (Hassard 1993:110).

Hassard (1993) acknowledges the potential for a richer description of the topic under investigation when 'methodological freedom [exists] in research design' (Hassard 1993:109) compared to when a single paradigm approach is employed. His suggestion that organisational analysis could benefit from 'developing a typology which specifies appropriate combinations of topics, methods, and paradigms' (Hassard 1993:110) is essentially an expression of support for mixed methods, multi-paradigm research.

A useful framework for working within a mixed-methods approach was provided when Cresswell (1994) and DePoy and Gitlin (1994) distinguished, and described, three levels of integrated designs. At the lowest level is the approach that Cresswell calls the *two-phase design*, in which the study phenomenon is investigated at different and separate stages using techniques conventionally associated with each paradigm.

Cresswell calls the next level of integrated design, the *dominant-less dominant design,* while DePoy and Gitlin refer to it as a *mixed method strategy*. The distinguishing characteristic of

this approach is that 'the researcher presents the study within a single, dominant paradigm' (Cresswell 1994:177) but, 'within that framework, action processes are borrowed from either the naturalistic or experimental-type continua to answer a single research question or query' (DePoy & Gitlin 1994:22). It is difficult to discern from the descriptions of this and the third level of integrated design, just where the design becomes *fully integrated* (DePoy & Gitlin 1994) or, in Cresswell's (1994) terminology, a *mixed-methodology design*. DePoy and Gitlin (1994:23) propose that at this third level, the researcher 'will use the frameworks of distinct philosophical traditions to answer different questions within one study', whilst Cresswell (1994:177-178) describes it in terms of mixing aspects of both paradigms at all or many methodological steps in the design, 'working back and forth between inductive and deductive models of thinking'. At this level of integration, the capacity to *triangulate* data derived from both paradigms seems to be assumed.

Because I suspect that the distinction between the second and third levels of integrated designs lies in how inductive and deductive reasoning are applied to the data, I propose that the present research is categorically a *fully integrated* or *mixed-methodology design*. Its specific form of mixed methodology design is a *collective case study*, and its dominant assumptions are consistent with those accorded the *naturalistic paradigm*. Hence, it is reported using the general conventions of that paradigm and the particular conventions of the case study method (Yin 1993; 1994). (Case study method is described in Section 1.7 following.) Whilst I note Cresswell's (1994:178) warning that the *mixed-methodology design* 'requires a sophisticated knowledge of both paradigms…that may be unfamiliar to many researchers', I have accepted the challenge of a relatively uncharted research method in order to produce the quality of outcome I desire for this thesis.

One important question has thus far only been addressed in passing. Why should a researcher want to mix methods and/or methodologies? Greene et al. (1989 cited by Cresswell 1994:175) advanced five reasons. Among them are *triangulation*, *complementarity*, and *expansion*. *Triangulation* involves reviewing and analysing evidence from multiple sources such that a study's findings are based on the *convergence* of that information (Yin 1994; Erlandson et al. 1993). *Complementarity* means that 'overlapping and different facets of a phenomenon may emerge, [while *expansion* means that] the mixed methods add scope and breadth to a study' (Cresswell 1994:175). All have the capacity to add rigour and credibility to a study.

According to Cresswell (1994), the term *triangulation* was borrowed by Denzin (1978) from navigation and military strategy. Jick (1979, cited by Cresswell 1994) argued that the strength

of the *triangulation process* lies in its capacity to neutralise any bias inherent in a particular data source, investigator, or method, when used in conjunction with other data sources, investigators and methods. *Data triangulation* is an inductive process (Yin 1994) and may involve various quantitative and/or qualitative data. A researcher might use a number of data collection strategies consistent with a single paradigm, such as a survey and an experiment (generally referred to as within-method triangulation), or, alternatively, data collection and analysis procedures from each paradigm, such as a survey and in-depth interviews (ie. between-method triangulation) (Erlandson et al. 1993). Overall, the strength of data triangulation is that it results in a "thick description" of the phenomenon of interest that would not be possible if fewer data collection strategies had been employed (Erlandson et al. 1993 citing Guba 1981) – essentially a case of all the data being necessary, but insufficient on their own to explain a phenomenon in a rigorous and credible manner.

It remains then to explore how a researcher employing a mixed-methodology design might handle various stages of the research report. In other words, how might I structure this thesis? Unfortunately, Yin's (1993; 1994) comprehensive treatment of case study method does not offer many guidelines to researchers on such practicalities of mixing methodologies. However, Cresswell (1994) offers some guidance. He suggests that in a mixed-methodology design, the introduction might be presented in an approach consistent with either paradigm. He cites Patton (1991) who recommends that throughout the process, the researcher 'should keep his or her assumptions explicit at all times' (Cresswell 1994:179) – one important reason why I have devoted a number of pages in the present chapter to discussing these paradigm issues.

Structuring the presentation of the *theory* and the *literature* in a research report of a single paradigm study should always be consistent with each paradigm's conventions. However, 'in a mixed-methodology design', Cresswell (1994:180) observes, 'it is difficult, if not impossible, to mix the two paradigms in the use of theory and the literature'. This does not mean that it cannot be done, for he goes on to say that in practice, theory and literature can be used 'without a strict interpretation of the inductive and deductive associations with their paradigms'. The present thesis uses the conventions of the positivist paradigm when, in Chapter 3, it overviews the theory and literature relevant to most of the study's outcomes. However, consistent with the conventions of its dominant paradigm – the naturalistic paradigm – theory and literature are not limited to Chapter 3. Rather, they are included in this chapter and Chapter 2, and subsequently woven into the presentation and discussion of the study's findings in various other chapters of the thesis.

So far as the *purpose statement* and *research questions/hypotheses* are concerned, Cresswell (1994:181-182) suggests that if a single, dominant paradigm is employed, the purpose statement and questions/hypotheses should be 'posed in the language of that dominant paradigm', whilst 'a secondary purpose would be described in the language of the less-dominant design'. This is the approach that I have employed.

Finally, how may a mixed-methodology design handle the *reporting* of various types of data collection methods? Cresswell (1994) cites a study by Gogolin and Swartz (1992) as an example of one approach. The researchers presented and discussed their qualitative and quantitative results separately and ended with separate discussions of the qualitative and quantitative implications. The present thesis uses a slightly different approach because the naturalistic paradigm conclusions draw on almost all of the study data – both quantitative and qualitative. The quantitative data are presented and discussed first, sometimes in conjunction with qualitative data, to draw the positivist paradigm conclusions, and a chapter is devoted to this purpose. Then selected quantitative data are analysed in conjunction with the relevant qualitative data, using inductive and/or deductive reasoning, to produce some of the naturalistic paradigm conclusions of the thesis. Other naturalistic paradigm conclusions are derived only from the qualitative data. One chapter is dedicated to reporting and analysing the qualitative data, analysing them in conjunction with relevant quantitative data using *between-methods data triangulation*, discussing the findings, and drawing the dominant paradigm conclusions of the thesis.

Overall, this type of structured reporting technique is both logical and practical, but it belies the complex and continuous interplay that occurs throughout the research process between the literature, the qualitative and quantitative data, and the inductive and deductive reasoning that have been applied variously to these data in the course of this research. The process I have used is summarised conceptually in **Figure 1(a)**. In view of the fact that mixed methodology research is 'largely uncharted territory' (Cresswell 1994:176), my conceptual model of the mixed methodology research process employed in the present thesis represents one of the theoretical contributions of the thesis. I acknowledge the influence of existing models of the methodology of naturalistic inquiry (eg. Guba & Lincoln 1988) on the development of my model.

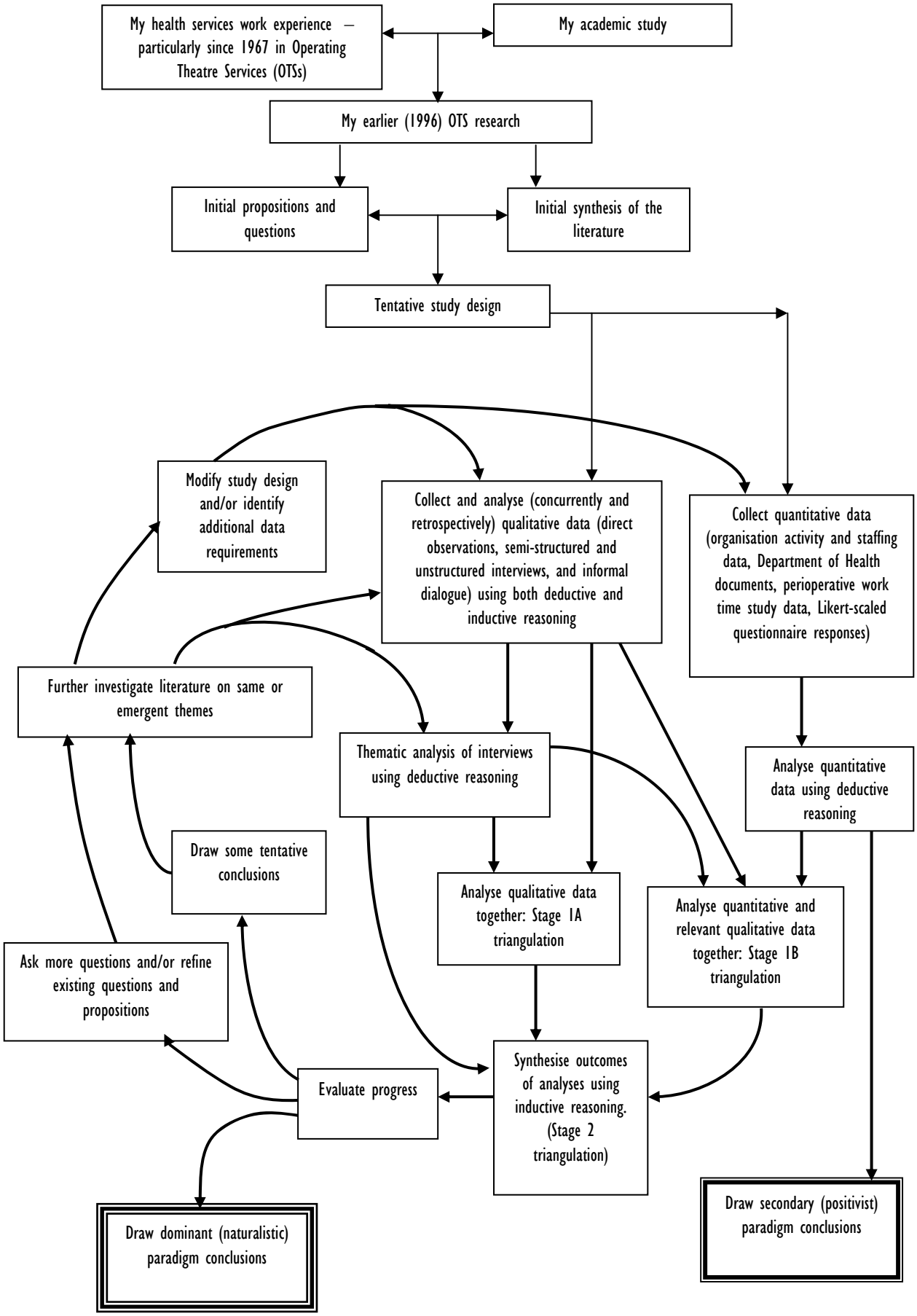
Consistent with the epistemological assumptions of naturalistic research, **Figure 1(a)** outlines how my 'engagement with the research problem' started in 1967 when I was introduced to OTSs as a student nurse. My subsequent years of working in OTSs, combined with my academic studies in health services management, commerce, and health economics constitute

a large part of the tacit knowledge that I have brought into this research. Some issues that I confronted when I was a manager of OTSs, particularly in the early 1990s, prompted me to undertake an exploratory study in 1996 whereby I began to broaden my understanding of the literature relevant to the present thesis. The results of that preliminary study raised other questions that gradually synthesised into a specific *research problem* (Lincoln & Guba 1985) that, in turn, translated into a number of *research questions* and *propositions.* These guided the development of my tentative study design that provided direction for the subsequent *'interactive, circular process of data collection, data analysis, and design review'* that Lincoln and Guba (1985, cited by Erlandson et al. 1993:70-71; cf. Commonwealth of Australia 1995c) propose continues 'until a point of redundancy is reached' - that is, until a point 'where no significant new information emerges or no major new constructions are being developed'.

Planning my tentative study design was quite a difficult process, partly because designing quality research is not an easy task at the best of times, but more so because of the practical implications of the research paradigm issues just discussed – in particular, the philosophical considerations surrounding the inductive/deductive dichotomy (Popper 1968; DePoy & Gitlin 1994; Cresswell 1994). Erlandson et al. (1993:39) explain how 'the "human instrument" allows data to be collected and analysed in an *interactive* process – how, 'as soon as data are obtained, tentative meaning is applied to them [and] when new data are obtained, meaning is revised'. This iterative process, which for me included constant review of the literature on the same or emergent themes connected with related research and related theories (Marshall & Rossman 1999), is reflected in **Figure 1(a)**, along with the essential philosophical components. **Figure 1(a)** highlights how the data analysis process is not a linear one (Marshall & Rossman 1999). It shows how interview data and other qualitative data were analysed both inductively and deductively at different phases (both during and after data collection), how the quantitative data were analysed deductively, and how the overall iterative process of data interpretation involving *between-methods data triangulation* was inductive.

There are strong similarities between this approach and the methods and assumptions of *grounded theory* – a naturalistic approach that DePoy and Gitlin (1994:142; cf. Glaser & Strauss 1967) described as the 'systematic discovery of theory from the data of social research [which is] a more structured and investigator directed strategy than [most other] designs along the continuum of naturalistic inquiry'.

Figure 1(a): Conceptual model of the research process used in this study



Grounded theory 'uses an inductive process to derive concepts, constructs, relationships, and principles to understand and explain a phenomenon [combined with] a structured data gathering and analytic process termed *constant comparative method*' (DePoy & Gitlin 1994:142-143) – a method described by Glaser and Strauss in 1967.

In summary, 'grounded theory systematises the inductive incremental analytic process and the continuous interplay between previously collected and analysed data, and new information' (DePoy & Gitlin 1994:271), and even involves the investigator working 'somewhat deductively' (DePoy & Gitlin 1994:267 citing Glaser & Strauss 1967) as (s)he brings the research process to closure. It would be fair to say, I suggest, that I employed a grounded theory approach, or more precisely, the constant comparative method, particularly whilst in the field. Hence, on this particular issue I have concluded that, whilst I have employed a case study method consistent with that proposed by Yin (1993; 1994), the research process and the ways of thinking about much of this study's data during the data collection phase closely parallel the constant comparative method as described by Glaser and Strauss (1967). Between-methods data triangulation represents the more structured approach to analysis that was employed after all of the fieldwork had been completed.

In review, the following statement by Erlandson et al. (1993:113-114) could well have been written to describe the process of the present thesis:

> [D]ata analysis in a naturalistic inquiry involves a twofold approach. The first aspect involves data analysis at the research site during data collection. The second aspect involves data analysis away from the site following a period of data collection. …this second aspect is conducted between site visits, prior to as well as after completion of data collection. [Furthermore] data analysis frequently necessitates revisions in data collection procedures and strategies. These revisions yield new data that are then subjected to new analysis. The result of this process is the effective collection of rich data that generate alternative hypotheses and provide the basis for shared constructions of reality… New data, obtained through refined procedures, test and reshape the tentative hypotheses that have been formed and further modify the data collection procedures. This iterative refining process never really ceases until the final report has been written.

To conclude this section, I reiterate that this thesis has employed a *mixed method strategy* in a *mixed-methodology design*. It is located dominantly within the *naturalistic paradigm* and is reported using the general conventions of that paradigm and the particular conventions of case study method in the form of a *collective case study*, which is now described.

1.7 Research Method: Collective case study

1.7.1 Case study as a research method

In this section I draw on the work of Yin (1993; 1994) and Stake (1995), in particular, for their detailed treatment of the principles and practice of *case study method*, and the rationale for studying multiple cases within a single study.

A number of traditions exist within the *naturalistic* approach, and although numerous typologies of qualitative research have been proposed by various commentators (eg. Marshall & Rossman 1999), Cresswell (1994:11-12) reports that four designs are frequently found in human and social science research: ethnographies, grounded theory, case studies and phenomenological studies. In all but the case study approach, the conventions concerning an *a posteriori theory* and *inductive reasoning* are, as far as I understand, uncontested. However, *case studies* often combine qualitative and quantitative techniques and logic to test theory or pose a rival theory, or to test causality, and possibly generalise results (Cresswell 1994; Yin 1993; 1994). They may start with *a priori* hypotheses and/or a fairly concrete research design (rather than the research design emanating from the research itself), albeit one which may be modified as the research progresses (Erlandson et al. 1993; Yin 1993; 1994).

Yin (1994:13) proposes that 'the case study as a research strategy comprises an all-encompassing method – with the logic of design incorporating specific approaches to data collection and to data analysis. In this sense, the case study is not either a data collection tactic or merely a design feature alone (Stoeker, 1991) but a comprehensive research strategy' (cf. Stake 1995). The case may be 'a single entity or phenomenon bounded by time and activity (a program, event, process, institution, or social group) …during a sustained period of time' (Cresswell 1994:12).

Yin (1994:13) adds that the case study method is a strategy that:

- copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as a result
- relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as a result
- benefits from the prior development of theoretical propositions to guide data collection and analysis.

Furthermore, 'in general use, case studies are the preferred strategy when "how" and "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context' (Yin 1994:1). The

present research has a large contemporary component as well as an historical component, and the case study is an appropriate method to handle both facets, because of its capacity to incorporate data derived from multiple sources (Yin 1994; Erlandson et al. 1993).

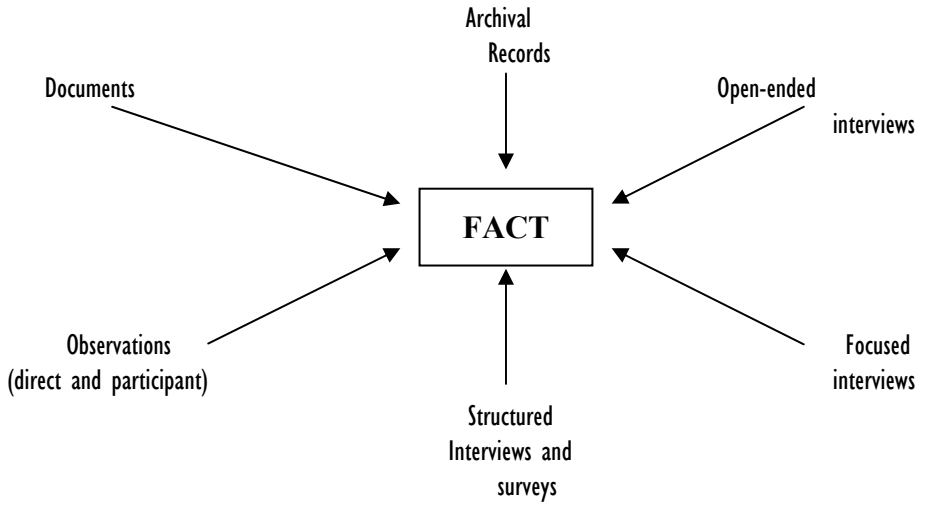
Yin (1994, p.78) also proposes that:

> evidence for case studies may come from six sources: documents, archival records, interviews, direct observation, participant-observation, and physical artefacts. In addition to the attention given to these individual sources, some over-riding principles are important to any data collection effort in doing case studies. These include the use of (a) multiple sources of evidence …converging on the same set of facts or findings; (b) a case study database, that is, the formal assembly of evidence distinct from the final case study report; and (c) a chain of evidence, that is, explicit links between the research questions asked, the data collected, and the conclusions drawn.

I address elements (b) and (c) in Section 4.10.2, but for now I focus my attention on (a), the principle of converging multiple sources of evidence. Yin's (1994:93) model of convergence of multiple sources of evidence in a single case study design is presented as **Figure 1(b)**. It reflects the principle of data triangulation that has already been discussed in a previous section – a principle that is implicit in the conceptual model of my study design shown earlier in **Figure 1(a)** and explicit in **Figure 1(c)** presented in Section 1.8.

To put it simply, the principles of triangulation are essentially the same as the logic employed in legal proceedings in which a defendant is judged guilty or not guilty on the basis of multiple types of evidence from multiple sources *converging* on a finding that is "beyond reasonable doubt".

Figure 1(b): Model of Convergence of Multiple Sources of Evidence (Single study example)



Source: Yin (1994:93)

Yin (1994) further advises that once the researcher has determined that the research problem is amenable to investigation using the case study method (and indeed, that it is deemed to be the most appropriate method), (s)he needs to define what actually constitutes "the case" and what are the boundaries of the study so that the data elements pertaining to the immediate topic of the study – the phenomenon of interest – can be distinguished from those relating to its context.

My initial impression was that a hospital represented "a case" in this study. However, on further consideration, I have determined that a hospital is a *research site* – the context of my study from which I can elicit important contextual data – and that the immediate topic of the study (ie. "the case") is the phenomenon of the process and consequences of the adoption of new intra-operative artefacts within the operating theatre service of an individual hospital. Five sites (hospitals) and hence, five "cases" constitute this *collective case study* (cf. Stake 1995).

1.7.2 Multiple cases in a single study – the collective case study

Stake (1995) proposes that decisions concerning how many individual cases should be studied will be influenced by the type of interest the researcher has in the phenomenon. He distinguishes *intrinsic interest,* in which the researcher's interest is limited to learning only about a particular case, from *instrumental interest* in which the researcher starts with 'a puzzlement, a need for general understanding' (Stake 1995:3) about some phenomenon and determines that an insight might be gained by studying a particular case. He proposes that if the researcher has an *instrumental interest* in the phenomenon, (s)he might decide that a better understanding of the phenomenon could be achieved by studying more than one case – and he assigns the term, *collective case study*, to this approach. This is different to a multiple case study in the sense that the collective case study might not analyse each case individually (cf. Yin 1994), but rather pools the data from all cases in order to build a more substantive body of evidence than might be possible from a single case. However, most of the principles described by Yin (1994) concerning multiple case studies are relevant to collective case study design. For example, Yin (1994:45) argues that:

> multiple-case designs have distinct advantages and disadvantages in comparison with single-case designs. The evidence from multiple cases is often considered more compelling, and the overall study is therefore regarded as being more robust. [However, because] the conduct of a multiple-case study can require extensive resources and time beyond the means of an …independent researcher …the decision to undertake multiple-case studies cannot be taken lightly. Every case should serve a

> specific purpose within the overall scope of inquiry. Here, a major insight is to consider multiple cases as one would consider multiple experiments – that is, to follow the "replication" logic [which] says [for example] that if three cases are studied, and similar results are obtained from all three, replication has occurred.

Replication can relate to either the similarities and/or differences between the cases – a *literal replication* from predicted similar results or a *theoretical replication* produced by contrasting results but for predictable reasons (Yin 1994). Either way, Yin advises that a rich theoretical framework needs to underpin this replication logic, and that this framework 'later becomes the vehicle for generalising to new cases' (Yin 1994:46). In these and other ways, Yin treats the case study method as a *de facto* experimental design. In so doing, he defends the case study's capacity to be used for *explanatory purposes,* both in terms of explanation-building and the development of rival explanations, in addition to its more accepted exploratory or descriptive purposes.

The longstanding debate concerning naturalistic inquiry versus logical positivist research can be accredited with the now weakening view that case studies are only an exploratory tool and not a vehicle to describe or test propositions (Platt 1992 cited by Yin 1994:3). In defence of case studies' explanatory capabilities, Yin explains how the method of generalisation employed in the case study method is *analytic generalisation*, 'in which a previously developed theory is used as a template with which to compare the empirical results of the case study' (Yin 1994:31).

Furthermore, he observes that:

> analysts fall into the trap of trying to select a "representative" case or set of cases. Yet no set of cases, no matter how large, is likely to deal satisfactorily with the complaint. The problem lies in the very notion of generalising to other case studies. Instead, an analyst should try to generalise findings to "theory", analogous to the way a scientist generalises from experimental results to theory …[T]he scientist does not attempt to select "representative" experiments (Yin 1994:37).

I determined that the present study should be a *collective case study* because of my *instrumental interest* in a number of phenomena (Stake 1995). Each of the cases in the "collection" has been purposefully selected on the basis of specific contextual differences (Marshall & Rossman 1999; Yin 1994), using, among other criteria, the "representativeness" criterion (Yin 1994). Initially, the between case replication logic described by Yin (1994) is applied to the analysis and reporting of much of the quantitative data. However, the quantitative data from each "representative" case are subsequently aggregated to become

some of the multiple sources of evidence in the between-methods data triangulation for the collective of cases. These matters are fully described in Chapter 4.

1.8 Introductory overview of study methods

The notion of the convergence of data from multiple sources was presented diagrammatically in **Figure 1(b)**, and is now expanded in **Figure 1(c)** to summarise the multiple sources of evidence and the mixed methods that are used in the present research. Chapter 4 offers a detailed discussion of the rationale for the choice of data sources and the methods employed in their collection and analysis, so, my purpose here is simply to provide the reader with a sense of the overall scheme of the research process.

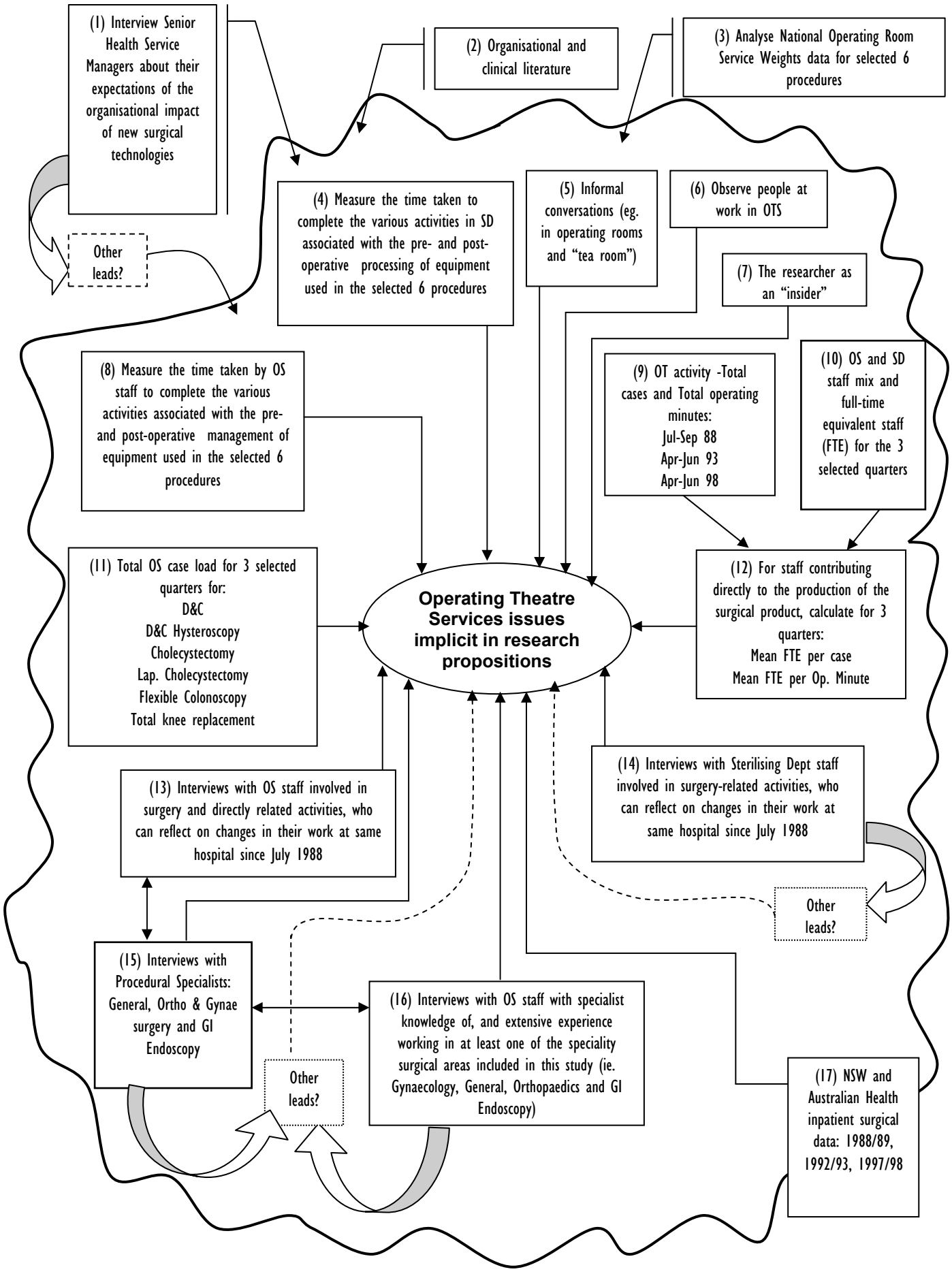
The model distinguishes data sourced from within operating theatre services (shown in Boxes 4 to 16 contained within the "circle") from data sourced from outside operating theatre services (see Boxes 1 to 3), and data sourced from either (see Box 17). It reveals how various qualitative and quantitative data constitute the "multiple sources of evidence" in the study.

Within OTSs, qualitative data collection methods included interviews, informal conversations, participant observations, and critical observation of both the six procedures selected for detailed study and the technologies employed generally in surgical production.

Three categories of OTS personnel were interviewed: operating theatre nurses (see Boxes 13 and 16), sterilising department technical aides (see Box 14), and procedural specialists (see Box 15). Anyone working within OTSs had the potential to be an informant via informal conversations, or otherwise to be observed in the course of his/her work (see Boxes 5 and 6).

Quantitative data were collected from OTS staffing rosters (see Box 10) and the *OTS Surgical Registers* (see Boxes 9 and 11) for the three month periods at the beginning, middle and end of the ten-year study timeframe. Staffing rosters were used to derive "full time equivalent" (FTE) staffing levels (see Box 12). The data collected from the surgical registers containing records of all surgical procedures were used to initially derive, for each three-month period at each of the five hospitals: (i) the total number of all procedures undertaken; (ii) the total time taken to perform all procedures (ie. total operating minutes); (iii) the frequency of each of the six selected procedures; and (iv) the total operating minutes for each of the six selected procedures. Furthermore, for each of the six procedures, a time study of all of the pre- and post-procedure human labour input to their production (see Boxes 4 and 8) was conducted.

Figure 1(c): Conceptual model of multiple sources of evidence in this study



External to OTSs, the only qualitative data were those derived from the interviews conducted with top health service managers (see Box 1). Quantitative data included the Likert-scaled responses by managers to a survey questionnaire, and a multitude of data sourced mainly from the NSW and Commonwealth Departments of Health pertaining to surgical activity in acute public and private hospitals and other related data (see Boxes 3 and 17).

Consistent with processes represented in **Figure 1(a)**, this model, **Figure 1(c)**, also shows how the empirical and descriptive literature constituted data (see Box 2), along with the tacit knowledge that I, as an "insider", brought to the study (see Box 7).

1.9 Limitations of the study

In naturalistic research, the context in which that research is conducted is generally acknowledged to limit the transferability of the results to other contexts. However, the preceding discussion has presented Yin's (1994) case for *analytic generalisation* as a technique whereby a multiple case study's conclusions may be transferable to other cases. I believe that the techniques employed in this collective case study, combined with the pervasive environmental characteristics of the Australian health care system across all states and territories, give this study a degree of transferability beyond that which is customarily attributed to naturalistic research.

However, the Australian health care system can be differentiated from other western health care systems in numerous ways, and several characteristics are of significance to this thesis. First is the fact that health care in Australia is available in public hospitals, which provide over 70 per cent of all hospital beds, to all residents under a universal health insurance system, Medicare (Duckett 1998; Donato & Scotton 1998). Secondly, individuals may also elect to purchase private health insurance which will cover most of the costs of treatment in private hospitals. Furthermore, procedural specialists are predominantly non-salaried, and yet the public and private hospitals in which they carry out their diagnostic and therapeutic procedures provide (with rare exceptions) at no cost to them, all of the necessary equipment and support staff (Richardson 1990; Richardson, Smith, Milthorpe & Ryan 1991; cf. Mooney 1998). These various issues are discussed in detail in Chapter 2. Suffice it to say at this juncture that the study's transferability must be limited to the Australian context. This necessarily precludes the health care system-specific conclusions from being generalised to other countries, although the technology-specific conclusions might have wider applicability. However, the theoretical conclusions are generic in nature.

The other limitation of the study relates to the boundaries that I have, by necessity, placed on the technological issues that have been explored. I have already described the inclusiveness of the research problem in terms of its focus on the characteristics and roles of intra-operative artefacts, the receivers of the artefacts, and those who have key roles in the new intra-operative artefact adoption decision process *within individual hospitals*. But it is also important to articulate what aspects of new surgical technology adoption are excluded. This thesis does not research issues concerning either the efficacy of the surgical technologies (ie. how effective they are in producing benefit to patients), their cost-efficiency relative to other modes of treatment for a similar condition, or the opportunity costs of acquiring one surgical artefact technology over another. Furthermore, it does not seek to explore the innovation or diffusion processes *per se* or, for example, how research and development firms influence the new intra-operative arefact adoption process in hospitals. However, cognisant of the fact that these issues have a bearing on the issues that are central to the present thesis, they are briefly discussed in Chapter 2 in the course of my examination of the literature concerning the various surgical procedures.

1.10 Overview of thesis chapters

This chapter has provided an introduction to the topic of the present thesis: its purpose, questions, propositions, significance, methodology and limitations. It has detailed how the principal proposition of this research has been investigated in an overarching *inductive* manner using the methods and assumptions of the *naturalistic* paradigm. Furthermore, it has detailed how the second proposition has been investigated using the methods and assumptions of the *positivist* paradigm. Although minor in terms of the proportion of the thesis devoted to it, the positivist paradigm outcome is no less significant than any other conclusion reported herein. During the course of my discussion of the paradigm issues I defended the mixed methods, mixed methodology research design and presented a synthesis, by way of a conceptual map, of how this approach has been employed throughout the research process. This was followed by a justification of the collective case study method as the "best" method to explore the research problem, and a brief introductory explanation of the methods employed in the study. Overall, it has provided important background to the rationale for the research design and methods, and to the transferability and limitations of the results of the present thesis.

Chapter 2 is a product of the 'interactive, circular process of [literature review], data collection, data analysis, and design review' (Erlandson et al. 1993:70-71). It provides details of the study's national and local context, and discusses aspects of the evolving structure of

the Australian health care system, characteristics of hospitals and their workforce, tools of management, and the evolutionary characteristics of the surgical processes and related surgical technologies that are relevant to this research. Arising from the latter, the chapter presents a foundational set of terms that are used throughout the present thesis. These terms form the basis of my model of the *classification of surgical technologies and their process relationships in surgical production*, which is one of the theoretical contributions of the thesis. The chapter also introduces and describes various aspects of the six surgical procedures selected for detailed analysis. It concludes with a brief introduction to the characteristics, roles and responsibilities of the four key internal stakeholder groups that are informants in this study, along with some pertinent inter-professional issues.

Chapter 3 concentrates on reviewing the empirical literature that provides the theoretical foundation of the dominant paradigm conclusions of the thesis. It reviews theories and perspectives from a number of social science disciplines, such as organisation theory, industrial sociology, decision-making in organisations, and micro-economics, as they relate specifically to influences on organisations' choices of artefact technologies, the new technology adoption decision process, and the consequences of new technology adoption in organisations. It includes an examination of the socio-technical and organisational research literature dealing with the environment-technology-structure relationship within both society at large and organisations. During the course of the research, a number of other theoretical areas were also explored. Some, such as labour process theory and feminist perspectives on technology, are briefly discussed as a way of demonstrating that I recognise that no phenomenon has a single explanation, and that the perspectives that I have emphasised in the present thesis reflect decisions I have made about the relative value of each to my research goals. These decisions were not made *a priori*, but rather they evolved *inductively* as part of the 'interactive, circular process of data collection, data analysis, and design review' (Erlandson et al. 1993:70-71) that characterised this research.

Chapter 4 details the specific methods employed in this collective case study. It explains the rationale for the ten-year study timeframe and the selection of research sites, informants and data types. It describes how the various qualitative data (ie. unstructured and semi-structured interviews, direct observation, and informal dialogue) were collected, collated and analysed, and explains how the principles of inductive analysis were employed during the data collection phase. It also explains how I used the qualitative analysis computer software, HyperRESEARCH™, in the deductive analysis of interviews. Furthermore, the chapter describes the purpose and content of a Likert-scaled questionnaire that top health service

managers completed in the course of their semi-structured interviews. It details how the quantitative data (ie. organisation activity and staffing data, departments of health data, perioperative work time study data, and questionnaire data) were collected and collated, and analysed using descriptive statistical analysis techniques. Subsequently, it explains how the principles of data triangulation were applied, culminating in the study's dominant (*naturalistic*) paradigm conclusions. Before concluding the chapter with an overview of the research's ethical aspects, it discusses the characteristics of the research that demonstrate the rigour of the investigative process and the trustworthiness of the findings reported and discussed in this thesis.

Chapter 5 commences with an overview of the characteristics of the five study hospitals and their activity relative to each other and all NSW hospitals. It then proceeds to describe the technologies used in the intra-operative and perioperative phases of producing the six selected procedures. These descriptions are a product of the research process. They provide the contextual background for analysis of both the volume of human labour input to producing these procedures and the changes resulting from new intra-operative artefact adoption between 1988 and 1998. Although data for individual hospitals are presented, most of the analyses use aggregated data to identify trends that might be representative of operating theatre services throughout NSW. Finally, the chapter analyses the current Australian estimates of the human labour costs associated with producing the six procedures within operating theatre services. The conclusions, which are sometimes discussed in conjunction with relevant qualitative data, represent the secondary (*positivist*) paradigm outcomes of the present thesis.

Chapter 6 presents the *naturalistic* paradigm results and conclusions of the present research concerning the goals, the choice-making process, the characteristics of technological change, and the consequences for surgical production within operating theatre services in hospitals of the adoption of new intra-operative artefacts. It provides a "thick description" of technological change in surgery in NSW operating theatre services between 1988 and 1998, and culminates with a discussion that brings together the evidence in support of the dominant paradigm proposition of the present thesis.

Chapter 7 concludes the thesis with a review of its principal findings and associated conclusions, an overview of its theoretical and practical contributions, and some recommendations for future research.

Chapter 2

Study Context

2.1 Introduction

This chapter provides the contextual background to the health services' organisational, technological, and human issues that are relevant to the present thesis. Most of the chapter takes the form of a literature review but, consistent with the description of the research process presented in association with **Figures 1(a)** and **1(c)**, this background has also been informed by the research process and my personal professional experience in operating theatre services. The chapter is structured to first describe the macro level Australian health services' structural and financing issues, and then to progressively work through to the micro level issues concerned with operating theatre services' key internal stakeholders.

It commences with a snapshot of the Australian health care system that provides the politico-economic and organisational backdrop against which the technological changes occurring in surgery and the management of operating theatre services can be understood. It explains the differences between the goals and operation of public and private acute hospitals in Australia and highlights some characteristics of the Australian health care system that influence patterns of new intra-operative artefact adoption.

The chapter then focuses on the structural aspects of acute hospital services within NSW, the focal state of the present thesis. It presents both a comparison of NSW public and private acute hospital activity and an overview of trends in acute public hospital provision of surgical services during the study timeframe, 1988-1998. Evidence is provided that changes in surgical technologies, whilst contributing to increases in health care costs, have contributed to significant reductions in the average length of hospital stay of surgical patients.

The chapter continues with a section devoted to the concept of *technology* and the topic of *health care technologies*. It commences with a brief background to innovation in medical practice, which leads into a review of the literature pertaining to some of the complexities associated with defining the concept of *technology*. The outcome of this discussion is a foundational set of terms that are used throughout the present thesis. These terms form the basis of my model, the *classification of surgical technologies and their process relationships in surgical production*, which is one of the theoretical contributions of the thesis.

This is followed by a brief examination of some of the historic antecedents of modern surgery, with the emphasis on changes occurring since the late 1980s. Particular issues of interest at this juncture are the nature and the clinical objectives of technological change in surgery, and the ramifications for hospitals of the changes. The literature dealing with

influences on new intra-operative artefact adoption by procedural specialists is then examined, followed by an brief overview of two Australian studies by Brewer, conducted during the 1980s, that explored the impact of new medical technologies on work, particularly nursing work, in hospitals. I then explain how the results of an exploratory study that I conducted in 1996 of nurses' experiences of technological change in operating theatres provided much of the impetus for, and direction of, the present research.

The procedures selected for detailed study are introduced at this juncture in the interest of coherence. This is followed by an overview of methods used in hospitals to quantify their production costs and to evaluate hospital efficiency and employee productivity, particularly in relation to operating theatre services. Techniques employed by the Australian Government to classify all types of procedures, and to determine their relative production costs, are then explored.

Finally, additional contextual background is provided by way of a description of the nature and role of operating theatre services in acute hospitals and a brief examination of the closed workplace characteristic of operating theatre services. The chapter concludes with introductory remarks about hospitals as professional organisations which provide the context for an examination of the characteristics of the key provider stakeholders in surgical production within operating theatre services, their new intra-operative artefact *receiver* status, and some pertinent inter-professional issues.

2.2 The Australian Health Care System: Structure, costs and financing issues

In the international context, the Australian health care system is a unique blend of public and private sectors in both the funding and structure of its health services. In 1997/98 total health care expenditure amounted to $47.3 billion, of which about 69 per cent was from public sources (AIHW 1999). During the ten-year timeframe of this study, total health expenditure in Australia ranged from about 7.5 per cent of GDP in 1988/89 to 8.3 per cent of GDP in 1997/98 (AIHW 2000; Duckett 2000). Increases in relative spending during the preceding ten years (AIHW 1994) provided the catalyst for academic interest in its causes, and efforts by governments to prevent further increases. Health care spending continues to be a major concern of governments in Australia.

For example, rising health care costs in the western world during the 1970s sparked a strong interest in research by economists into the possible relationships between rising health care expenditures and other system characteristics. Of particular interest were new health care technologies; systems of health insurance, including the effects of 3rd party payments and the

public provision of health care; and the agency role of doctors (Scitovsky 1985; Weisbrod 1991; Doessel 1992; Mooney 1992; Folland, Goodman & Stano 1993; Gelijns & Rosenberg 1994; Connelly 1998). The cost-benefits of adopting certain technologies over alternative technologies also attracted a lot of attention (cf. Drummond 1981; 1987; Richardson 1991; Drummond & Mooney 1983; Drummond 1987; Gelijns & Rosenberg 1994). Scitovsky's (1985) pioneering study of health care costs in the USA over a period of twenty years to 1971 (cf. Doessel 1992; Folland et al. 1993) caused her to conclude that the net effect of changes in treatment were cost-raising.

Gelijns and Rosenberg (1994) have proposed three distinct mechanisms by which technology may contribute to rising health care costs: intensity of use, the introduction of new or modified technologies, and expanded applications of new technologies. However, they believe that new technologies need not increase health care costs, and argue that 'the way in which a new technology ultimately will affect costs depends on the manner in which it is incorporated into the larger system of medical care – how the profession chooses to use it and to modify it' (Gelijns & Rosenberg 1994:33-34; cf. Fett 2000).

In a similar vein, Folland et al. (1993:381-384) concluded that 'technological change may be cost-reducing when it improves the productivity of health care resources, or it may be cost increasing when it improves the quality of care or introduces new and costlier products'. However, Gelijns and Rosenberg (1994:33-34) are of the view that the modification of technologies and their application to other clinical uses 'ultimately leads to marginally beneficial applications that raise overall spending levels'.

In Australia, state governments, 'with varying levels of Commonwealth financial assistance, are primarily responsible for the funding and operation of public hospital services' (Donato & Scotton 1998:21). For example, in 1994/95, the Commonwealth contributed about $5 for every $4 contributed by state governments to the public hospital sector. Total expenditures of $10.2 billion represented 27.9 per cent of annual recurrent health care expenditure, which is the largest single category of health expenditure in Australia (AIHW 1997, in Donato & Scotton 1998:29). Expenditure by private hospitals accounted for an additional 6.9 per cent of recurrent health care expenditure (Donato & Scotton 1998:20).

Medicare, Australia's "universal health insurance system" is administered by the Health Insurance Commission and financed out of both general taxation and a 1.5 per cent levy on taxable income. Among other benefits, it provides access to public hospital care for all Australian residents at no charge (Clinton & Nelson 1998; Donato & Scotton 1998; Duckett 2000). However, individuals may also elect to purchase private health insurance which

'provides coverage for a range of services not included under Medicare, of which the largest component comprises accommodation costs in private hospitals' (Donato & Scotton 1998:24), mostly in conjunction with surgical services (Donato & Scotton 1998; Clinton & Nelson 1998). In 1998, the Private Health Insurance Commission estimated that approximately 32 per cent of the population was covered by some form of private health insurance (Donato & Scotton 1998).

By comparison with other western health care systems, these and other characteristics of the Australian health care system are most like the Canadian system, but quite different to the National Health Service of the United Kingdom (UK) and the predominantly private system in the United States of America (USA) (cf. Duckett 2000). The UK has an annual health expenditure of approximately 5.5 per cent of GDP, and most of its doctors and other health professionals are salaried to the Health Service Trusts. The USA, on the other hand, has an annual health expenditure approaching 15 per cent of GDP, combined with an estimated 37 million of its population uninsured by either private health plans or government-funded plans for the poor and chronically ill (Folland et al. 1993; Clinton & Nelson 1998).

2.3 Acute public and private hospitals in Australia

Operating theatre services (OTSs) in Australia are provided in the category of public and private hospitals that are known as *acute hospitals,* or in day surgery facilities. Day surgical facilities, a phenomenon of the last decade or so, have arisen as a result of technological changes that have occurred in anaesthesia and surgery (Duckett 2000). Broadly speaking, *non-acute* hospitals provide care for the chronically ill, the mentally ill, and the aged, and do not provide operating theatre services. The role of *acute* hospitals, on the other hand, is broadly to provide care to people during acute episodes of illness, which, by and large, require relatively short periods of admission to hospital (AIHW 1994; National Health Strategy 1991; Duckett 2000).

Acute hospitals vary in the variety (ie. *scope*) and complexity (ie. *level*) of health services they offer, and the majority of acute public hospitals provide surgical services. In the *public sector*, a hospital's level and scope of services are generally determined at a regional level on the basis of the anticipated volume and range of health services needed by the community in the geographical area it serves. At the same time, efforts are made to achieve some economies of scale by locating certain specialist services in a limited number of hospitals in a region, and possibly only in one hospital (NSW Health 1998a; National Health Strategy 1991).

In the *private sector* there is also an element of centralised decision-making concerning a hospital's scope and level of services, because most private hospitals are owned and operated by large corporations (The Parliament of the Commonwealth of Australia 1987; Productivity Commission 1999; Duckett 2000). Although a private hospital's executive manager will have a greater influence than his/her public hospital counterpart on the scope and level of services offered by his/her hospital, both have limited decision roles in these matters (Grant 1985; Duckett 2000).

Private hospitals can be either *for-profit* or *not-for-profit*, the latter category usually being operated by religious/charitable organisations. Their corporate goals vary slightly in that *for-profit* private hospitals are highly unlikely to offer any services for which they cannot achieve a profitable financial return, whilst *not-for-profit* private hospitals are inclined to offer some unprofitable services for altruistic reasons (The Parliament of the Commonwealth of Australia 1987). The public health sector, on the other hand, has a mandate to provide the necessary health services to the community regardless of whether some of those services can be operated profitably or not (cf. Grant & Lapsley 1992; National Health Strategy 1991).

Typically, private hospitals operate on a flexible budgeting model whilst public hospitals operate with capped budgets that are fixed annually by the states within the context of five-year funding agreements between the Commonwealth and State Governments (AIHW 2000). According to Donato and Scotton (1998:30), tight capping of public hospital expenditures is a manifestation of 'the stringent fiscal conditions prevailing at all levels of government in Australia (and on governments of most developed countries) since the early 1990s'. They see funding constraints and rising health care costs as being some of the main contributors to the emergence of long waiting lists for admission to public hospitals (mostly for surgery) in recent years (cf. Duckett 2000).

The period since the mid-1980s has been characterised by rapid increases in the relative cost of the provision of health services. Both in Australia and overseas, this has been largely attributed to the rapid growth in the availability and application of increasingly complex medical technologies which are generally expensive to acquire and operate (Newhouse 1988; Folland et al. 1993; Gelijns & Rosenberg 1994). However, these newer technologies have also been attributed with a dramatic change in diagnostic and treatment options, a phenomenon that has been accompanied by ever-heightening consumer expectations about their rights to access the latest technologies (Fett 2000). These technologies, particularly in surgery, have resulted in significant reductions in the length of time an individual spends in hospital. For example, the Australian national average length of stay (ALOS) decreased from

5.4 days in 1989/90 to 4.2 days in 1994/95 (CDHFS, in Donato & Scotton 1996), and by 1996/97 in NSW it was 3.6 days (NSW Health 1998b; 1998c). This trend prompted a strategy to reduce the number of beds in public hospitals. In fact, bed supply fell by about 25 per cent between 1989/90 and 1997/98 although, overall, there has been a rise in the actual number of people treated in hospitals (Duckett 2000).

Technologies are not the only significant costs associated with the delivery of hospital services. Health care is a service industry (cf. Coombs & Green 1989), and human labour usually represents a high proportion of hospitals' resources costs. However, the proportion has declined in NSW acute hospitals from around 70 per cent during the 1980s to 58.8 per cent in 1997/98 (NSW Health 1999b; cf. AIHW 1994). This is further indication of the relative increase in non-labour costs, concerning which new technologies have been attributed with being the main contributing factor (cf. Productivity Commission 1999). Strategies designed to manage resources costs are outlined in Section 2.6, but at this juncture the overview of NSW acute hospitals continues with an explanation of how they are classified according to their size, and the scope and level of services they provide.

2.4 Classification, size, scope and level of services of NSW acute hospitals

The NSW Department of Health uses eight categories to define its *acute public hospitals*. The classifications, as they were in 1998, are identified and defined in **Table 2(a)** along with 1996/97 data about the relative volume of hospital *separations* (ie. numbers of in-patient episodes of care – this being the number of people admitted to hospital then discharged, transferred to another institution, or died) occurring in each category. The classification descriptions that were used until 1992/93 to distinguish the four types of public hospitals in the present study (ie. A1, B1, B2 and C1 in **Table 2(a)**) are provided in **Table 2(d)**.

Acute private hospitals are distinguished only on the basis of size and ownership. Their average size nationally is 72 beds. Almost 41 per cent of NSW private hospitals are in the median range of 51-100 beds, whilst only about 16.5 per cent have more than 100 beds. The larger among them tend to provide a wider range of services, including obstetrics and "super-specialty" services such as cardiac surgery. Ownership ranges from large corporations to religious or charitable organisations (Productivity Commission 1999).

Table 2(a): Classification, definition and representation of types of NSW Acute Public Hospitals

NSW Acute Public Hospital classification	Definition of hospital classification	Proportion of total separations in NSW acute hospitals by category: 1996/97
A1 Principal Referral	Acute hospitals, treating over 25,000 acute casemix weighted separations per annum.	45.6%
A2 Paediatric Specialist	Establishments where the primary role is to provide specialist acute care services for children.	3.5%
B1 Major Metropolitan	Acute hospitals, treating between 10,000 and 25,000 acute casemix weighted separations per annum.	16.4%
B2 Major Non-Metropolitan	Establishments located in rural areas providing acute specialist and referral services for a catchment population from a large geographical area.	9.1%
C1 District Group 1	Acute hospitals, treating between 5,000 and 10,000 acute casemix weighted separations per annum.	9.0%
C2 District Group 2	Acute hospitals, treating between 2,000 and 5,000 acute casemix weighted separations per annum, plus acute hospitals treating less than 2,000 acute casemix weighted separations per annum but with more than 2,000 separations per annum.	8.7%
D1 Community Acute	Acute hospitals, treating less than 2,000 acute casemix weighted separations per annum, and less than 2,000 separations per annum, and with less than 40% non-acute and outlier bed days of total bed days.	3.6%
E Ungrouped Acute	Establishments which have a primary role in providing acute services, but have no logical peer within the state.	4.1%

Sources: NSW Health (1998d), pp.xvi, 4. One hospital from each of the four shaded categories, A1, B1, B2 and C1, is included in this study.

The latest available data pertaining to the study period with which to compare the activity of acute public and private hospitals in NSW is for the 1996/97 year. **Table 2(b)** compares the two sectors on a range of measures. Overall, acute public hospitals provided 69.7 per cent of separations while using 75.4 per cent of all acute hospital bed days (NSW Health 1998b; 1998c). The data in **Table 2(b)** are for all categories of separations – both medical and surgical.

Table 2(b): Summary of NSW Acute Hospital activity 1996/97

1996/97	Number of separations	Number of bed days	Proportion same day separations	Average length of stay	Average hospital cost weight
NSW acute private hospitals	507,915	1,467,240	57.0%	2.9	0.9
NSW acute public hospitals	1,166,787	4,521,308	40.1%	3.9	1.04

Sources: NSW Health (1998b; 1998c).

In 1996/97, the NSW average cost per separation was approximately $2213.00, representing a *hospital cost weight* of 1.

Table 2(b) shows the relativities of the costs per separation in acute public and private hospitals based on their respective average costs weights, and the difference between 1.04 and 0.9 means that the average cost per separation in an acute public hospital is approximately $310 higher than it is in an acute private hospital. The background to cost weights, combined with their relevance to hospital management, is provided in Section 2.6.

Chapter 1 advised that sample data in the present study were collected for three quarterly periods over ten years. These periods were July to September 1988, April to June 1993, and April to June 1998, and the rationale for selecting these periods is explained in Section 4.2.1. The following tables, **Tables 2(c), 2(d)** and **2(e)**, provide data by which to compare acute public and private hospital activity during these periods. Very little data were collected by the NSW Department of Health during the 1980s, so the best available data for the approximate commencing period of this study are for the 1989/90 reporting year. Prior to this, area health services were only required to report financial and statistical data for areas as a whole (NSW Health Department 1989). It is only since the early 1990s that the number of surgical separations have been reported as a subset of all hospital separations, but neither average length of stay for surgical separations alone, nor the total cost of surgical separations, can be readily extracted from any data to date.

Table 2(c): NSW acute public hospital activity 1989/90

NSW Acute Public Hospitals	Hospital separations	Average available beds
TOTAL	990,158	22,729

Source: NSW Health Department (1990: 1, 8, 14, 21, 23, 28).

Tables 2(d) and **2(e)** present data for the four categories of acute public hospitals that are represented in this study. The "all other categories" group comprises the hospitals classified as A2, C2, D1, and E in **Table 2(a)**. The two tables respectively summarise the surgical activity for 1992/93 and 1997/98 in each of the four categories and in NSW overall, and indicate what proportion of all hospital separations were surgical. There is no marked change in the overall pattern of surgical activity between 1992/93 and 1997/98.

By comparison, there were 446,000 NSW private hospital separations in 1997-98 (representing about 27 per cent of all NSW acute hospital separations), whilst the 6476 available private hospital beds represented 30 per cent of all available NSW hospital beds (calculated from data in **Table 2(e)** and Productivity Commission 1999:142).

Table 2(d): NSW acute public hospital activity 1992/93

NSW Acute Public Hospitals	1992/93 classification description for study hospitals	Hospital separations	Average available acute beds	Number of surgical separations	Proportion of separations as surgical in each category
A1: Principal Referral	Principal Referral	351740	5114	88993	25.3%
B1: Major Metropolitan	District High	100162	1488	23034	23.0%
B2: Major Non-Metropolitan	Major Rural Base	78091	1187	23189	29.7%
C1: District Group 1	District Medium	241087	3637	73097	30.3%
All other categories		338,847	6252	73520	21.7%
TOTAL in NSW		**1,109,927**	**17,678**	**281,833**	**25.4%**

Note: The 1997/98 system of hospital classification is used throughout this thesis.
Source: NSW Health (1994b: viii-ix; 2, 10, 26, 34, 54).

Table 2(e): NSW acute public hospital activity 1997/98

NSW Acute Public Hospitals	Hospital separations	Average available beds	Number of surgical separations	Proportion of separations as surgical in each category
A1: Principal Referral	544,783	6472	121487	22.3%
B1: Major Metropolitan	223,329	2654	48,239	21.6%
B2: Major Non-Metropolitan	113,998	1437	31919	28.0%
C1: District Group 1	103,998	1374	30679	29.5%
All other categories	222,304	3427	54,069	24.3%
TOTAL in NSW	**1,208,412**	**15,364**	**286,394**	**23.7%**

Source: NSW Health (1999b: 4, 5, 18, 19, 52, 53, 64, 82).

Table 2(f): Relative distribution of surgical separations in NSW acute public hospitals 1997/98

NSW Acute Public Hospitals	Proportion of all NSW surgical separations performed in each category
A1: Principal Referral	42.4%
B1: Major Metropolitan	16.8%
B2: Major Non-Metropolitan	11.1%
C1: District Group 1	10.7%
All other categories	18.9%
TOTAL	**100%**

Source: NSW Health (1999b: 4, 5, 18, 19, 52, 53, 64, 82).

Table 2(f) summarises the proportion of all surgical separations that were performed in each category of public hospitals in NSW during 1997/98. It shows how the four categories of hospitals examined in this thesis accounted for 81.1 per cent of surgical separations in the

state's public hospitals, which, in turn, accounted for about 55 per cent of all surgical separations (cf. Productivity Commission 1999). Mindful that in NSW, acute public hospitals treat more than twice the in-patients than the acute private hospitals (refer to **Table 2(b)**), it is readily evident that surgical separations represent a substantially higher proportion of all private hospital activity (possibly more than 70 per cent) compared to the public hospitals' rate of 23.7 per cent in 1997-98, shown in **Table 2(e)**.

2.5 Health care technologies

It is necessary to preface this section introducing the topic of health care technologies with a clarification of some terms. "Medical technologies" is commonly used to refer to all of those health care technologies employed in the practice of medicine by doctors and in the provision of "medical care" by other health care professionals. However, "medicine" and "surgery" are two distinct branches within medical care, and this thesis focuses on the technologies employed in the specialist field of surgery as it is practised within *operating theatre services*. These technologies are referred to as *surgical technologies*.

2.5.1 History, theories and definitions

Innovations in medical care

Innovations in the diagnosis and treatment of illness are not unique to the last decade or century, but pervade all cultures and periods of human history. In our modern era, the volume of medical research and its accompanying literature is evidence of the ongoing nature of medical experimentation and changes/innovation in routine medical practice (cf. Gelijns & Rosenberg 1994). From time to time, major discoveries change the course of medical history. For example, Marie Curie's discovery of radium in 1898 was a forerunner to modern cancer treatments using radiation. Louis Pasteur's discovery of bacteria in the mid-19th century founded the science of microbiology with the "germ theory of disease". The discovery of penicillin in 1928 by Sir Alexander Fleming, its isolation in 1939 by the biochemist, Ernst Chain, and the antibiotic's subsequent development commercially under Sir Howard Florey, resulted in penicillin subsequently becoming the "big gun" in the pharmaceutical arsenal for the treatment of bacterial infections (Funk & Wagnall's New Encyclopedia 1983).

More recently, another significant medical milestone occurred in France. In 1987 a human gall bladder was surgically removed for the first time using a minimum access surgical (MAS) technique rather than the established "open" large incision approach (Brune 1996a; Hirsch 1994; Perissat 1993). This event was the forerunner of many of the recent changes in surgical technologies that constitute much of the focus of the present thesis. The

characteristics and importance of this procedure, known as *laparoscopic cholecystectomy*, are discussed in various places throughout this chapter.

However, prior to directing attention to surgical technologies in particular, it is necessary to explore how the concepts of "technology" and "health care (or medical) technologies" have been defined and described in the literature.

The concept of technology

The characteristics of *technology* about which there is the greatest consensus for definitional purposes are those that define technology in terms of both tangible (or physical) and intangible (or abstract) elements, and acknowledge technology's role in converting inputs to outputs. MacDonald (1983:27) summarised this well when he said that 'technology is really the sum of knowledge – of received information – which allows things to be done, a role that frequently requires the use of machines, and the information they incorporate, but conceivably may not'. This is consistent with Perrow's (1979) earlier conceptualisation of *technology* as techniques or tasks that may or may not involve the use of tools or mechanical devices.

In their paper, 'Organisations, Technology and Structuring', Roberts and Grabowski (1996) presented seven different definitions of "technology" from various sources to highlight the diversity of opinion on the topic. They cite the synthesis of Collins, Page and Hull (1986) who proposed that there are three coexistent and interdependent technologies that are used to convert inputs into outputs in the production sector: mechanical technologies, human technologies and knowledge technologies. Collins et al. (cited by Roberts & Grabowski 1996:411) suggest that *human technologies* consist of the skills and physical energy involved in production which have the potential to be replaced by mechanical technologies.

MacDonald (1983) highlighted the role of *knowledge technologies* with an example from agriculture. He posited that the innovative idea of crop rotation was probably a more significant technology than any other agricultural improvement in Europe during the eighteenth and nineteenth centuries. He suggested that when notions of technology being hardware-dependent are removed from one's thinking, it is not difficult to regard technology as simply 'the way things are done', or to think of technological change as 'the addition of new knowledge to old knowledge, usually to allow things to be done in what are thought to be better ways, and sometimes to do new things altogether' (MacDonald 1983:27).

The term, "medical technology" has been applied to technologies that are involved in both the 'clinical and administrative delivery of health services' (Geisler 1999:56), but the present

research is limited to clinical technologies – those that are categorically *health care technologies* (discussed following), exclusive of those employed in managing the health care environment (cf. Geisler 1999).

Health care technologies

Richardson's (1990:5) broad definition of new technology in health care 'as any change in the method or organisation of treatment' is consistent with MacDonald's generic definition, which describes technology first in *process* terms, and then in terms of the possible application of something tangible to the process.

The health economist, Doessel (1992), distinguishes changes in medical technology in terms of *product* and *process innovation*. Both potentially have physical and abstract elements. As his starting point, he uses Blaug's (1963) definitions whereby *process innovations* are 'novel ways of making old goods' and *product innovations* are 'old ways of making novelties' (Doessel 1992:17). Doessel (1992) limits his working definition of *product innovation* to the creation of a new product or service for a medical condition for which there was no prior product or service, and exemplified this with developments in the treatment of end-stage kidney disease. He proposed that the advent of renal dialysis represented *product innovation* because there had previously been no treatment available for the condition. However, he describes kidney transplants as a *process innovation* because it represents a new and different way of treating end-stage kidney disease. Hence, he regards "the product" as the treatment of end-stage renal disease, and it seems of no consequence to him that what he calls a process innovation (kidney transplant) involves very different techniques, hardware and outcomes.

More recently, Pusić (1998:73) used Tushman and Anderson's (1986) definitions when he described "*new process technologies*" as new 'tools, devices, and knowledge that mediate between inputs and outputs' (cf. MacDonald 1983; Collins et al. 1986), and changes in "*product technologies*" as 'new products or services', although not in Doessel's (1992) restrictive sense.

Brewer (1983) did not use the terms "process" or "product" in her study of "technological hardware" used by nurses, but she, nonetheless, categorised new technologies 'into two broad, but crude divisions within the hospital context' (Brewer 1983:13) that closely parallel Doessel's (1992) definitions. Her first category 'consisted of procedures and equipment which attempted to facilitate an existing task, eg. an electronic thermometer' – what Doessel (1992) would define as a *process innovation*. Her second category related to technologies that performed 'tasks which could not previously be done' (Brewer 1983:13) – a definition which

is consistent with Doessel's (1992) definition of a *product innovation*. However, the issue of what constitutes a task (or a therapy) that could not previously be done is a moot point, because Brewer (1986) exemplified this category with the electronic foetal heart monitor. Was she unaware that foetal heart sounds have been, and still may be, monitored (ie. listened to and recorded) by nurses using a simple metal foetal stethoscope and written records, or did she interpret the new electronic device as producing a different product/outcome, and hence, it is categorically a product innovation? If it is the latter, then there are subtle differences between Brewer's and Doessel's interpretations on this matter.

Cognisant of these ambiguities, I have elected to use MacDonald's (1983:27) conceptualisation of "technology" as 'the sum of all knowledge…' as my starting definition, and to distinguish the generally acknowledged physical and abstract characteristics of "technology" using Winner's (1977) trichotomous classification (explained below). Other classification schemes, such as Geisler's (1999) physical, information, and knowledge perspectives of technology, were considered in the course of my research, but Winner's (1977) approach was found to provide the most appropriate framework upon which to build my description and analysis of *surgical technologies*. Winner (1977:8-12) categorises tools, instruments, machines, and the like, as *apparatus*; skills, methods, and procedures as *techniques*; and rational-productive social arrangements as *organisation*. However, I have substituted the term *artefact* (cf. Geisler 1999 – any physical "thing") for *apparatus*, because the current meaning of "apparatus" is confounded by notions of it being 'a complex appliance' or 'an assemblage of instruments/machinery', whereas *artefact* refers to 'an object made by humans with a view to subsequent use' (*The Macquarie Dictionary* 1997).

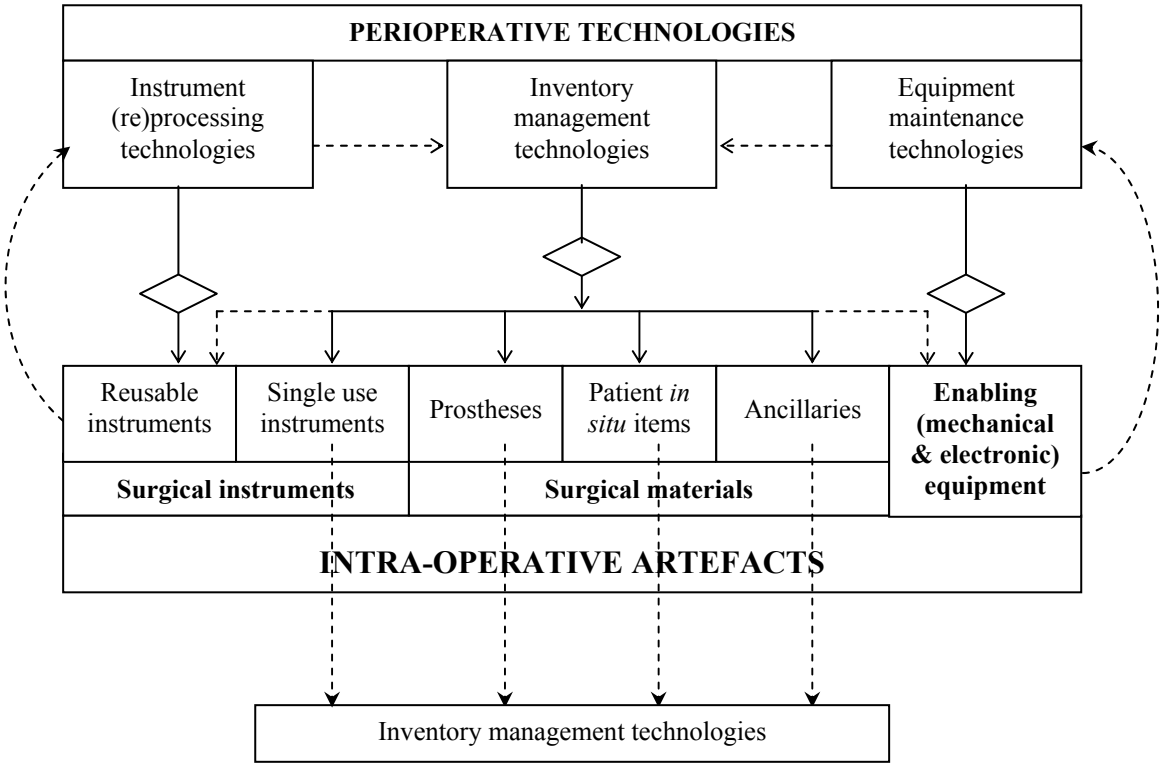
Using Winner's (1977) distinctions, the new instruments and related equipment that facilitated the first laparoscopic removal of a gall bladder can be described as *new intra-operative artefacts*, whilst the technology whereby a surgeon employs a new and different way of dissecting tissue without requiring any new artefact, would be referred to as a *new intra-operative technique*. Changes in the configuration of intra-operative artefacts and/or the work arrangements of staff in an operating room when new intra-operative artefacts are adopted would be referred to as *surgical re-organisation*. All three represent *technological change*.

Figure 2(a) provides a synthesis of my analysis of the *surgical technologies* that relate to the human activities that have been explored in the present research. The model, including its terminology and the definition of terms, is an outcome of the research process and one of the theoretical contributions of the present thesis. It is a representation of the process

relationships between the various *intra-operative artefacts* and *perioperative technologies*. The model is presented at this juncture to introduce the reader to both the terminology used throughout the thesis and the process issues that are central to the phenomena explored herein.

All perioperative activities associated with the use, maintenance and management of intra-operative artefacts are referred to as *perioperative technologies*. They may relate to the *artefact*, *techniques* and/or *organisation* aspects of technology. I have categorised them as: *instrument (re)processing technologies*, *inventory management technologies* and *equipment maintenance technologies*.

Figure 2(a): Classification of surgical technologies and their process relationships in surgical production



Because the present research did not explore the operative process *per se*, only one category of intra-operative technologies, *intra-operative artefacts,* is included in the model. *Intra-operative artefacts* are *surgical instruments*, *surgical materials*, and the associated mechanical and electronic equipment that I have called *enabling equipment*. Within the hospital, much of the enabling equipment would be referred to as "biomedical equipment", and I refer to the technologies involved in their between-use care and maintenance as *equipment maintenance technologies.* Intra-operative artefacts represent one category of what Geisler and Heller (1996:3) refer to as *medical devices* – 'the equipment, instruments,

machines, and other devices used for clinical diagnostics, clinical care and other medical and administrative functions'.

Surgical instruments are tools/implements manipulated by a member of the *operative team* during the operative phase of surgical production. They are predominantly reusable, in which case they require reprocessing using *instrument (re)processing technologies*. *Single use instruments*, often referred to as *disposable instruments*, are not reprocessed. They are resupplied via *inventory management technologies*.

Surgical materials are articles of any kind (exclusive of surgical instruments) that are manipulated by any member of the operative team during the operative phase of surgical production. I have categorised them as *prostheses*, *patient in situ items* and *ancillaries*. Definitions of these, and other key terms, can be found in Section 6.3.1 and Appendix E. Suffice it to say at this juncture that all types of *surgical materials* are used during only one procedure and are resupplied via *inventory management technologies*.

All elements in the model are discussed further in Section 6.3 where the qualitative evidence that guided the development of the model's content and structure is presented.

Before concluding this section, I refer to another useful means of differentiating technologies – one that has been identified and applied to medical technologies by Richardson (1990) and Richardson, Smith, Milthorpe and Ryan (1991). The first category is a *replacement technology*, whereby a new technology makes another obsolete – the new becomes a substitute for the old. The second category is an *alternative technology*. Here the old and the new technologies co-exist, for various reasons, as options. The third is a *complementary technology* – a case in which the new technology provides an enhancement on the old, which is still deemed necessary. These elements are present in varying degrees in each of the procedures (introduced in Section 2.5.4) that I selected for detailed analysis in the present thesis.

2.5.2 Surgery: History and technologies

Surgery, as a branch of medical practice, has been reported in the Egyptian, Greek and Roman literature, but the successful practice of surgery did not occur until recent centuries with the advent of safe and effective anaesthetic techniques (circa 1845) and Pasteur's discovery of bacteria. Pasteur's discovery influenced Lister when he formulated his theory concerning sepsis and antisepsis in the 1860s, thereby initiating a reversal in high incidence of the post-operative (and post-natal) infection that had plagued medical practice for centuries. This was achieved via "innovative" practices such as doctors washing their hands

under running water between examining or operating on different patients (McMillan 1966). However, a sixteenth-century French "barber surgeon", Ambroise Paré has, for several reasons, been accorded the title, "the father of modern surgery". His innovations included cauterising wounds with boiling oil and using ligatures on blood vessels to prevent haemorrhage (Funk & Wagnall's New Encyclopedia 1983; cf. Brune 1996a; 1996b).

However, throughout most of its history, surgery carried a high risk of intra-operative death, or subsequent gangrene, haemorrhage or infection. It was not until the 1940s that surgery became a widely accepted, safe mode of treatment for a wide range of medical conditions. The significantly reduced risk of post-operative complications, combined with the introduction of safer anaesthetic agents, subsequently resulted in a renewed interest in some of the diagnostic and therapeutic techniques that were tried years before, but not widely adopted. Consequently, the adoption and rapid diffusion since 1988 of MAS – often known as *minimally invasive surgery* or *keyhole surgery* (Hirsch 1994) – is not, by and large, the result of recently occurring innovation in surgical technologies. Rather, it has occurred because refinements in intra-operative artefacts since the late 1980s have resulted in such a high degree of safety in their application, and predictability in their outcomes for patients, that many of the techniques, which, in many cases had been documented in the medical literature decades earlier, have become the standard therapy for the medical conditions concerned (cf. Brune 1996a; Hobbs 1995; Mencaglia & Perino 1986). In other words, surgeons had envisaged innovative ways of performing certain procedures, but the surgical "hardware" and other supporting technologies were at too crude a stage of development to support diffusion of the techniques until recent decades.

For example, in the case of laparoscopic cholecystectomy, Brune (1996a:7) records that it was the outcome of a 'slow and tedious evolution which took nearly one century' because, in addition to the risks already mentioned, a number of technical problems needed to be resolved. *Endoscopy*, the technique of using an illuminated instrument to visualise internal body organs which had a natural orifice (such as the bladder, uterus and bronchus), has been practised since the late 19th century (cf. Johnstone 1990; Wood & Postma 1988; Menaglia & Perino 1986). In this connection, Mencaglia and Perino (1986:431) report that the technique of 'endoscopy began in 1805 with Bozzini', and that the second generation of endoscopes began in 1879 with Notze incorporating a light source inside an endoscope tube. The beginning of the 3rd generation (ie. the present generation) of endoscopy began around 1900, at which time, according to Brune (1996a), the first reported series of diagnostic laparoscopy occurred. Another milestone occurred in 1924 when Zollikofer from Switzerland inflated the

abdominal cavity with carbon dioxide instead of filtered air or oxygen so that he could use electrocoagulation to perform an intra-abdominal procedure during laparoscopy (Brune 1996a). The emergence of cold light fibreoptics in 1952 (Menaglia & Perino 1986; Gelijns & Rosenberg 1994) and subsequent refinements in optical technologies made possible the development of flexible endoscopic instruments during the late 1960s, and more recently, the transmission of high-resolution images via an endoscope onto television screens.

These are all landmark events that, with the application of digital technologies to intra-operative enabling equipment, came together in 1987 with the first operation in France to remove a gall bladder laparoscopically (Perissat 1993). Within four years, laparoscopic cholecystectomy had replaced conventional open surgery in the elective treatment of gall bladder disease (Barkun et al. 1993; Williams, Chapman, Bonau et al. 1993). Zucker (1992:297) viewed the 'rapid and widespread acceptance of laparoscopic cholecystectomy [as being] without precedent in modern surgical history'. Such a dramatic change in the standard mode of surgery is all the more significant when, as Zucker (1992:297), a medical doctor, pointed out, 'tens of thousands of general surgeons throughout the world… returned to the animal laboratory or spent long hours working beside experienced colleagues to learn the intricacies of laparoscopic surgery', a technique most had never used before. Such was the magnitude of its impact.

In an early report on the diffusion of MAS, Hirsch (1994:3) reported that:

> minimal access surgery has significant potential advantages over open surgery. In an open operation, not only is there a large wound, but retraction, handling and direct trauma by instruments cause tissue damage, exposure, cooling and drying of the internal structures. The consequences are post-operative pain, hospital stays which are often over a week, and prolonged convalescence, which is often up to six weeks. …A major advantage of MAS is that by minimising the size of the wound it also reduces post-operative trauma, thereby shortening hospital stays and convalescence. For example, many patients can be discharged from hospital one to two days after laparoscopic cholecystectomy and typically return to work or normal activity within a week. Comparable periods for the open surgery alternative were discharge seven days after operation and return to normal activities in six weeks… The use of laparoscopy was well established in gynaecology in the 1970s, but major surgical applications in laparoscopy, arthroscopy and hysteroscopy were established in the early 1990s. …The application of laparoscopic or "keyhole" surgery to general surgery is one of the most significant of these developments.

MAS techniques have now been adopted in most surgical specialties including general surgery, gynaecology, orthopaedics, neurosurgery, cardiovascular, thoracic, urology and plastic/cosmetic surgery (Zucker 1992; Champion & McKernan 1996; Durtschi 1993; Proot et al. 1996; Stuart et al. 1995; De Salles & Lufkin 1997; Goldenberg et al. 1997; Vogt et al. 1997; Moll et al. 1998; Vigneswaran & Podbielski 1998; Wadley et al. 1999). Concurrent developments in medical imaging technologies have contributed to some of these changes. For example, some previously open surgical procedures, particularly in cardio-vascular and neurological surgery, are now performed in a MAS manner within conventional operating suites, medical imaging departments, or in specialist interventionist centres (Hamlin 1999; Laerum, Borchgrevink & Fayelund 1998). Hamlin (1999) cites recent developments in intraluminal aortic bypass surgery and frameless stereotactic neurosurgical procedures as examples of procedures that are best performed in the medical imaging department, where the necessary sophisticated fixed radiological equipment is located (cf. Apuzzo 1996; Rosenfeld 1996; De Salles & Lufkin 1997; Wadley et al. 1999). Moreover, it has been standard practice for over ten years for an endoscopic procedure known as ERCP (Endoscopic Retrograde Cholangiography), performed in conjunction with gastroscopy (Rhodes, Sussman, Cohen & Lewis 1998), to be undertaken within medical imaging departments by the specialist endoscopy doctors and OS nurses.

Enhancements continue to occur in the intra-operative artefacts used in MAS procedures, and most recent endeavours appear to be attempting to redress some of the human-technology interface and ergonomic problems experienced by surgeons in the application of MAS technologies (cf. Satava & Ellis 1994; Schurr et al. 1995; Troccaz & Delnondedieu 1996). However, I could find no evidence in the literature that the labour process impact of these technologies on OTS nurses and technical aides is being considered by their developers independently of changes necessitated for infection control purposes.

In 1996, a report to the Australian Government raised concerns about the fact that the cost savings expected in the national health budget from developments in MAS were not being realised (Commonwealth of Australia 1996). Where had such expectations come from? Overseas studies, for example, showed that the new procedures were cost-effective from a social welfare gain perspective (Bass, Pitt and Lillemoe 1993), but most expectations of savings accruing to hospitals from shorter stays have not been realised (Bass et al. 1993). A case in point is that in Australian acute private hospitals, with their dominantly surgical casemix, ‘average per patient cost rose by just under 8 per cent in real terms between 1991-92

and 1997-98. Higher non-labour costs – due in part to technological changes – were the major drivers of this increase' (Productivity Commission 1999:xiv).

Gelijns and Rosenberg (1994) cite a 1993 analysis by Legurreta et al. that concluded that laparoscopic cholecystectomies had reduced the unit cost of cholecystectomy by 25 per cent, mostly because of shorter hospital stays, but that the wider-spread application of the new technology had resulted in an increase in total expenditures on cholecystectomies, thereby contributing to the rising national health care expenditure. In Australia, the average length of stay in 1996/97 for laparoscopic cholecystectomy was 3 days (compared to 8.2 days for open cholecystectomy) (CDHAC 1999a), whereas one English study reported about 50 per cent of laparoscopic cholecystectomies were done on a day case basis (Prasad & Foley 1996).

In 1997/98, 51.5 per cent of elective surgical separations in NSW public hospitals were categorised as "same day separations" (NSW Health 1999b), an increase from 28.5 per cent in 1992/93 (calculated from NSW Health 1994b). However, there has been no concomitant decrease in the average cost per episode of care. It appears that the substantial savings that are being made from reduced lengths of stay are being cancelled out by increased OTS costs. The key OTS budget areas are capital (ie. all artefact technologies), recurrent costs and human resource costs, and, as was previously mentioned, managerial strategies concerned with controlling OTS costs necessarily focus on these "factors of production".

In review, my examination of health care technologies has so far overviewed the history and impact of innovation in technologies in health care generally, and in surgery, in particular. It has been unavoidable that the discussion has dealt largely with the diffusion of MAS technologies, but it is important to note that innovations in intra-operative artefacts have not been limited to these types of technologies. In fact, of the four categories of procedures studied in detail in the present thesis, three employ MAS technologies, whilst one, total knee replacement, is a conventional open surgical procedure that has undergone technological change during the study period.

2.5.3 New technology adoption in hospitals

Influences on new surgical technology adoption by procedural specialists

This subsection commences with a brief look at the role of *procedural specialists* in the development of new surgical technologies and then examines the reasons why new surgical technologies are adopted. It is important to highlight at this juncture that my interest in new intra-operative artefacts starts at the point when they are commercially available for adoption.

Gelijns (a medical doctor) and Rosenberg (an economist) (1994:31) have drawn attention to what they refer to as 'a serious misconception' that the development of a new medical technology ends with its adoption into clinical practice. They highlight that medical devices (such as intra-operative artefacts) are characterised by high levels of incremental change, and that 'actual adoption constitutes only the beginning of an often prolonged process in which important redesigning takes place [by way of] feedback of new information generated by users'. Consequently, many procedural specialists are actively involved with biomedical scientists in the research and development activities that both precede and follow the adoption and diffusion of new surgical technologies (cf. Geisler 1999). Indeed, 'they develop as they diffuse' (Geisler & Heller 1996:134). Referring to medical innovations generally, Gelijns and Rosenberg (1994:30) have observed that this is contrary to the 'popular perception [that] medical innovation is one in which a group of biomedical scientists has a bright new idea, which then moves in a linear progression from the laboratory to animal models, to select populations, and finally to the bedside'. They say that although a considerable proportion of medical innovation occurs in this way, it is least likely to occur in this linear fashion where artefact innovations are concerned.

To exemplify this, mention was made earlier of the significance of the emergence of cold light fibreoptics in 1952 to the types of MAS procedures that are now possible because of the constant process of refinements that have occurred in the intervening years. These refinements are actually the result of the continuous interplay between users (procedural specialists, in particular) and the biomedical research and development personnel. In the words of Gelijns and Rosenberg (1994:31): 'these modifications have resulted in improved flexibility, manoeuvrability, miniaturisation, and visibility, and have vastly expanded the therapeutic possibilities of endoscopy'. This dynamic evolutionary characteristic of developments in intra-operative artefacts is an important factor in the present thesis.

So far as the decision to adopt a new surgical technology is concerned, Escarce (1996:716) reported that procedural specialists' abilities 'to alter their diagnostic and treatment practices to adapt to the constantly changing technological environment…depend on acquiring and processing information about the clinical value and profitability of new technologies and practices'. Among factors that influence them are: (a) weighing up the clinical risks against the potential benefits; (b) the likely personal cost of up-skilling; (c) the likelihood of mastering the technology; and (d) taking a gamble on potential patient demand (Escarce 1996). A report to the Australian Government in 1996 also identified that commercial pressures associated with a possible loss of "market share" have contributed to the adoption

of new surgical technologies by some surgeons who might otherwise have been reluctant to do so (Commonwealth of Australia 1996).

Apparently, there are a number of sources of information that influence procedural specialists in their new technology adoption behaviour. These include professional journals, meetings and conferences, and informal discussions with peers (Escarce 1996).

Developers of new technologies have traditionally regarded procedural specialists as the principle users and, hence, the principal decision-makers concerning the adoption of new technologies because of their important role as agents for their patients (cf. Mooney 1998). Consequently, once new intra-operative artefacts are commercially available, procedural specialists have been among the key targets of marketing strategies. Gelijns and Rosenberg (1994) observed that in the USA, which is dominated by the private hospital sector, the demands of other stakeholders, such as hospital administrators, 3rd party payers and industry regulatory bodies, are increasingly being recognised by research and development firms as influencing new technology adoption decisions. This, in turn, is putting pressure on them to direct incremental improvements, not just at enhancing performance in accordance with the clinical needs of the procedural specialist, but also at redesigning to reduce costs.

Brewer's Australian research on new technology adoption in hospitals

During the 1980s, Brewer (1983; 1986) reported on two studies that investigated issues concerning new medical technology adoption in Australia and the labour process implications of those new technologies. Despite some similarities between the phenomena she studied and the present research, there are two important differences. First, individuals working in operating theatre services were not among her study informants (although one small group of informants in the 1986 study worked in a cardiac catheter laboratory, where procedures were undertaken under surgical conditions). Secondly, the technologies identified by her informants were limited – in the 1983 study, to 'instruments and electronic devices used specifically by nurses' (Brewer 1983:13) and, in the 1986 study, to "equipment" used by various health care professionals, but mostly nurses, working in hospitals (Brewer 1986:25-27).

Four of the objectives of her second study (Brewer 1986) reflect aspects of a research problem that are similar to the problem explored in the present research. Among other things, she investigated: the decision-making processes employed in the introduction of new technologies; the influence of new technologies upon the employment, work design and occupational health and safety of health workers; and the type, methods and opportunities of

skill formation for health workers (Brewer 1986). 'The technologies most frequently named [by her informants] were: infusion pump, cardiac monitor, ventilator, bed and ward design, computer, computer terminals and word processors, cardiographs and C.T. scanners' (Brewer 1986:3). Her conclusions that are most relevant to the present thesis are included in the following overview of the research that I conducted in 1996 amongst OS nurses.

My previous research on the impact of technological change on OS nurses' work

Prior to undertaking an exploratory study during 1996 (Johnstone 1997; 1998; 1999; 2000), I could not locate any research that investigated the impact of the adoption of new surgical technologies on OTS work or the workers. Overall, there is a dearth of research, other than clinical and/or technical research, on OTS issues, and those which are of background interest to this thesis only examine factors such as the work environment, workload, and employee stress arising from the interpersonal aspects of the work (eg. Denison & Sutton 1991; Paquet 1993; Rohleder 1993; Morgan 1996).

In my 1996 study (Johnstone 1997; 1998; 1999; 2000), I investigated OS nurses' perceptions of the effects of new medical technologies (ie. surgical, patient monitoring, anaesthetic, life support and instrument reprocessing technologies) on several aspects of their work life during the preceding three years. The research instrument was a survey questionnaire, and the informants in this study were all categories of nurses working in operating suites. Sterilising department staff were not included. I found there was a strong perception amongst the 433 nurses in the two-state study that medical technologies had changed the nature of their work significantly; had contributed to their increased workloads and higher levels of stress; and yet had not diminished their satisfaction with their jobs as might be expected from the increased workload and stress. I found evidence that characteristics of the new technologies and inadequate training opportunities in their use, combined with other organisational factors, particularly those relating to human and financial resource constraints and operating suite throughput pressures, were the principal factors that had contributed to nurses' increased workload, role conflict and stress. Furthermore, nurses who worked mostly with the surgical technologies (n=348) reported more frequently (at statistically significant levels) than other categories of nurses that the increased use of medical technologies in operating theatres was a factor contributing to their heavier workloads and increased levels of stress (Johnstone 1999). These results, combined with phenomena described in Sections 1.2 and 1.3, were among the factors that influenced the focus of the present thesis to be *intra-operative artefacts* only. They also led to the development of the set of research questions in the present research in

which the scope of the issues explored is far greater, and the informants and research methods are more diverse, than my 1996 study.

Brewer's (1983; 1986) conclusions about the aforementioned work life issues, although not relating to operating theatre services, were not dissimilar to what my 1996 research concluded about OS nurses' experiences of technological change. For example, she reported that 'over 40 per cent of participants reported that new technology increased work stress, work pace, workload, hazards for patients, [and] hazards for staff' (Brewer 1986:4). She also identified that serious gaps existed in staff training in the use of technologies (Brewer 1986), and concluded that nurses had 'little control over skill formation, job design or participation in administrative or clinical decision-making' (Brewer 1989:445).

Returning to surgical technologies, a national study conducted for the Australian Government examined the ramifications for hospitals of MAS (Commonwealth of Australia 1996). Tucked away in the report, but apparently ignored, are the views of thirteen OTS nurse managers. Their comments about some of the effects of the new technologies on the labour process are relevant to this thesis. They reported that:

> laparoscopic surgery places more demands on nursing staff hours. More time is required for the preparation and setting up of laparoscopic procedures than in the equivalent open operations. Instrumentation for open surgery has to be available if case conversion to an open operation becomes necessary. [Furthermore] initially, many hospitals had a limited set of laparoscopic equipment, requiring nursing staff to spend increased time cleaning laparoscopic instruments between procedures …but as more equipment has been purchased, much of this role has been transferred to the sterilising departments (Commonwealth of Australia 1996:20).

2.5.4 Introduction to the procedures selected for detailed study

In the preceding section of this chapter, I explained how product innovation since 1988 has occurred both in conventional open surgery and MAS. The following procedures were selected for detailed study in this research because they not only covered both conventional surgery and MAS, but had undergone innovation since 1988, and are high volume procedures from four high volume surgical specialty areas. The four surgical specialty areas and their representative procedures are:

1. General surgery – Open Cholecystectomy and Laparoscopic Cholecystectomy
2. Flexible endoscopy – Colonoscopy.
3. Gynaecology – D&C (Dilatation of cervix & Curettage of uterus) plus Hysteroscopy
4. Orthopaedics – Total Knee Replacement

Table 2(g) details the frequencies of these procedures in Australia during 1996/97. Data are extracted from the Commonwealth Casemix Unit's 4-digit ICD-9-CM data for all acute hospitals' *medical* and *surgical* procedures with frequencies of fifty or more per year Australia-wide (CDHAC 1999b). There are 2,235 procedure types in the data set, but many are high volume *medical* procedures such as haemodialysis (n = 391,130), and obstetric procedures like artificial rupture of membranes (n=46,781).

Table 2(g): Frequency and ranking of selected procedures in acute public and private hospitals in Australia 1996/97

ICD-9-CM Procedure code	Description	Number of occurrences in public hospitals	Number of occurrences in private hospitals	Total occurrences	Ranking in all procedures in public hospitals	Ranking in all procedures in private hospitals
5123	Laparoscopic Cholecystectomy	20047	13786	33833	44	31
5122	Cholecystectomy (open)	5892	2368	8260	136	193
6909	D & C	59051	40363	99414	8	7
6812	Hysteroscopy	31358	26199	57557	32	19
4523	Colonoscopy	53835	97447	151282	12	1
8154	Total Knee Replacement	5586	8098	13684	143	56
8155	Revision Knee Replacement	623	1034	1657	639	350
	TOTAL - these procedures	**176392**	**189295**	**365687**		

Note: In the ICD-9-CM code set, the ranking shown relates to each procedure's relative position in a data set containing all medical and surgical procedures. Surgical procedures are represented by less than half of the 2,235 procedures in the source data set, and data elements are not mutually exclusive. For example, closed large bowel biopsy (code: 4525) and endoscopic large bowel polypectomy (code: 4542) are performed in conjunction with colonoscopy (code: 4523) but are recorded in the ICD-9-CM data set individually. Hysteroscopy (code: 6812) is often performed in conjunction with D&C (code: 6909). Consequently, the total procedure count does not equate with the number of individual patient separations.

Mindful that the procedures performed within operating suites actually account for less than half of the data set, the rankings shown in **Table 2(g)** according to the frequency in both public and private hospitals of my selected procedures, should demonstrate that they are, indeed, high volume diagnostic and/or therapeutic procedures. For example, colonoscopy is ranked 12th most common procedure in public hospitals and the highest ranked procedure in private hospitals (cf. Duckett 2000). Furthermore, when both categories of total knee replacement (codes 8154 and 8155) are combined, its ranking would shift to 129th overall in public hospitals and 46th overall in private hospitals.

2.6 Tools of management

Significant attempts have been made since the late 1980s in Australia to improve the data and techniques necessary for the effective administrative and financial management of health services. The ICD-9-CM system of coding procedures, mentioned in the preceding section, is one such initiative. This section describes and critiques this and other tools of management

that have been introduced into the practice of managing health services over the last decade or so. These are diagnostic related groups (DRGs), hospital cost weights, hospital and surgical casemix, and National Operating Room Service Weights (NORSWs).

2.6.1 Evaluating employee productivity and production costs

In Australia over the last ten years, workplace agreements have been entered into by employers with their workforce and/or their representative unions or industrial associations concerning a number of conditions of employment. Of background interest to this thesis are the agreements that have been reached concerning wage rises and increased employee productivity (QNU 2000; Pittard & Smith 1997; Harley 1995). Like all workers throughout Australia, health care workers, in an industry beset by spiralling capital and recurrent costs, are not unaffected by managerial expectations of increased employee productivity. These issues will be discussed more in Chapter 3, but, suffice it to say, a number of historical and current characteristics of health services make the customary methods of evaluating employee productivity problematic.

For example, Fetter (1999:20) explained that employee productivity in a manufacturing plant can be evaluated in quantifiable terms such as 'completed type-P components produced per employee per 8-hour day'. This type of evaluation is dependent on the predictability of all of the inputs to production. If a new machine technology was introduced into the production process, it would be expected that the decision-makers will have undertaken an economic analysis of the benefits to the firm arising from acquiring the new machine.

The new technology might serve only to enhance the quality of the component or it might be designed with an automating capacity that is intended to displace some human labour, thereby off-setting the capital costs of the new technologies. (Chapter 3 discusses these topics in detail.) Consequently, when people think of new technologies in the workplace, it is not surprising that they think of 'return on investment', labour displacement, increased productivity, and so on. However, in Section 2.5.2, I briefly discussed how, despite diverse views on the net effect of new medical technologies on health care costs, they were more often than not attributed with increasing the costs of health care – a cause-effect relationship that Gelijns and Rosenberg (1994:29) regard as one that 'contradicts conventional wisdom [because] outside of medicine, technological change is identified as the primary driving force behind improved productivity and economic growth'.

Historically, in health care, the data and tools required to rigorously test this cause-effect relationship (beyond the residual approach mentioned by Gelijns and Rosenberg 1994:33) have not been available. That is, the cost of all of the individual *inputs* to the production of

specific health care services have not been known and, until the mid 1980s, no serious attempts had been made in Australia to identify all of the inputs to specific products, let alone cost them. Furthermore, health services are just that – services – which are both numerous and diverse, and for which there are a range of intangible elements that are difficult, if not impossible, to quantify.

Hospitals have expressed employee productivity, for example, in terms of occasions of service relative to the full-time equivalent numbers of people employed to provide those services, and efficiency in terms of total bed days relative to the total expenditures. Attempts are now being made to develop ways of comparing the productivity/efficiency of hospitals, according to their respective level and scope of services, by adjusting these output measures to reflect the relative complexity and human labour intensity of the health services they provide. Substantial efforts have been made in Australia over the last 7 to 10 years in this regard (see Section 2.6.2), developments which, so far as OTSs are concerned, occurred in 1994. These developments are discussed in Section 2.6.3.

2.6.2 Diagnostic Related Groups (DRGs) and Hospital Casemix

During the 1980s and 1990s, the health service industries in western countries came a long way in developing their capacities to identify the component costs of each type of service they provide, in order to devolve a set of estimated costs for an episode of hospital care for every possible illness condition (Fetter 1991; Palmer, Aisbett, Fetter et al. 1991; cf. AIHW 1994). The term used to describe each unique illness condition is *diagnostic related group (DRG)*. The first step in this process (which is still undergoing refinement) was to identify what the full range of illness conditions actually were – a very complex task, given the potential numbers of possible conditions and the multitude of variations that may occur within any single condition. For example, in the case of appendicitis, different treatment costs will result from variations such as the age of the patient, the severity of the illness, whether or not surgery was actually performed, whether or not there were factors that complicated the surgery, and whether or not the patient had other medical or surgical conditions (ie. co-morbidities) that required treatment at the same time (cf. Fetter 1999). All of these factors impact on the treatment options during hospitalisation and the patient's length of hospital stay and, hence, the total cost of treatment.

Historically, two approaches have been employed in hospital cost estimations for individual DRGs. Both approaches are methodologically complex but certain distinctions between the two need to be made. The first, the "bottom up" or *clinical costing* approach, 'is based on the creation of computerised feeder systems which capture data about all patients dealing with

the use of services such as those provided by operating theatres, pathology laboratories and radiology departments' (Palmer et al. 1991:315). These are then added to overhead costs and converted into cost estimates per patient by the application to them of a predetermined *relative value unit* or a similar estimate of the relative cost of the service for each type of patient (Palmer et al. 1991). The second approach, referred to as *cost-modelling* or the "top down" approach, is 'based on the concept of the *average accounting cost* to the hospital associated with each DRG' (Palmer et al. 1991:317-318). It 'takes general ledger data and patient activity data to estimate hospital-specific prices by DRG [using] "service weights" [eg. pathology and theatre weights] to estimate service costs in each DRG, which are then summed to yield an estimated cost and relative weight for each DRG' (Duckett 1998:108-109).

Public hospitals in most Australian states are already being funded using a formula that applies the estimated cost of each DRG to the annual volume of each DRG (constituting the hospital's casemix) in respect of inpatient services (Duckett 1998). It is to this end that the Commonwealth Government incorporated case-mix-based output measures into its granting formulae for the states in its 1998-2003 funding agreements (Donato & Scotton 1998). For example, in 1997/98 the average cost per separation in an Australian *public* hospital was $2,412, and this dollar value equated with a hospital cost weight equal to 1. (Incidentally, this is higher than the NSW average cost of $2213.00 cited earlier for all medical and surgical separations in 1996/97.) So, if a DRG has a hospital cost weight of 0.5, its average cost is reckoned to be 50 per cent of $2,412. Total knee replacement without complications or co-morbidities has a national public hospital cost weight of 4.87; so in a casemix-based funding scenario, a hospital performing one hundred of these procedures in a year would be funded at the level of $2,412 x 4.87 x 100 for these separations.

Table 2(h) provides 1997/98 Australian public hospital cost-weights, along with average length of stay, for all of the variations of the six procedures examined in this thesis. Whereas **Table 2(g)** provided summary frequency data according to ICD-9-CM procedure code for the six procedures, **Table 2(h)** reports the data according to the various, more recent, Australian DRG codes that include the distinguishing dimensions of complexity and/or co-morbidities, with the result that there are two or more codes for many procedures.

It should be noted that DRG definitions and codes were revised during the period of the present research, and the 1997/98 Australian Revised (AR)-DRG version 4.0 code set was the first to differentiate open cholecystectomy and laparoscopic cholecystectomy. Unfortunately, the latest available data from the NSW and Commonwealth Governments are based on two

different codes sets, so the earlier Australian National (AN)-DRG version 3.1 codes have been used to link the two for the purposes of the present thesis. In this way, **Table 2(h)** provides a cross-reference to both coding systems for all the DRGs representing this study's six procedures.

Table 2(h): 1997/98 Australian public hospital numbers of separations, cost weights, and average lengths of stay for all categories of Cholecystectomy, Colonoscopy, D&C Hysteroscopy, and Total Knee Replacement identified by both AR-DRG v4.0 and AN-DRG v3.1 codes.

AR-DRG v4.0 code	AR-DRG v4.0 Description	Lay description	AN-DRG v3.1 code approx. equivalent to v4.0	1997/98 Australian public hosp No. of separations	1997/98 public hospital National cost weight	1997/98 public hospital National ALOS (days)
H03A	Cholecystectomy+Closed+Cs cc	Open Cholecystectomy with complicating factors	365	268	4.06	12.81
H03B	Cholecystectomy+Closed Cde-Cscc	Open Cholecystectomy – no complicating factors	366	3365	2.30	6.33
H04A	Cholecystectomy-Closed Cde+Cscc	Laparoscopic Cholecystectomy with complicating factors	365	390	2.42	7.11
H04B	Cholecystectomy-Closed Cde-Cscc	Laparoscopic Cholecystectomy – no complicating factors	366	19751	1.22	2.66
G43Z	Complex Therapeutic Colonoscopy	Colonoscopy	333	387	0.51	1.99
G44A	Other colonoscopy+Cssc/Cx Pr	Complex Colonoscopy with complicating factors	334	2418	1.82	7.75
G44B	Other colonoscopy-Cssc/Cx Pr	Complex Colonoscopy without complicating factors	334	7238	0.94	3.79
G44C	Other colonoscopy + Sameday	Diagnostic Colonoscopy	335	63169	0.33	1.00
N10Z	Dxc Curettge, Dxc Hysteroscopy	D&C with or without Hysteroscopy	661	23230	0.37	1.07
I04A	Knee Replacement & Reattach+Ccc	Total Knee Replacement with complicating factors	406	6530	6.03	15.42
I04B	Knee Replacement & Reattach-Ccc	Total Knee Replacement – no complicating factors	407	1257	4.83	9.79
		TOTAL for all possible DRGs			**1.00**	**3.51**

Sources: Commonwealth of Australia (1998a; 1998b); NSW Health (1998b; 1998c).

In anticipation of its impact on nursing services, some studies were conducted several years ago within NSW by Picone et al. (1993; 1995) to develop DRG-based nursing weights (the associated costs of which are a component of the hospital cost weight). These are estimated costs of nursing care per DRG that reflect actual patient acuity (ie. the severity of illness and the dependence of the patient on nursing care) at different phases of an episode of care in a hospital ward. Similarly, and of particular relevance to this thesis, attempts have been made to estimate the OTS costs component of the hospital cost weight of all surgical DRGs – a component referred to as the OR service cost and/or the National OR Service Weight (NORSW).

2.6.3 National Operating Room (OR) Service Weights and Surgical Casemix

In 1994, the Operating Room Cost Weights Study was commissioned by the Australian Commonwealth Government (CDHSH 1995a; 1995b) to estimate the various costs of the OTS component of surgical DRGs. The study used a modified "bottom up" approach (CDHSH 1995a). Cost estimates for the various elements, such as theatre nursing, technician, sterilising department, prostheses, drug, supplies, equipment, and overheads, were reported as *relative costs*. In the absence of specific data (such as were used for prosthetic costs and identifiable special drug costs), these were based on the average length of time a patient classified as, say, AR-DRG-HO3A, was in the operating room *relative* to a patient classified as AR-DRG-G44B. This "time in the operating room" is also referred to as *operating time*. It equates with what I refer to throughout this thesis as *intra-operative time*.

In 1995, a *conditional operating room service weight* of 1 equated with $1,190 which was the estimated average cost of producing an operation in the OTSs of Australian hospitals (CDHSH 1995a). The 1995 OR service weights were refined in 1998 (Aisbett, Palmer, Balnave et al. 1998) but only by means of reviewing and further analysing the data that were originally collected during 1994 (Clarke 1999). This resulted in a new estimated average OR service cost of $973. In other words, in Australia in 1997/98, for episodes of care involving surgery, the cost of the OTS component of the average total hospital cost of $2,412 per episode of care, was estimated to be $973.

Table 2(i) details the 1995 data for the estimated average human resource costs for the sterilising department and the operating suite, along with the estimated average total OTS cost for all of the variations of the six procedures examined in this thesis. The NORSW reflects the relativity between the average total cost of each procedure by DRG and the 1995 estimated average OTS cost of $1,190. For example, in 1995 the estimated OTS cost of producing one AN-DRG-365 was 1.56 x $1,190 (ie. approximately $1,860).

What is the interest of the present thesis in the National Operating Room Service Weights? Its interest lies in the fact that the human labour component of the NORSWs were estimated from available hospital data in 1994/95 – from activity data that were limited to *intra*-operative times, and hence to only the *direct* labour component of surgical production (cf. Littler 1985). The *peri*operative labour component (ie. the *indirect* labour) has never been quantified. Consequently, total labour requirements per DRG were estimated using the broad assumption that the volume of *perioperative labour* was directly proportional to *intraoperative time* "refined" by the "informed guesses" of the team of experts (Brennan 2000) co-opted by the consultancy group (CDHSH 1995a).

Table 2(i): 1995 Australian national operating room service weights and estimated staff and total costs

AN-DRG v.3.1 code	AN-DRG v3.1 Description	1995 estimated Sterilising Department staff cost	1995 estimated Operating Suite staff cost	1995 Total (incl drugs, protheses, staff) OR cost	1995 National OR Service Weight (NORSW)
365	Cholecystectomy W C.D.E. W CC	$119.00	$542.00	$1,860.00	1.56
366	Cholecystectomy W C.D.E. W/O CC	$81.00	$561.00	$2,006.00	1.69
367	Cholecystectomy W/O C.D.E.	$99.00	$441.00	$1,465.00	1.15
333	Complex Therapeutic Colonoscopy	$46.00	$147.00	$688.00	0.58
334	Other Colonoscopy W CC	$54.00	$120.00	$815.00	0.68
335	Other Colonoscopy W/O CC	$50.00	$106.00	$734.00	0.62
661	Dx Curettage &/or Dx Hysteroscopy	$99.00	$98.00	$623.00	0.52
406	Knee Replacement W CC	$145.00	$504.00	$7,590.00	6.38
407	Knee Replacement W/O CC	$119.00	$465.00	$7,119.00	5.98

Source: CDHSH (1995a). Note that the current National OR service weights data set still defines procedures using AN-DRG v3.1 codes.

My suspicion that there is no positive linear correlation between direct and indirect labour input to the production of surgical procedures is reflected in the second of my research propositions stated in Chapter 1: *that the estimated costs of the human resource component of the National Operating Room Service Weights for specific surgical procedures by designated Diagnostic Related Group (DRG) do not accurately reflect the volume of human labour input to their production*.

The following example should demonstrate the potential weakness of using the current NORSWs as the basis of funding OTSs if my proposition is correct. A hypothetical OTS performs only two procedures, A and B. In a given year, 2,000 cases of procedure A and 3,000 cases of procedure B are performed, resulting in total annual volume (V) of 5,000 procedures. If procedure A has a NORSW of 1.5 and procedure B has a NORSW of 0.7, the average OR service weight (W) for that OTS would be:

$$W = [(2000 \times 1.5) + (3000 \times 0.7)] / (2000 + 3000) = 1.02$$

Then, based on the 1998 value equivalent of the NORSW of 1 being $973, this OTS budget ($B_1$) for staffing, supplies and overheads would be calculated as:

$$B_1 = \$(973)VW = \$973 \times 5{,}000 \times 1.02 = \$4{,}962{,}300.$$

However, if procedure B's NORSW is based on an underestimate of the indirect labour input required to produce it, such that its NORSW should be 0.85 rather than 0.7, the OTS's average OR service weight (W) would be 1.11 instead of 1.02, with the result that its budget should be:

$$B_2 = \$(973)VW = \$973 \times 5{,}000 \times 1.11 = \$5{,}400{,}150.$$

The shortfall of $437,850 could clearly employ many more staff. If an actual hospital's case mix was made up of a large number of procedures whose NORSWs were *under*estimated, the funding shortfall would have dysfunctional consequences for employee workloads. In the event that indirect labour had been *over*estimated in the NORSW, the reverse logic would apply and the OTS would end up being over-funded for staffing. Given the currency of these issues for the Australian health care system, I believe that it would be a serious oversight in a study such as this if I neglected to include an analysis of the NORSWs in conjunction with the quantitative data that have been collected in relation to the human labour input into selected surgical procedures. I had not envisaged exploring these issues until I was well into the research process, and it was not until quite late in the process, when I was undertaking some modelling of these quantitative data, that I realised the potential importance of my results.

This concludes the background to the macro level factors that are relevant to the present thesis. The remainder of the chapter is devoted to providing a background to OTSs and their key internal stakeholders, that is, to the micro level context of this research.

2.7 The nature and role of operating theatre services in acute hospitals

This section describes the nature and role of operating theatre services in acute hospitals along with trends in operating theatre services' activity during the ten years, 1988/89 to 1997/98. In the course of this overview, I present definitions of some key terms as they apply throughout the present thesis. (A comprehensive set of definitions of key terms is in Appendix E).

For the purposes of this thesis, I have defined an *operating theatre service* (*OTS*) as "the collection of operating suite services, endoscopy services, and sterilising services, regardless of how they might be physically located or administratively structured within individual hospitals". The configuration of OTSs will vary from hospital to hospital and is dependent on a number of factors. These include the size and location of the hospital, the level and scope of services that it provides, the physical relationship between the various units or departments that constitute the OTS, and the judgement of managers as to how the OTS at their hospital can best be managed. My purpose in this thesis is not to offer any analysis of the diverse configurations. Rather, it is to discuss the characteristics of the *intra-operative* and *perioperative* work connected with *intra-operative artefacts* used in surgical production within *operating theatre services*, without concern for where that work is carried out or by whom. For example, at one hospital, colonoscopies might be carried out in an operating room (OR) or a procedure room (PR) within an operating suite (OS), while at another they might

be carried out in a separate Endoscopy Unit (EU). One hospital might employ a technical aide to re-process the colonoscopes (ie. the instruments) whereas at another hospital, OS nurses might perform this function. Furthermore, in most hospitals, the instruments used during colonoscopies are re-processed within the OS or EU, but in some hospitals selected items are sent to the Sterilising Department (SD) for re-processing. Once in the SD, they might be totally manually processed or some machines might perform one or more of the re-processing functions.

The important issue for the present thesis is that *surgical production* involves numerous people located in diverse places within OTSs – people who are, at different times, performing one or more of the activities that contribute to that production process. For the purposes of the present thesis, I have defined *surgical production* as "the bundle of activities undertaken before, during, and after procedures within a hospital's OTS that relate to the use, management and maintenance of intra-operative artefacts and the associated perioperative technologies". As a general rule, surgical production involves all activities from the moment someone removes an intra-operative artefact from its place of storage to assemble it with other artefacts in readiness for a specific procedure, to the point at which all artefacts, after they have been used and reprocessed, resupplied, or given the necessary post-operative maintenance, are returned to their places of storage. However, in some cases, production starts when instruments are requested for loan from a biomedical company, and ceases when that borrowed instrumentation is despatched back to the company after it has been used and re-processed.

Procedures undertaken in OTSs are classified as *elective* or *emergency* (or *non-elective*). That is to say, a patient can *elect* to enter hospital for a nominated procedure and be treated by a procedural specialist during the course of his/her regular operating session, which may be a half- or full-day in duration. *Emergency* surgery is performed at any time of the day or night on demand, and it is sometimes necessary to postpone elective surgery to accommodate a patient requiring emergency surgery. In this study, the hospitals categorised as A1 and B2 are principal referral hospitals for emergencies in their catchment areas and, hence, are more likely than the other hospitals to perform emergency surgery. In order to provide around-the-clock emergency surgical service, OTS nurses and procedural specialists are required to serve on "on call" rosters.

Each procedure is carried out by a team of doctors and nurses (ie. an *operative team*). A typical operative team comprises a procedural specialist, a surgical assistant (often a surgical intern), and an instrument nurse, although some complex procedures, such as open heart

surgery, require a larger operative team. Their work is contained within the "sterile surgical field". Customarily, a procedure is carried out in an operating room or procedure room using a collection of intra-operative artefacts that have been assembled for use on a specific patient undergoing a specific procedure. In this sense, production is *customised* to every patient. Prior to another patient entering the room for his/her procedure, the room must be cleared of all of the intra-operative artefacts from the previous procedure, cleaned, and "set up" with a customised collection of intra-operative artefacts for what is possibly a quite different procedure. In the case of elective surgery, all of the intra-operative artefacts for each surgeon's operating session are usually assembled in individual "case carts" (or similar), prior to the session, by a nurse who may or may not be a member of the operative team that will use them.

In addition to the members of the operative team, a number of other personnel provide direct care to patients while they are in the department. Among them are the circulating nurses and the anaesthetic nurses or technicians. They, along with the operative team, constitute the *surgical team* which, depending on the category of hospital, may also include radiographers, perfusionists, and so on. The primary role of a circulating nurse is to provide direct assistance to the operative team. The anaesthetic nurse assists the anaesthetist throughout the time that the patient is in the suite, and it is his/her duty to ensure that all anaesthetic, life support and patient monitoring equipment and drugs are readily available. Other OS staff are the recovery room nurses and the porters. Porters transport patients to and from the suite and in and out of the operating room, move operating room furniture and frequently undertake cleaning duties between procedures, such as washing the operating table and mopping the floor. However, it is not uncommon for operating suite nurses to assist with these latter activities.

Some staff involved in surgical production do not have direct contact with patients. For example, the SD technical aides perform much of the reprocessing of instruments. After a procedure is concluded in an operating room, most of the instruments requiring reprocessing are despatched to the sterilising department where they are dismantled, checked, cleaned, reassembled, checked again, packaged, labelled, sterilised and returned to the operating suite.

Coordination of all of these activities is undertaken by one or more nurse managers, and, depending on the size of the operating suite, possibly a manager of the sterilising department. The senior nurse manager has overall responsibility for the continuity and quality of the OTS activities, for the management of staff on a day-to-day basis, and the management of the OTS budget. Many operating suites have a registered nurse employed full-time as a clinical

educator, or otherwise an experienced nurse whose duties include continuing staff education and the training of new staff.

2.7.1 The "closed" workplace characteristic of operating theatre services

Operating theatre services are unique workplaces in numerous ways. They represent what is arguably the most technologically intensive and diverse area of a hospital. Although some technologies used within OTSs are used in some other hospital departments (such as patient monitoring and life support technologies employed in an intensive care unit), most are unique to OTSs (ie. anaesthetic and surgical technologies). Health professionals working outside of OTSs are rarely exposed to these latter technologies.

In addition to the specialist nature of the work conducted in OTSs and the technologies employed, there are several other characteristics relevant to this thesis that make OTSs unique. For example, there are the interdependent roles of a wide range of specialist personnel and the constant challenge of coordinating everyone's activities in an environment in which scheduling of procedures is categorically unpredictable. These characteristics were comprehensively described by Buchanan and Wilson (1996a; 1996b) in their case study of operation scheduling problems at Leicester General Hospital in England.

Another distinctive characteristic of OTSs is that they are what Salaman (1974) described in terms of *closed occupational communities*. Mahony (1996) subsequently applied this concept to a category of workers she refers to collectively as "Triple-O-Party workers", such as police, ambulance officers and emergency room nurses. She proposed that one distinguishing characteristic of Triple-O-Party workers was that they operate in close-knit, culturally distinct work groups. She suggests that 'the "clubbishness" or group solidarity exhibited by nurses and other occupational groups has a lot to do with the nature of the work' (Mahoney 1996:4), and that occupational members believe that 'only other members of their profession could possibly know and understand the real rigours of the job' (Mahony 1996:15; cf. Lawler 1991).

Specialisation within occupations, combined with occupational members working in diverse settings, results in the phenomenon described as *local occupational communities* in which one group in a particular occupational community is, for all intents, *closed* from, and therefore does not understand the rigours of the work of, another group (Salaman 1974). I describe procedural specialists and OS nurses as *local occupational communities* that are also categorically *'adjacent occupational groups'* (Brewer 1986:1; Lloyd 1993:28) because they share a specific work situation. OS nurse and SD technical aides are also adjacent occupational groups. The work of each group is *closed* from both the public and, as a general

rule, all other staff in the hospital. Consequently, the only images held by many non-members of OTSs of the nature of OTS work are the often distorted ones that are portrayed in the entertainment and news media.

The fact that OTSs are closed to outsiders professionally, culturally, and physically, is particularly important to the present thesis in connection with the role of top managers. This professional group is responsible for most resourcing decisions concerning the resourcing of OTSs, yet most are unlikely to have ever set foot inside an operating suite. Although some top managers have clinical health qualifications that might give them a limited understanding of the OTS environment, they are categorically "outsiders", and are unlikely to fully understand its unique workplace characteristics.

2.8 The characteristics of key internal stakeholders in operating theatre services

Hospitals are categorically *professional organisations/bureaucracies* (cf. Mintzberg 1998; Denis, Langley & Lozeau 1991; Hickson, Butler, Cray et al. 1986) that have numerous characteristics that distinguish them from more traditional bureaucratic organisations. One such characteristic is the large size of the *operating core* that is made up of the many and various experts in diverse fields who contribute to the production of the organisation's products or services (Mintzberg 1998; Robbins & Barnwell 1998). Another is the empowerment of the professionals who make up the operating core to play key roles in an organisation's decision processes (Pusić 1998; Mintzberg 1998; Denis et al. 1996; cf. Ashmos et al. 1998) – an issue that is discussed in more detail in Chapter 3.

My purpose in raising the topic of the professional organisation at this juncture is not to debate whether or not the occupational groups represented in the present thesis are "professions" by definition (cf. McCoppin & Gardner 1994; Lloyd 1993; Probert 1989; Child & Fulk 1982). Rather, it is to draw attention to the fact that the three categories of OTS informants in this study are members of that operating core of the hospital: the OS nurses, SD technical aides, and procedural specialists. The fourth category of "expert" informants in this study are the top health service managers, who are part of what Mintzberg (1983) calls the *strategic apex* of the organisation.

Each expert group has a unique history that has shaped the current status, roles and gender-distribution of its members. The following section overviews what are the key characteristics and recent past and present roles of each group in general, and in relation to OTSs, in particular.

2.8.1 Operating theatre services staff

Operating suite nurses

In Australia, OS nurses are predominantly registered general nurses (ie. they are qualified, probably at baccalaureate level, and registered by the nurses' registration board in the state in which they work). In order for a registered general nurse to practise within OTSs, additional training is required – training that may be undertaken on the job or via post-graduate nursing courses. Some operating suites also employ a category of nurse known as an enrolled nurse – usually in relatively small numbers in public hospitals, but to a greater extent in private hospitals. Enrolled nurses have a restricted but important role to serve in many areas of nursing, but cannot practise independently of a supervising registered nurse (Nurses Registration Board NSW 2000).

Female dominance of nursing is an undisputed fact of history (Oakley 1993). In 1997/98, 92 per cent of the 42,581 nurses registered to practise in NSW were female. Moreover, of the 2,843 nurses who worked in an OTS in 1997/98, 93.6 per cent were female (NSW Health 1999c).

There are a number of specialist roles performed by nurses in operating suites. The major ones are instrument (or "scrub") nurse, circulating (or "scout") nurse, anaesthetic nurse, recovery room nurse, and nurse managers. Of these, only instrument and circulating nurses have roles that are directly and uniquely contributing to *surgical production* as defined in the present thesis. Only registered nurses perform the instrument nurse role but the circulating nurse role may be performed by either a registered nurse or an enrolled nurse. Their roles encompass both *intra*-operative and *peri*operative activities connected with intra-operative artefacts.

Nurse managers are registered nurses who have certain responsibilities that relate to the operational aspects of the surgical technologies, ones that include ensuring that staff are trained in all aspects of the use and care of all intra-operative artefacts. In some operating suites, nurse managers are also required to undertake some clinical nursing in addition to their managerial duties, and so they might perform the instrument or circulating nurse roles from time to time.

Sterilising department technical aides

Sterilising departments are staffed by non-clinical personnel who are certificated SD technical aides or, otherwise, unqualified personnel who are trained on the job. New entrants to sterilising department work are required to possess a sterilisation certificate from a College

of Technical and Further Education or be prepared to complete certificate qualifications within a stipulated period of time. Industry-wide data are not available on the gender mix of SD technical aides, but about 80 per cent of the more than 70 staff working in sterilising services at the largest hospital in this study were female, and none of the sterilising departments at the smaller hospitals in this study had any male staff.

Technical aides undertake the reprocessing of most surgical instruments. Their role is distinctively *peri*operative.

2.8.2 Procedural specialists

The term, *procedural specialists*, is used throughout this thesis to refer to specialist surgeons of all surgical specialties as well as to specialist physicians who perform diagnostic and/or therapeutic gastro-intestinal (GI) endoscopy. This is to accommodate the fact that GI endoscopy may be performed by both specialist general surgeons and specialist GI endoscopy physicians.

Most procedural specialists are not employees of the hospital(s) at which they undertake procedures. Rather, they are independent health care professionals who are granted rights to practise at specific hospitals under negotiated terms of hours and remuneration for the treatment of Medicare (ie. public) patients, whilst treating privately insured patients on a fee-for-service basis (cf. Duckett 2000). The term, *consultant*, is commonly used to describe their status. In private hospitals, procedural specialists treat patients on a fee-for-service basis, except where the public sector has contracted a private hospital to provide certain services for public patients. In public hospitals which participate in the post-graduate training of medical doctors, it is customary for consultants to perform the procedures on private patients, but to supervise advanced graduates, known as Registrars, who are training in a speciality area, as they perform entire procedures or certain stages of a procedure on Medicare-funded patients.

Comprehensive state-by-state data are not available for the medical workforce but, in Australia, there are almost 49,000 registered and practising doctors. Of these, 36 per cent have specialist qualifications (NSW Health 1999c) and 27 per cent are female (1995 data) (NSW Health 1996). The category of procedural specialists who are informants in this study, number about 978 nationally and represent approximately 2.3 per cent of all registered and practising doctors. They have achieved Fellowship status in a discrete area of clinical practice such as general surgery, obstetrics and gynaecology, orthopaedics, or gastro-intestinology, and about 3 per cent are female – one of the lowest female representations in any medical speciality (NSW Health 1996).

2.8.3 Top health service managers

Senior health service managers who work within the executive unit of a hospital or an area health service in line-management roles that traverse divisional or sector boundaries are referred to throughout this thesis as *top managers* (cf. Langley & Truax 1994; Thomas 1994; Nutt 1991). Their job titles may be general manager, chief executive officer (CEO), director of corporate services, or the like, and they have various responsibilities that are concerned with the overall efficient and effective operation of the hospital or health service at which they are employed. At the most senior level within the NSW public health sector, CEOs of area health services are accountable to the NSW Minister for Health to manage their health services in a manner that is in alignment with the Department's strategic goals and directions for health services within the state (NSW Health 1998a).

The study of the professionalisation of occupations (eg. Furnham 1998; Lloyd 1993) offers some analysis that is relevant to the emergent role of health service managers in Australia. Historically, generalist health service managers in Australia evolved from the clerical, accounting and administrative services, with the most senior position in the 1960s being Hospital Secretary. During the 1970s, tertiary education programs in health services management were developed (Powell in Griffith 1976). This contributed to the progressive enhancement in the power, status and salaries of health service management professionals to the extent that today, the CEOs of area health services are among the highest paid salaried staff in the NSW public health system (ODEOPE 1999).

Based on membership data of the peak national professional body for health service managers, the Australian College of Health Service Executives (ACHSE), the virtually total male membership of the College throughout its formative decades from the late 1940s (Cornwell & Howes 1997) has gradually shifted to approximately 25 per cent female membership in 1998 (ACHSE-NSW 1998; cf. Harris & Bleakley 1991). These latter data parallel the estimate from the Office of the Department for Equal Opportunity in Public Employment of 30 per cent female representation amongst executive managers in the NSW public health sector (ODEOPE 1999).

2.9 New technology receiver status of informants

The procedural specialists, the OS nurses and the SD technical aides in the present study are categorically *receivers* of new intra-operative artefacts. I have defined *receivers* as individuals for whom the adoption of a new intra-operative artefact has necessitated that some degree of adjustment be made in the *techniques* or *organisation* of their work. Top managers, are categorically *non-receivers*.

Receiver has been used instead of a term like *end-user*, which is accorded the meaning of an individual who is the customer for whom a product is ultimately designed (cf. *The Macquarie Dictionary* 1997), and that the product is used as a means to an end. *Receiver* accommodates both end-users and others, such as the OS nurses, who *work with* the artefacts but are not end-users by definition, and the SD technical aides for whom the intra-operative artefacts are the *objects* of their work.

2.10 Inter-professional issues: nurses, doctors and health service managers

Nurses significantly outnumber doctors in Australia, and yet it is well recognised that doctors are the most politically and industrially powerful of the two occupational groups. According to Larson (1977, cited by Lloyd 1993:41-42), this power has been partly the result of medicine's ability to convincingly portray the ideological benefits of rational and efficient scientific medical knowledge associated with the prevention, diagnosis and treatment of disease and illness within society during a period in which the cultural status of science was rapidly advancing.

However, despite the dominance of the medical profession, Wicks (1999) does not defer to the view that nurses have been powerless in shaping their occupational role and status. Rather, she adopts a more moderate view – that the lives of nurses as a group of mostly women workers, are, 'at least to some extent, shaped and directed by the social structures of class and gender' (Wicks 1999:1) and inter-woven with the history of the professionalisation of medicine in western capitalist societies (Wicks 1999; cf. Lloyd 1993).

A number of researchers have explored the professional relationships between nurses and doctors in hospital ward settings (eg. Wicks 1999; Oakley 1993; Brewer 1983; Ehrenreich & English 1973) but there appears to be a dearth of empirical literature on the professional relationships between nurses and doctors working within the operating suite. The present thesis explores the latter in Section 6.4.4. Concerning the former, Wicks (1999) studied the interactions of nurses and doctors (predominantly resident/"house" doctors) in a general medical ward of a teaching hospital in Australia. She concluded that nurses and doctors often work together 'as a team with genuine humour, goodwill and pleasure' (Wicks 1999:175). Oakley's (1993) interpretation of the doctor-nurse relationship, however, was not a commentary on the interpersonal relationships described by Wicks (1999) but a commentary on their roles. She proposed that 'the doctor-nurse-patient relationship mirrors that of the traditional nuclear family' (Oakley 1993:50), that is, the traditional father-mother-child relationship.

Nurses and doctors have also been distinguished on the basis of what values and attitudes are reflected in their work orientations. According to Oakley (1993:43), 'doctors are rational, scientific, unemotional, and uninvolved' – an orientation that is congruent with the strong identification of males with the functional aspects of things (cf. Wajcman 1993). However, *caring* continues to be a central tenet of nursing, a humane characteristic that is strongly linked to nursing's origin as a specialised form of domestic work, possibly associated with the female religious orders and/or the traditional ideals of feminine vocations (Mahony 1996; Oakley 1993).

The professional relationship between doctors and health service managers also demands a brief examination. According to Lloyd (1993), the medical profession has relative freedom from external intervention, and a state-sanctioned, although weakening position of dominance within the health care sector. However, in the Australian public health sector, all employees, including managers, are employees of the state. Top managers have a power that is legitimised by the state to allocate and manage the financial resources that are provided by the state to operate their health services. So, despite the state-sanctioned power of the medical profession, the potential for absolute power of the procedural specialists in the new intra-operative artefact adoption process, for example, is curtailed by the state-sanctioned power of the health service management professionals to manage relatively scarce financial resources (cf. Brewer 1986). According to Lloyd (1993), such a situation creates an environment for professional tension.

2.11 Conclusion

This chapter has provided the contextual background to the new intra-operative artefact adoption issues that are central to the present thesis. In summary, the chapter has described the structure of the Australian health care system along with associated cost and financing issues, and overviewed the characteristics of acute public and private hospitals in Australia. The discussion then narrowed to the focal state of the thesis, NSW, and the classification of hospitals according to their size and the scope and level of services provided.

Attention was then given to the topic of *technology*, and *surgical technologies* in particular. Key concepts were defined and explained in conjunction with an innovative model of the *classification of surgical technologies and their process relationships in surgical production*. Then, drawing on the empirical literature, influences on new intra-operative artefact adoption by procedural specialists, and some consequences for nurses of new technology adoption, were explored.

The chapter introduced the various surgical procedures that will be the focus of analyses concerning the direct and indirect labour required in surgical production, and overviewed the tools with which various levels of government in Australia are endeavouring to better manage the financing of its health services generally, and operating theatre services in particular. This was followed by a description of the nature and role of operating theatre services in acute hospitals, after which the key terms used in relation to operating theatre services throughout this thesis were defined. It concluded with a description of the characteristics, roles and responsibilities of the study's key internal stakeholders, their new intra-operative artefact adoption *receiver* status, and some pertinent inter-professional issues.

The following chapter is a review of the empirical literature that provides the theoretical foundation of the dominant paradigm conclusions of the present thesis. It reviews theories and perspectives from the social sciences, such as organisation theory, industrial sociology, decision-making in organisations, and micro-economics, as they relate specifically to the five research questions.

Chapter 3

Theoretical framework – Review of the literature

3.1 Introduction

This chapter concentrates on reviewing the empirical literature that provides the theoretical foundation of the dominant paradigm conclusions of the thesis. Its pervasive themes are the *choices* in, and the *consequences* of, new technology adoption in organisations.

Previously, Chapter 1 dealt with the literature pertaining to the paradigmatic and methodological issues relevant to this research, and presented my conceptual model of the mixed methods, mixed methodology case study research design employed throughout the research process. Chapter 2, which provided an overview of the health services context of the research, can best be described as a review of the pertinent literature inter-woven with numerous insights gained in the research field. Treatment of some topics covered in the second chapter, such as the workplace characteristics of operating theatre services, the categorisation of surgical technologies, and the tools of management, came about essentially as a product of the overall inductive research process. They were included because they had emerged as highly relevant contextual aspects of the study. One outcome of the present research, my model of *the classification of surgical technologies and their process relationships in surgical production*, was also introduced.

This chapter reviews theories and perspectives from a number of social science disciplines, such as organisation theory, industrial sociology, decision-making in organisations, and micro-economics, as they relate specifically to influences on organisations' choices of "artefact" technologies, the characteristics of the new technology adoption decision process, and the consequences of new technology adoption in organisations. It necessarily includes an examination of the socio-technical and organisational research literature dealing with the environment-technology-structure relationship both within society at large and organisations.

It is important to reiterate that my research explores phenomena associated with changes in intra-operative *artefacts* employed during surgical procedures – diverse "physical things" in the form of surgical instruments, surgical materials, and enabling mechanical or electronic equipment – within operating theatre services (as discussed in Section 2.5.1). However, most studies concerned with technological change in organisations have been carried out in manufacturing organisations where the products are tangible (Robbins & Barnwell 1998), as opposed to the service sector where the products are 'intangible, impermanent or immaterial' (Coombs & Green 1989:279). Hence, there is a strong manufacturing bias in the literature (cf. Geisler & Heller 1996) that is reviewed here. On the one hand, this could be viewed as

problematic, but the very dominance of this literature is indicative of the gap that exists in the literature on the topic of new artefact technology adoption in health services and, in particular, in surgical production occurring within operating theatre services.

In a manner similar to Chapter 2, the choice of literature is largely the result of the overall inductive research process. My pre-research theoretical orientation was founded in classical organisation theory and my formative research propositions concerning both the labour process impact of new intra-operative artefacts and managers' expectations of the organisational outcomes of new technology adoption, had their origins in this theoretical area and, consequently, influenced the original study design. It has continued to be an important theoretical area in the present thesis, but it also became the "launching pad" for my excursions into a range of other theoretical areas, prompted by phenomena that I was observing in the field.

Figure 1(a) in Chapter 1 provided a conceptualisation of how the themes that were emerging inductively from my data during the research process were followed up with an examination of the relevant literature. New or revised questions often followed, thereby influencing my stream of consciousness when I conducted subsequent interviews and engaged in other data collection activities. This was a continuous iterative process. On numerous occasions my excursions into new theoretical areas proved to be so marginally relevant to the research questions and/or the context of my study that I decided that nothing would be gained by pursuing the particular line of thinking. Regardless, the exercise was important as a means of ensuring first, that I covered the theoretical field as much as is humanly possibly; secondly, that the academic literature herein reviewed is, indeed, the most relevant to the questions that guided this research; and thirdly, that the outcomes of the present research are truly additions to the body of knowledge.

Influenced by Cresswell (1994) on the matter of structuring a literature review in a mixed methods dominantly naturalistic study, I have elected to review the literature that has emerged as being most relevant to my dominant paradigm research proposition and the five research questions derived from it, in a style consistent with the positivist tradition rather than the naturalistic tradition (ie. to overview and critique the literature, for the most part, independently of the discussion of the research findings, even although investigating the literature was largely a part of the research process). Much the same approach was used by Thomas (1994) in his book entitled, *What Machines Can't Do*, a report of research that has strong parallels with the techno-structural focus and methodological aspects of the present research, albeit in a different organisational context.

Consequently, the literature that I explore in this chapter falls into one of two categories:

(a) highly relevant to the research area, the research questions, and my goals for this thesis, or

(b) highly relevant to the research area and at least some of the research questions, but of secondary relevance to my goals for this thesis.

Examples of the category (b) literature are reviewed only in sufficient detail to highlight their relevance to the research area. They are representative of alternative theoretical frameworks that could have been employed to interpret the phenomena that I have studied. By including some of them here, I am acknowledging that during the course of my research I will have consciously and subconsciously excluded data that would be of interest to researchers who have different perspectives on these phenomena (cf. Burrell & Morgan 1979).

However, the primary and secondary paradigm outcomes of this research are grounded in the category (a) literature, which consequently dominates this chapter. The concepts of *choices* and *consequences* of new artefact technology adoption in organisations are the pervasive themes.

The chapter commences with a critique of the literature concerning determinism and voluntarism in technological change within organisations. On the one hand, it shows how choices made by individuals or groups influence how institutions' human, capital, and other resources are organised (ie. how an organisation is *structured*), but that human agency alone is not the determinant of organisational structure. On the other hand, it shows that technological change can, and does, result in alterations of an organisation's structural characteristics, but that technology alone is not the determinant of organisational structure. It presents a synthesis of the literature that seeks to explain new technology adoption in organisations from a perspective that accommodates both *strategic choice* and *technological determinism* and, in so doing, argues that the achievement of an integrated perspective is unnecessarily obstructed by the long-standing and unresolved philosophical debate concerning determinism and voluntarism.

Subsequently, the chapter is structured to explore what the literature – predominantly that which adopts a functionalist perspective of organisations (cf. McKenna 1999; Burrell & Morgan 1979; Hassard 1993) – has to say about: the technical goals of artefact technologies; why organisations adopt (or do not adopt) them; what are the consequences of new technology adoption for end-users, the labour process, and the organisation; and then, finally, who decides and how – these being the issues that are central to the five questions that the present research seeks to "resolve" concerning new intra-operative artefacts.

First, the dominant technical goals of artefact technologies of *automating* and *informating* are explored from an historical perspective. Then the organisational goals of new artefact technologies are discussed under two main headings: *altruistic and/or self-interest objectives*, and *strategic choices*. My wide reading on the latter issues has resulted in the identification of three broad categories of strategic reasons why organisations choose to adopt new technologies: *organisational longevity/survival*, *quality of work life* and *control of the workforce*. Emphasis is given to topics such as organisational efficiency and productivity, the division of labour, labour displacement, deskilling, specialisation and job satisfaction. The section dealing with control of the workforce briefly overviews three non-functionalist perspectives on the topic that view technological change as being consciously motivated by the desire to change the balance of power between organisational groups (defined by occupation/profession, class, gender and/or ownership of capital).

Then some quality of work life issues concerned with ways in which new artefacts can alter the characteristics (and hence, skill requirements and quality of work life) of a person's job, are examined. This singles out the characteristics of task routineness and variability, product variability, and the propensity of a job to technological innovation, and, in so doing, focuses on changes in the technologies of *techniques* and *organisation* that are associated with changes in *artefacts*.

The chapter concludes by revisiting the topic of human agency. However, the focus shifts from the determinist/voluntarist debate with which the chapter commenced, to a synthesis of the literature dealing with organisational decision-making, and, in particular, with the political dimensions of multiple-actor decision processes in professional organisations, such as hospitals, concerning the adoption of new technologies.

3.2 Technological determinism and strategic choice

The history of work organisations, since the transition from feudal to capitalist production in the western world, is essentially a history of technological change, that is, changes in *technology* in the senses defined in Chapter 2 as *artefacts*, *techniques* and/or *organisation* (after Winner 1977). Much of the reported history of technological change in organisations (to be discussed in Section 3.3) reveals how new ideas may culminate in the introduction of new machines or other *artefacts* into the production process, or in the application of new *techniques*, such as cost-benefit analyses or the "principles of scientific management", that may or may not lead to different ways of organising the productive potential of an organisation's resources. What this history generally fails to report, however, are those ideas that were never promoted or developed, or, otherwise, were promoted/developed but never

adopted (cf. Pacey 1983). Such omissions can lead to the erroneous perception that the changes that have occurred have been because the technologies concerned had an inertia of their own that caused them to be adopted, and, in so doing, determined their effects within organisations. This interpretation of technological change ignores the role of human agents in making choices between alternative and often worthwhile technologies, or, perhaps, making choices not to change at all (Noble 1986). The competing interpretations of the relationship between new technologies and organisational change reflected by these observations find their expression in organisation theory in the *strategic choice* and *technological determinism* perspectives.

These two terms need definition and some preliminary discussion. According to Grint and Woolgar (1997:7) *technological determinism* 'holds that humans (human behaviour and even the course of history) are largely determined by, rather than having influence over, technology'. At its simplest, it 'portrays technology as an exogenous and autonomous development which coerces and determines social and economic organisations and relationships, [appearing] to advance spontaneously and inevitably' (Grint & Woolgar 1997:11; cf. Winner 1977; Mathews 1989; Braverman 1974). Pacey (1983:24) put it bluntly when he suggested that 'technological determinism…presents technical advance as a process of steady development dragging human society along in its train'.

According to Jones (1995:214), 'the term technological determinism was coined by Thornstein Veblin in about 1900 to describe a society where basic decisions were shaped by available technological capacity rather than the traditional political process based on ideology and value systems'. However, the idea of technology shaping society was put forward centuries earlier when Francis Bacon, described by Carlisle and Manning (1999:89) as the father of the theory of technological determinism, pronounced in his *Novum Organum*:

> It is well to observe the force and virtue and consequence of discoveries, and these are to be seen no more conspicuous than in those three which were unknown to the ancients, and of which the origins, though recent, are obscure and inglorious; namely, printing, gunpowder, and the magnet. For these three have changed the whole face and state of things throughout the world; the first in literature, the second in warfare, the third in navigation; whence have followed innumerable changes; insomuch that no empire, no sect, no star seems to have exerted greater power and influence in human affairs than these three mechanical discoveries.

If their description of Bacon as 'the father …of technological determinism' is simply intended to convey that Bacon seeded the idea that changes in technology have

transformational consequences for society, then I have no argument with their assertion, for Bacon's statement does not offer any position on the role of human agency in "human affairs". However, the statement clearly gives rise to the question asked in recent years by the likes of Heilbroner (1972), Winner (1977), Marx and Smith (1994), Bimber (1994), and Jones (1995): "does technology drive history?" Much of the literature that offers a response to this question appears to emphasise technology in its machine/artefact form, just as Bacon did.

I propose that the search for answers to the question, "does technology drive history?" is strongly founded in the longer-standing and unresolved philosophical debate concerning determinism and free will (cf. Berofsky 1966; Gopalakrishnan & Dugal 1998). In what is possibly an over-simplification of this age-old philosophical quandary concerning free will, the question asked by philosophers is: "is an individual's actions/behaviour determined such that (s)he could have acted/behaved in no other way in a given situation?" The argument is that if (s)he could have acted in another way (ie. (s)he was free to choose one alternative action over another), then free will was exercised. If the individual could *not* have acted/behaved in any other way, then his/her action is deemed to be determined by something(s) that pre-existed the action. The philosopher's stance is that the action is *either* determined *or* free will has been exercised – it cannot be both (cf. Berofsky 1966; Bourgeois 1984). Hence, determinism and free will are mutually exclusive opposite concepts.

My reading of the literature is that this philosophical question has been articulated in the socio-technical literature as: "does technology of its own essential nature, determine the characteristics of society?" The perspective that answers "yes" is referred to as *essentialism*, and is encapsulated in the notion of *deus ex machina* – the "machine god" (Grint & Woolgar 1997) which has the characteristic attributed to many deities – that of determining the course of an individual's life and/or human affairs in general. The perspective that answers an unequivocal "no" to this question, and regards human agency as the determinant of society's characteristics/structure, represents the *anti-essentialist* perspective (Grint & Woolgar 1997). I contend that the range of possible responses being limited to "yes" or "no" is strongly indicative of the influence of the philosophical perspective on these issues.

At this societal level of analysis, voluntarism or human agency is commonly described in terms of *social choice* (Child 1972; 1997; Buchanan & Boddy 1983; Thomas 1994; Winner 1977). According to Winner (1977:46), the basic tenet of this *social choice* perspective is that 'human beings have full and conscious choice [for example, in technological change] …and that they are responsible for choices made at each step in the sequence of change'. However,

at this level of analysis, the particular human agents who may or may not influence the structure, values, or other characteristics of society at large, are not specified. Similarly, analyses from the determinist (ie. essentialist) perspective do not specify what particular technologies may or may not determine society's characteristics. Rather "technology" is an abstract concept (Grint & Woolgar 1997). Hence, the question of whether technology drives history is essentially a philosophical one.

Grint and Woolgar (1997:7; 113) explain the dilemma confronting both socio-technical and organisation theorists with the "either/or" position as follows:

> There have been various attempts to discard the technological determinist "coat" in the form of socio-technical systems theory, the social shaping approach, socio-technical alignments, and actor-network theory, but all, in their view, seem to rescue technology from the clutches of technological determinism, only to reaccommodate it as one among several independent variables which determine action and behaviour… It seems that it is not easy for anti-essentialism to throw off the imagery of *deus ex machina*: the symbolic power of a divine spirit being encased within a machine.

Numerous authors, such as Astley and Van de Ven (1983), Hrebiniak and Joyce (1985), Littler (1988), Wajcman (1991), Adler (1992), McLoughlin and Clark (1994), and Thomas (1994) have, in various ways, expressed the need for an approach that accommodates both the technological determinism *and* social choice perspectives rather than being constrained by an either/or situation. Littler (1988:12), for example, who referred to the two views as the *technology push* and *need pull* views, posited that 'the truth may lie in the territory between the two perspectives'. Heilbroner (1972; 1994), Adler (1992), and Marx and Smith (1994) talked of *hard* and *soft* forms of technological determinism, whilst others talk of *minimum choice* and *maximum choice* perspectives (eg. Marlin, Lamont & Hoffman 1994). Marx and Smith (1994:xiv), on the other hand, debate the issue from the perspective of whether human choice 'is an expression of freedom or an expression of necessity'. However, this latter approach is strongly reminiscent of the philosophical approach, and all the more so if "choice as an expression of necessity" is really another way of saying, "no choice can be exercised".

Heilbroner's (1972) commentary on the topic, originally published in 1967, is widely regarded as seminal. He concluded that:

> to relegate technology from an undeserved position of *primum mobile* in history to that of a mediating factor, both acted upon by and acting on the body of society, is not to write off its influence but only to specify its mode of operation with greater precision. Similarly, to admit we understand very little of the cultural factors that give

> rise to technology does not depreciate its role but focuses our attention on that period of history when technology is clearly a major historical force, namely Western society since 1700 (Heilbroner 1967:37).

Twenty-seven years later, Heilbroner (1994:77-78) reinforced his position when he said:

> even in the most dramatic instances of technological determinism, as when we can trace the socioeconomic effects of the factory, the technique of mass production, or the modern-day computer, we can never eliminate the soft causal elements that are always present with, and within, those of the economic force field itself. Among these soft elements we must place many volitional elements, including most of what we call political decision, social attitudes, cultural fads and fashions, and those aspects of maximising itself in which the agent's final determination hinges on time horizons, risk aversion, and similar judgements about which no behavioural generalisations can be made. Hence the clarifying power of determinism, even at its greatest, must always allow for some degree of uncertainty. This is perhaps only tantamount to saying that our conceptions of "history" cannot embrace either a fully determined or a wholly undetermined narrative of events – a state of affairs that no doubt reveals more about our psychological limitations than about the actualities of historical sequence, whatever they may be.

In his concluding sentence, Heilbroner (1994) highlights the problems that confront theorists when their analyses of the determinism-voluntarism dichotomy do not fit neatly within either the essentialist or anti-essentialist logic. It raises a number of questions: Are the notions of "determinism" and "cause and effect" so entrenched in the mode of reasoning that theorists cannot escape the constraints of the philosophical logic that has traditionally provided the basis of inquiry? Should any single factor in society, or an organisation, be attributed with being categorically deterministic? What is so contentious about proposing that the characteristics of society are the products of interacting influences? And within organisations, what is so contentious about proposing that an organisation's characteristics are the products of interacting influences – that no single factor is *the* determinant?

Such is the dilemma confronting organisation theorists that recently Child (1997:44) expressed the growing view that 'something must be done to pull together the different perspectives on organisations if progress in the subject [of strategic choice and determinism] is to be made'. In fact, in his 1997 paper, in which he revisited his original 1972 strategic choice thesis, Child (1997:72) argued that 'the polarisation of determinism and voluntarism in organisational analysis is misleading'. This statement begs the question, "why then has

determinism been pitted against voluntarism in organisational analysis?" I propose, as I did earlier concerning macro-level social analysis, that the reason is the pervasive influence of the philosophical debate concerning determinism and free will on the questions confronting organisation theorists – questions that are different to those that concern the philosopher and the socio-technicist because they concern the micro-level world of individual organisations, as I now discuss.

The main questions on this theme that are relevant to the present thesis, and which have preoccupied many organisation theorists, particularly over the last four decades, have been: (a) 'is organisational life determined by intractable environmental constraints, or is it actively created through strategic choice?' (Astley & Van de Ven 1983:245) and (b) "does technology determine organisation structure?" (eg. Thompson 1967; Mohr 1971; Galbraith 1973; Perrow 1967; Woodward 1980). These questions are located in the area of research that is often referred to as *environment-structure research*, of which *technology-structure research* is a sub-set. In the process of their research, organisation theorists have increasingly sought to examine technology in 'a particular material form' such that its 'particular effects' can be identified' (Grint & Woolgar 1997:128). The questions have a degree of specificity that is absent in the social analysis of the environment-structure relationship, such as "what is the relationship between A and B?" or, "did A cause B?" (or, in its "softer" form, "is A an important cause of B?"). The answering of such questions is confounded by the phenomenon of *uncertainty* (cf. Thompson 1967; March & Simon 1967).

Child (1972:2) defined *organisational structure* as 'the formal allocation of work roles and the administrative mechanisms to control and integrate work activities including those which cross formal organisational boundaries'. In other words, it is an all-embracing term used to refer to what technologies and other organisational resources are selected, and how they are coordinated (eg. how the labour process is designed), who reports to whom, and how tasks are allocated (Robbins & Barnwell 1998). In their attempts to answer these questions, researchers have often re-worded them to an equivalent or some version of: "what unitary or multiple internal and/or external factors influence, or possibly determine, an organisation's structure?" In this way they have sought to ascertain whether or not technology is, indeed, *the* determinant of organisation structure, or only one of a number of influencing factors, where *human agency*, often expressed as *strategic choice,* is one of the latter (cf. Aungles 1991).

Within organisational technology-structure research, the investigation of the role of human agency has focused on the activities of the dominant coalitions, whom Child (1997:43) described as those 'leading groups who [have] the power to influence the structures of their

organisations'. Managers are *ex officio* members of the dominant coalitions. It is in this connection that, in the context of his discussion about the influences of environment, technology and organisational size on organisational structure, Child (1972) coined the phrase *strategic choice*. Strategic choice is a specific form of human agency exercised within the organisational context, and a sub-set of *social choice* (cf. Buchanan & Boddy 1983; Thomas 1994).

According to Thomas (1994:229):

> a central issue in the debate over the relationship between technology and structure is the *location* of the stimuli to change. From the technological determinist perspective, change occurs as a result of exogenous events and forces that upset the equilibrium and cause organisational adaptation. From the social choice perspective, exogenous developments certainly play a role, but they are mediated either by top-level strategic choice or by an overarching managerial imperative.

Like Child's (1997) general position, it is clear from the above statement that Thomas is not satisfied with an *either* technological determinist *or* strategic choice explanation of the technology-structure relationship. In a similar vein, Kling (1991), using phrases such as 'managerial actions helped reshape work through computerisation' (Kling 1991:363), concluded (as succinctly stated by Grint & Woolgar 1997:127) that 'although technology does not *determine* change it nevertheless has an independent effect; whether that effect is transformative or not depends on the nature of the technology itself and the way it is produced, disseminated and consumed'. Pacey (1983:25) sees technological innovation as an 'outcome of a cycle of mutual adjustments between social, cultural and technical factors [that] may begin with a technical idea, or a radical change in organisation', such that 'technology and organisation *structure one another* over time' (Thomas 1994:224-225; cf. Giddens 1984; Noble 1986).

I propose that the positions of Kling, Thomas, Pacey, and Child are supported by a substantial body of evidence in the volume of organisational research that implicitly contradicts the notion that the technology-structure relationship can only be interpreted from either an essentialist or anti-essentialist perspective. This literature, spanning at least four decades, has identified a range of factors beyond strategic choice and technology that inter-dependently influence an organisation's structure. Among them are an organisation's market, ownership, size, the nature of its business, and the characteristics of its employees (cf. Woodward 1965; Perrow 1979; Thompson 1967, 1987; Buchanan & Boddy 1983; Child 1972, 1997; Robbins & Barnwell 1998). Furthermore, taking a stance on either an essentialist or anti-essentialist

explanation also makes a nonsense of the attention given to *technique* and/or *organisation* over several centuries by the likes of Adam Smith, Charles Babbage, Frederick Taylor, Henri Fayol, Henry Mintzberg, and many, many others, concerning the management of organisations – issues that are discussed in Section 3.3.2.

Technology-structure research since the mid-20th century has gone through several phases (Adler 1992). The first phase in the 1950s and 1960s was dominated by the analysis of continuous process industries, and technologies were seen as strongly determining both the nature of the work and the way that work was organised (Aungles 1991) – a case for *technological determinism* (cf. Woodward 1980; Wajcman 1993; McLoughlin & Clark 1994). The *automating* capability of machines was either explicit or implicit in most analyses.

The second phase of research, occurring mainly during the 1970s (Adler 1992), argued against the determinist thesis on the basis that the implementation of the same technology would have very different effects in different types of societies (cf. Sabel 1982), and that the differences could be accounted for by the conscious choices of organisational members. Domains of choice include 'the markets they compete in, the techniques they employ to produce their goods or services, and the shape or structure they find most appropriate to achieving their valued goals' (Thomas 1994:2), as well as economic factors (cf. Mathews 1989). This phase saw the beginning of a shift in focus from automation *per se*, and it was early in this phase that Child (1972) published his *strategic choice* thesis.

The third phase, during the late 1970s and early 1980s, shifted away from the question of broader trends to the 'microdynamics of changes in technology and work' (Adler 1992:7) and took on more of an industrio-political emphasis (cf. Mathews 1989), particularly in relation to the 'social construction of skill definitions' (Adler 1992:8). Also, researchers started to explore phenomena, such as pre-implementation issues, that were not limited to the *effects* of technology and the *impact* of technological change on social organisation (Thomas 1994; Wajcman 1993).

The terms, *social shaping* and *social constructionist approaches* to technology were introduced in the 1980s to describe this third phase approach that recognised that (a) there were multiple factors – political, ideological, technical, economic, and other environmental factors – that shape technologies, (b) there was a range of intersecting influences on choices and negotiation within the process of technical change (cf. Wajcman 1993), and (c) 'the relationship between society and technology [was] not a linear one between two separate

elements, but [was] reciprocal' (Wajcman 1993:21; cf. Hrebiniak & Joyce 1985; Gopalakrishnan & Dugal 1998).

However, during the third phase, researchers, such as Buchanan and Boddy (1983), were continuing to emphasise the strategic choice perspective and were arguing that, just because the tasks that have to be performed change when technology changes, it does not mean that a technology is deterministic.

Subsequently, Thomas (1994) proposed his *power-process perspective* that accommodates both the technological determinist and social choice perspectives in the sense that it 'simultaneously diverges from and bridges the technological determinist and social choice perspectives' on organisational change (Thomas 1994:224). He argued that it is not a case of *either/or*, but one of *both* technological determinism *and* social choice.

Despite such a body of evidence to show that neither the essentialist/determinist nor anti-essentialist/voluntarist perspectives of technology can be sustained, attaining a post-essentialist position, is, according to Grint and Woolgar (1997:114), 'a position to which we aspire rather than one we can claim to have yet attained'. They explain that:

> as prisoners of the conventions of language and representation, we display, reaffirm and sustain the basic premises of essentialism that entities of all kinds, but most visibly and consequentially technical artefacts and technological systems, possess characteristics and capacities, and are capable of effects. This seems to be a fundamental property of the objectivist language game in which we are all embroiled (Grint & Woolgar 1997:114).

Progress towards the integrated perspective sought by many researchers is not only constrained by the "conventions of language and representation", but by a range of other factors. For example, Buchanan and Boddy (1983:18) cited Bedian who, in 1980, reported that 'the research dealing with the influence of technology on structure is not only conflicting but in extensive disarray'. Some of the problems Bedian identified related to the analysis of different types of organisations, different levels of within-organisation analysis, and the application of different concepts of "technology". For example, many researchers have limited their definition of "technology" to artefacts. Others have considered it inappropriate to explore the technology-structure relationship where the artefact (if there be one – cf. Heilbroner 1994:77; Winner 1977) is considered independent of its intangible aspects such as the knowledge inherent in it, the human skills associated with its application, or the particular features of how the technology is incorporated into a specific organisational context.

I suggest that interpreting the research today is confounded even further by the blurring of the boundaries between societal and organisational levels of analysis, and what type of determinism (eg. technological, environmental) is being pitted against what particular category of human agency (eg. social choice, strategic choice, individual choice) (eg. Hrebiniak & Joyce 1985; Gopalakrishnan & Dugal 1998). However, I propose that the principal "stumbling block" to an integrated perspective is the pervasive logic of the philosophical debate concerning determinism and voluntarism, and I devote the remainder of this section to my *mediated attribution perspective* on this "problem".

Hrebiniak and Joyce (1985:337) confronted the influence of the philosophical position on the debate when they proposed that, within organisations, 'choice and determinism are not opposite ends of a single continuum of effect but in reality represent two independent variables'. Their proposition was subsequently given credence by Marlin, Lamont and Hoffman's (1994) research. Marlin et al. (1994) studied a number of environmental variables (among them "technological sophistication") in association with strategic choice, and concluded that 'strategic choice and environmental determinism [were] identified empirically as independent factors' (Marlin et al. 1994:237).

I believe that their conclusion draws attention to a fundamental but, apparently, overlooked characteristic of the organisational environment-structure relationship that should distinguish the logic of voluntarism and determinism at the human individual level (ie. the purely philosophical level) from that of voluntarism and any form of determinism at the organisational level (or, indeed, the macro-social level). I propose that it is a flawed logic that treats the technological determinism and strategic choice debate within the organisational context as an extension of the philosophical debate concerning determinism and free will. The important point is that the philosophical debate concerns a single actor for whom determinism and free will *are* mutually exclusive opposite concepts. The same is not true for organisations, because determinism and human agency will each have its own continuum of effect (cf. Hrebiniak and Joyce 1985). Moreover, the notion of "continuum" implies not only *either/or*, but *and* – and thus it accommodates degrees of strength of *both* factors across their individual continua of effect. It is evident from the technology-structure relationship literature, that in organisational analysis, two or more "actors" are involved, each with its own 'continuum of effect'. In the dominant "machine/artefact" perspective of technological determinism, the two "actors" are the inanimate *deus ex machina* (Grint & Woolgar 1997) and the animate human agent. They are both independent and inter-dependent (cf. Thomas 1994; McLoughlin & Clark 1994; Wajcman 1993).

Furthermore, the environment-structure literature draws attention to how the *degree of specificity* of analysis of determinism and voluntarism differs in organisational analysis to social and individual human analysis. The following observation serves to highlight this point. Carlisle and Manning (1999:90) proposed that:

> Babbage became the leading exponent of the principle of technological determination of the diminished labour value of men working without machinery. This he did by distinguishing the slow making of articles by coordinated hands from the swift synchronised manufacture of artefacts by blueprint design and template reproduction.

This statement contains both organisational and social dimensions, because Carlisle and Manning (1999) have identified how, within a capitalist economy, technological innovation in one firm has consequences for both the innovative organisation and other firms. In Babbage's scenario, the consequence for other (non-innovative) firms is the diminished labour value of their workers. This is categorically a *social consequence* that may or may not have been a conscious consideration of the decision-maker(s) in the innovative firm. However, there is also a cause-effect relationship at play here, regardless of whether the manager/owner of the innovative firm made a conscious choice to devalue the labour of unknown workers elsewhere. In other words, in the context of the capitalist market, the decision of one firm to innovate will determine that the labour value of workers in competing firms is diminished, *ceteris paribus*.

In the Babbage scenario there were also *within-organisation consequences* of introducing the machinery in the innovative firm. I propose that the choices of decision-maker(s) to introduce machinery were made with certain outcomes in mind (eg. increased productivity, producing products at more competitive prices, and so on). Whilst doing so, they knew that, unless they also wanted to increase their organisation's output volume, they would achieve their desired outcome(s) only by reducing the number of workers (cf. Mill 1871 in Kapp & Kapp 1949:150). The process of managers weighing up these costs and benefits, along with their consideration of how the new technology might affect organisational structure, is implicit in the concept of *strategic choice* (after Child 1972).

But the question remains, did the introduction of the machines *determine* the nature of work for the retained workers? Certainly the machines necessitated changes in how the workers did their work. This is evident in the distinction between the 'slow making of articles by coordinated hands [and] the swift synchronised manufacture of artefacts…' (Carlisle & Manning 1999:90). However, this does not mean – workers' potential influence aside – that the manager/owner did not make choices about how to configure the machinery within the

factory, how labour would be divided to accomplish the various tasks, or what the daily output (and, hence, the pace of work) of individual workers should be (cf. Coombs 1985). Consequently, based on the persuasive evidence of current literature, I propose that in this scenario *both* the machinery *and* the choices made by human agents were contributing causal factors in the changes to the workers' work.

This conclusion articulates into a general principle: that all new technology can be *attributed* with the power to transform organisational structure somehow (ie. to effect change in some entity and/or process), otherwise there is nothing new about it, but its capacity to do so is *mediated* by individual and/or collective human agency. This is not inconsistent, for example, with Gidden's (1984) structuration theory or Thomas' (1994) power-process perspective. Nor is it inconsistent with Noble's (1986:xi) summation that 'technology does not necessitate, it merely consists of an evolving range of possibilities from which people choose', or Coombs' (1985:169) conclusion that a new technology forms 'a nucleus for [the] process of change, but… it does not determine the work changes'. However, cognisant of the influence of the socio-technical literature on the debate (eg. Grint & Woolgar 1997; Jones 1995; Winner 1977), I have sought to sustain this conclusion by way of 'a reasoned argument' (Gopalakrishnan & Dugal 1998:10) about why it is inappropriate to treat the technological determinism and voluntarism debate within the organisational context as an extension of the philosophical debate concerning determinism and free will.

3.3 Technological change in organisations – choices and consequences

The concepts of *choice* and *consequences* have been pervasive themes of the preceding section, which devoted much of its discussion to the theoretical debates surrounding the influence of human agency/choice on organisational structure and the deterministic nature of artefact technologies in organisations. This section, whilst no less founded on the theoretical literature, explores the more practical aspects of the logic behind organisations' choices of technologies and the consequences of new technology adoption for both the organisations and their workers.

3.3.1 Technical goals of "artefact" technologies

In this section, the technical goals of artefact technologies applied to the production of goods or services are explored in terms of their capacity to *automate* and/or *informate* the production process. It is useful to start an examination of the technical goals of artefact technologies employed in the production of goods or services with a snapshot of the history of production over the last few centuries. Most literature on the subject distinguishes work in

feudal times – work that was characterised by family units engaged in agricultural and craft labour – from the nature and organisation of work that occurred during, and has occurred since the Industrial Revolution (cf. Mumford 1962). This "revolution" is acknowledged as having commenced in the western world in the late 18th century. Deane (1965), Mathews (1989), Wren (1994), and others refer to the evolution from largely feudal to industrial work organisation as the *first industrial divide/revolution* to distinguish it from a more recent *second industrial divide* that is largely associated with the use of computers to control production.

Zuboff (1988:22-23), in *The Age of the Smart Machine*, observed that 'throughout most of human history, work has inescapably meant the exertion and often the depletion of the worker's body'. However, since the first industrial revolution that brought about the progressive destruction of feudal work organisation, manufacturing technologies (ie. machines) have been 'systematically applied to the problem of the [human] body', amplifying and surpassing the organic limits of the body, and compensating for the body's fragility and vulnerability. Consequently, 'industrial technology has substituted for the human body in many of the processes associated with production and so has redefined the limits of production formerly imposed by the body' (Zuboff 1988:22). In short, mechanical devices applied to primary and secondary industry production are characterised by their capacity to complete tasks quicker and with more consistent quality than a human worker. They can also perform tasks that are physically demanding or impossible for human workers to do (Littler 1988).

According to Mathews (1989:15), in *Tools of Change,* 'mechanisation has been the principle source of technological change in the workplace over the past century, taking over former craft areas one by one'. Mechanisation *automated* one or more of the processes that had previously been *manu*factured (ie. made by hand – from the Latin *manus,* "hand", and *facere,* "to make") (cf. Cockburn 1983; Heilbroner 1989; Hirschhorn 1984; Aungles & Parker 1992; Williams 1992). Until the mid-1900s these machines were predominantly physically operated and controlled by workers. The introduction of the assembly line by Henry Ford at his motor vehicle plant in 1913 added the dimension of the control of a worker's pace of work by bringing the work to the worker via a continuously operating, endless-chain conveyor system (Mathews 1989; Probert 1989). However, the tasks performed by the worker did not begin to change until the introduction of mechanically sequenced assembly systems. These latter changes represented the second phase in the automation of machines – what Mathews (1989) refers to as *hard automation.* This is pre-computer programmed automation characterised by

assembly systems or robots that followed predetermined mechanical sequences that were built into them (cf. Braverman 1974). It was a phase of automation that was implicated in the diminished role of the human operator in the control of machines, and was a predecessor of computer-controlled automated production.

The *second industrial divide* (Piore & Sabel 1984) is generally regarded to have occurred with the application of computerisation to automated production. As Hirschhorn (1984:52) explained, 'beginning in the early 1960s, …computer technology wedded to solid-state circuitry' provided a new technical basis for controlling production – a phase that Mathews (1989) describes as *programmable automation* (cf. Noble 1986), and characterised by what Zuboff (1988) and others (eg. Elam 1994) refer to as the *informating* of the automation process. The transformation from hard automation to programmable automation was, by virtue of the latter technologies being controlled by information coming from outside their direct working mechanism, a phenomenon often referred to as "machine intelligence", that incorporates processing, memory and programming capacity.

According to Zuboff (1988:11):

> automation is a necessary but not sufficient condition for informating. [In fact] these dual capacities of information technology are not opposites [but] are hierarchically integrated. Informating derives from and builds upon automation [but] it is quite possible to proceed with automation without reference to how it will contribute to the technology's informating potential.

Importantly, informated machines are generally more flexible in the functions they perform than their predecessors (Braverman 1974; Littler 1988; Adler 1992). Hirschhorn (1984:57) put it this way:

> Flexible machinery creates a machine system potential, a capacity to produce many different parts, or combination of parts, and to change the volume of production. Moreover, as [a] company's market changes, the machine system's distinctive competence will change. Engineers will develop new software, new control programs, and new configurations of the hardware at hand to adapt the machine to its setting.

Overall, changes in the nature of work since the second industrial divide are generally regarded as having further reduced the physical component of human labour but increased the mental labour component (Adler 1992; Zuboff 1988; cf. Coombs 1985), such that many production workers no longer come into physical contact with the products, but rather "watch through an interface" and "push the buttons" that operate the machines that make the products (Adler 1992; Williams 1992; Hirschhorn 1984; Cockburn 1983). It has also

stimulated debate about the feasibility or otherwise of operator-less machines (Adler 1992; Zuboff 1988).

These observations raise some important questions, such as: (a) "what goals are new artefact technologies expected to achieve for an organisation, and why?"; (b) "what are the implications for workers of new technologies being introduced into their working environments?"; and (c) "what and who drives the technological innovation and adoption processes, and why?" The following sections review the literature that provides responses to these questions.

3.3.2 Organisational goals of "artefact" technologies

In the light of the foregoing discussion on the automating and informating capacities of new artefact technologies, the guiding question here can be reworded to ask, "why might organisations employ informated and/or automated technologies in the production of their goods and/or services?"

The previous discussion highlighted the fact that technological developments do not occur in an historical or motivational vacuum. Rather, new technologies are created and further developed with one or more purposes in mind, and are usually the result of innovation followed by a process of gradual modification to, and new combinations of, existing technologies (Wajcman 1991; cf. Littler 1988; Pacey 1983). Furthermore, any one or more of a number of factors might influence the adoption of new informating and/or automating technologies, the choice between technologies, and their methods of implementation within organisations. It would be impossible to attempt to discuss all of the specific reasons why organisations might adopt new product technologies in the production of their goods and/or services. However, in the course of my reading on the question, I have concluded that the organisational goals of new artefact technologies can be effectively discussed under two headings: (a) altruistic and/or self-interest goals and (b) strategic choices. These goals are not mutually exclusive of one another.

Altruistic and/or self-interest goals

Underpinning the discussion here is the fundamental principle that all social organisation exists for a purpose (Robbins & Barnwell 1998; Shafritz & Ott 1987). Two purposes are predominant: the *altruistic* goal of satisfying consumers' changing needs and wants for products and/or services, and the owner's (and possibly shareholders') *self-interest* goal for financial gain. These concepts of *altruistic goals* and *self-interest goals* represent two extremes of a continuum concerning the reasons for any organisation's existence.

I propose that, in its extreme form, *altruism* is characterised by an intense concern for improvements in social welfare, charity, and not-for-profit. At the other end of the continuum, *self-interest* is characterised by the profit motive with no regard for improvements in social welfare. Whether or not it is feasible for an organisation's goals to be described as purely altruistic or purely self-interested is not important here but, rather, what might be the *dominant* characteristic of an organisation's goal(s). (Here, the notion of "dominant characteristic" refers to the value – altruism or self-interest – that exerts the greater influence on an organisation's behaviour.) Some organisations might espouse to purely altruistic goals (for example, religious orders and their "faith" workers), whilst others might appear to be single-minded in making as much profit as they can. However, in practice, these dominant goals are moderated by, on the one hand, for example, a religious order's need for the financial resources necessary to fulfil its goals, and, on the other hand, the ethical obligations of for-profit organisations concerning the impact of their behaviour on society (such as environmental protection, non-exploitation of workers, and so on).

Concerning self-interest (cf. March 1982), the literature in the disciplines of economics and marketing deal with the interdependent concepts of the supply of, and consumer demand for, goods and services (eg. Skinner 1970; Folland et al. 1993), and the dominantly self-interested profit motive of organisations to produce the goods and/or services to satisfy consumer demand (ie. to fill a niche in the market) (cf. Cockburn 1983; Shafritz & Ott 1987). The self-interest goal is clearly stated in the frequently quoted words of Adam Smith (1776, reproduced in Skinner 1970:44) when he observed, 'it is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own self-interest'.

New technologies play an important role in dominantly self-interested organisations insofar as they provide the means to maximise their potential for operating at a profit and staying in business (cf. Babbage 1832; Richardson et al. 1991).

The micro-economics literature differentiates between consumer demand/wants and consumer need (Folland et al. 1993; Mooney 1992), and it is consumer need that the altruistically motivated organisation aims to satisfy. Again, the role of new technologies is to assist in the achievement of an organisation's goal(s). It might operate some need-satisfaction technologies at a financial loss, because it is able to produce other goods or services at a profit. Hence, unprofitable products or services can continue to be produced to the extent of an organisation's fiscal limits, tempered by its economic judgement concerning both the opportunity costs of producing one product mix over another and the potential for a social

welfare gain resulting from any given mix of profitable and unprofitable products/services (cf. Richardson 1990; Wilson & Wilson 1982).

These 'conventional market' (Mooney 1998:4) economic principles reflecting the *self-interest* of the capitalist producer are expressed in the 1871 writings of Mills (published in Kapp & Kapp 1949:150) who observed that:

> …the production of a commodity is the effect of labour and expenditure, [and] whether the commodity is susceptible to unlimited multiplication or not, there is a minimum value which is the essential condition of its being permanently produced. The value at any particular time is the result of supply and demand; and is always that which is necessary to create a market for the existing supply. But unless that value is sufficient to repay the cost of production, and to afford, besides, the ordinary expectation of profit, the commodity will not continue to be produced. Capitalists will not go on permanently producing at a loss.

Chapter 2 briefly discussed some of the structural and operational differences between public and private hospitals in Australia. Although all hospitals would argue that their fundamental goal is to improve social welfare by means of improving the health status of the population, it is well recognised that public hospitals and not-for-profit private hospitals are more likely to provide some unprofitable services than the for-profit private hospitals. This means that, in their new technology adoption decisions, the for-profit private hospitals can be considered to be motivated more by self-interest than the other two categories of hospitals. However, such a simple analysis becomes "muddied" by the fact that it can also be argued that it takes a degree of self-interest for a public hospital, operating on a fixed grant budget, to produce its services on a break-even basis, because otherwise it could not stay in the business of providing the health services required by the community. In other words, even the most altruistic of organisations wanting to fulfil its service goals needs to adopt strategies whereby it can ensure its survival (Robbins & Barnwell 1998).

However, all of an organisation's stakeholders might not share an organisation's dominant value concerning the technical and/or organisational goals of new technologies. Of particular relevance to the present thesis is the largely autonomous, consultant status of procedural specialists (discussed in Section 2.8.2) and their motives for adopting new clinical diagnostic or therapeutic technologies. Clinical goals aside (discussed in Section 2.5.3), procedural specialists have a vested pecuniary interest in the introduction of new intra-operative artefacts and, although hospitals acquire most of the technologies for them to use, they stand to gain financially from the professional fee they will obtain when they use the technologies. This

situation is complicated by the nature of the consultant doctor-patient relationship that Mooney (1992; 1998) refers to as a special form of *agency* in which:

> …in the consumption of health care, the consumer sovereignty of the individual is threatened by the position occupied by the doctor. The patient has to trust that the doctor will act in his or her (ie. the patient's) best interest. … [However], while acting as an agent for the patient in shaping the demand for treatment, at the same time the doctor specifies the supply of treatment. In doing so the doctor is constrained, by his/her acceptance of medical ethics, to determine the treatment through his/her role as agent and not, as would be the case for suppliers in other sectors of the economy, for self-gain – pecuniary or otherwise (Mooney 1998:10).

Hence, procedural specialists are positioned as key stakeholders with several vested interests in the acquisition of new intra-operative artefacts.

Strategic choices

Implicit in the concept of *strategic choice* (cf. Child 1972; 1997; Thomas 1994; McLoughlin & Clark 1994) is the notion that the strategies that are employed with the goal of maximising an organisation's technical and productive potential represent only some of those alternative potentially successful strategies considered by organisational decision-makers at any time. In an environment of uncertainty and diverse stakeholder interests, it is a question of choices having to be made about what strategies are most likely to be successful in achieving an organisation's goals. Several strategic goals of new technology adoption are now considered: organisational longevity/survival, quality of work life, and control of the workforce.

Organisational longevity/survival

Mills' (1871) previously cited statement (in Kapp & Kapp 1949:150) that an organisation's revenue must be at least 'sufficient to repay the cost of production' highlights the fundamental principle of organisational *longevity/survival*. Most organisations have the goal of staying in business for the long term. This is achieved either by attracting sufficient charitable donations to sustain their operations or by conducting profit-making ventures in the competitive market. Either way, if it is to survive, an organisation needs to employ an appropriate mix and volume of human, technical and capital resources, along with the strategies to maximise its technical and productive potential (cf. Coombs 1985; Wren 1994).

It is generally regarded that developments in both *automating* and *informating* technologies have increased the output potential of the average human worker (in terms of increased output quantity, the production of new products/services that could otherwise not be

produced, and improved product/service quality). In other words, new technology's capacity to amplify and surpass the organic limits of the body (Zuboff 1988) has resulted in more *productive* employees and, hence, more productive organisations. However, increased productivity alone will not ensure an organisation's survival. Rather, survival in the market is dependent on the organisation being able to produce the "right" volume of goods and/or services and to sell them at a cost that is at least no lower than the income it derives from their sale *and* at prices that consumers are willing to pay (Mills 1871 in Kapp & Kapp 1949; Williams 1992). Implicit in this latter notion is the *price competitiveness* of the goods/services – something that will be very dependent on how *efficiently* the organisation can produce and sell its products.

Now, *efficiency,* viewed by classical organisational theorists as the dominant goal of organisations (Shafritz & Ott 1987), is generally thought of in terms of achieving maximum output from a given input of resources to the production process, combined with *cost minimisation*. This is *technical efficiency* in the microeconomic sense (Folland et al. 1993). Emerson (1924:x), in *Twelve Principles of Efficiency,* picked up on Adam Smith's three inputs (ie. "factors") to production to refer to *efficiency* as 'less labour and capital and land per unit of production', whilst, more recently, the Massachusetts Institute of Technology coined the phrase, *lean production*, to describe this notion (Bradley, Erickson, Stephenson & Williams 2000). In the long term, an efficient organisation is likely to undercut an inefficient one on selling price on similar goods/services and still return a *profit*, thereby enhancing its potential to achieve its economic objectives and stay in business.

Probert (1989:132) encapsulates the key "rational management principles" (cf. Guillen 1994) or return-on-investment principles in the following statement:

> The driving force behind …technological innovation is the competitive structure of the capitalist economy. Firms which fail to find the funds for reinvestment or expansion face extinction in the longer run. Profit-maximising behaviour is a requirement of the system. However, …profit-maximising is not simply a question of finding technical improvements which lead to greater efficiency. It is equally a question of finding new methods of controlling the labour force, both to ensure that it works as fast as possible and to minimise costs.

The distinction here between *technical improvements* (ie. *new artefacts*) and *methods* (ie. *techniques*), which was discussed in Chapter 2, is an important one. It is important because an organisation's economic objectives are not necessarily dependent on the application of

artefact technologies, although it is likely that, in many instances, it will involve them (Mathias 1983; cf. Macdonald 1983).

However, the widely acknowledged influential contributions of commentators such as Adam Smith (reproduced in Skinner 1970), Charles Babbage (1832), Frederick Taylor (1947, 1967), Max Weber (translation of 1911 work in Parsons 1947), and Peter Mathias (1983) on the topic of the *technical efficiency* of organisations, focus largely on *techniques* associated with the efficient organisation of work aimed at maximising the benefits accruing to organisations from their technologies. For example, Mathias (1983:18), a general economic historian, proposed that 'gains in productivity do not come alone from the installation of new [artefact] technology – but involve also the commitment of workers, the efficiencies of management and organisation, the provision of specialist financial and business professional services, [and] the financing, distribution, selling and marketing of products'.

Furthermore, there is evidence that the availability of new artefact technologies is no guarantee that they will be adopted, or, indeed, that they will result in increased productivity (Bradley et al. 2000). In her study of organisational communication before computers, Yates (1989:274-275) concluded that 'technologies are not necessarily adopted when they are invented, but rather when a shift or advance in managerial theory [leads] managers to see an application for them'.

The formative commentaries on the *organisation* aspect of technology as a means of enhancing organisational efficiency and productivity are located largely in the political economy literature. Whilst these and the *techniques* aspect of technology need to be appreciated in their historical context, most remain influential today (cf. Mathews 1989; Robbins & Barnwell 1998). The *division of labour* is probably the most significant and enduring of *"organisation" technologies*.

In her thesis on the division of labour, technical change and economic growth, Corsi (1990) reported how the concept of the division of labour is included in the writings of many eminent Greek philosophers, but that it was not until the 17th century economic literature, by the likes of Petty, that the concept was rediscovered and linked with the concepts of productivity, cost reduction and competitiveness in "modern manufacture". However, according to Landreth and Colander (1994), Smith (1723-1790) was the first writer to emphasise the principle that *specialisation* and *division of labour* increased the *productivity* of the labour (cf. March & Simon 1958; Rueschemeyer 1986).

In the first chapter of Book 1 of his seminal work, *An Inquiry into the Nature and Causes of the Wealth of Nations,* Smith (1776, reproduced in Skinner 1970:46) identified two types of division of labour, both of which are of interest in the present thesis: (a) the *social division of labour* (ie. 'by types of employment'), and (b) the *industrial division of labour* (ie. 'within each employment'). Smith illustrated the latter type – known also either as the *division of labour by process* or as *task fragmentation* – with, as he put it, 'the celebrated example of the pin; a very trifling manufacture which nonetheless required some eighteen distinct processes for its completion' (Smith in Skinner 1970:46). Each distinct process would be completed sequentially by a different worker or by machines that could duplicate or assist in one or more of the processes otherwise performed by a worker. The net effect of the industrial division of labour was a dramatic change in the nature of work from the former craft modes of production (Heilbroner & Galbraith 1990:23).

The great benefit that Smith (in Skinner 1970:110) saw deriving from the division of labour was that 'so far as it can be introduced, [it] occasions, in every art, a proportionable increase of the productive powers of the labour', something he ascribed to *artefacts*, *techniques*, and *organisation* – the latter accruing from worker *specialisation* and 'the saving of time which would otherwise be lost in passing on from one type of work to another' (Smith in Skinner 1970:46). Over fifty years later, Babbage (1832) wrote, in Chapter XIX of *On the Economy of Machinery and Manufactures*, that 'the most important and influential cause' of cost saving from the division of labour had, however, past unnoticed:

> that the master manufacturer, by dividing the work to be executed into different processes, each requiring different degrees of skill or of force, can purchase exactly that precise quantity of both which is necessary for each process; whereas, if the whole work were executed by one workman, that person must possess sufficient skill to perform the most difficult, and sufficient strength to execute the most laborious, of the operations into which the art is divided (Babbage quoted by Braverman 1974:79-80).

By the beginning of the twentieth century, machines powered by steam and other forms of energy, and assembly lines, had become the "norm" of manufacturing industries, and it was at around this time that Frederick Taylor argued that 'high levels of productivity could only be achieved where management was in total control of the production process, and where workers obeyed "scientifically" determined details down to the finest detail' (Probert 1989:128). Taylor's *scientific management* principles were based on using the "right way"

[the most efficient way] of doing each task (Taylor 1947; Wren 1994). Zuboff (1988:43) summarised the essential logic of Taylor's approach in three steps:

> First, the implicit knowledge of the worker was gathered and analysed through observation and measurement. Second, these data, combined with other systematic information regarding tools and materials, laid the foundation for a new division of labour within the factory. It became possible to separate planning from task execution, to increase the fragmentation and thus the simplicity of production jobs, and so to minimise the amount of skill and training time associated with efficient operations. Third, the new system required a variety of specific control mechanisms to ensure the regularity and intensity of effort while continuing to supply managers and planners with the data necessary for adjustment and improvement.

According to Wren (1994:229-230), 'scientific management was not an invention; it was a synthesis, a stage in evolving management thought'. He proposed that while Babbage 'could lay a valid claim to the formation of a rational, systematic approach to management', it was Taylor who 'gave systematic management a voice' and provided the synthesis that resulted in a set of *techniques* (cf. March & Simon 1958) and 'a philosophy of managing human and physical resources in a technologically advanced world where people had gained greater control over their environment than ever before'. However, Taylor's contribution was not limited to management *techniques* which resulted in 'the ultimate standardisation of all elements surrounding and accompanying the job'. This was because these changes often stimulated improvements in *artefact technologies* – 'tools, machines, and materials' (Wren 1994:110) – an outcome possibly partly attributable to the increased co-operation that Taylor (1947) claimed to have occurred between management and the workman (*sic*) (see chapter endnote) as a result of the mental revolution that had occurred under scientific management (cf. Wood 1989).

A later development on these Tayloristic principles has been *operations research.* Baumol (1961:4) refers to this in terms of 'optimality analysis'. However, Wren (1994:395-396) proposed that 'the differences between the "one best way" and an "optimal" decision is moot' because both schools of thought 'sought through the scientific method to rationally evaluate alternatives in an effort to find the best possible decision ...to solve the age-old management problem of the optimum allocation of scarce resources toward a given goal' (cf. Shafritz & Ott 1987; Guillen 1994).

Now, concerning *artefact technologies*, Littler (1988:83) argues that 'companies may feel compelled to participate in the development of technology because they believe the future

will be different from the past and because they fear that if they do not keep abreast of technological change, they may be left behind by those competitors who do'. He suggests that an organisation may employ a new artefact technology for one or more of four reasons (Littler 1988). All are categorically *strategic choice* strategies concerned with the organisational efficiency/optimality goal of maintaining a commercially viable product portfolio and protecting an organisation's present and future markets. All are important for organisational longevity/survival and success.

It is widely recognised that since the first industrial revolution, artefact technologies and their associated technologies have progressively replaced the relative demand for human labour in production (cf. Shafritz & Ott 1987; Wren 1994; McKenna 1999). In fact, when Smith (1776, in Skinner 1970:46) spoke about increased productivity resulting from the division of labour, he included, as an important contributing factor, the fact that machines 'facilitate and abridge labour, and enable one man to do the work of many'. In other words, they *displace human labour* (Wajcman 1993; Thomas 1991; Hill 1988; Shafritz & Ott 1987). In 1911, Taylor (1967) promoted his scientific management philosophy on the basis of its capacity to increase the prosperity of workers, thereby improving their quality of life as a result of their potential to earn more because of his piece rates incentive system based on worker output. Although he strongly defended scientific management principles against allegations that increased production efficiencies would 'throw men out of work' (Taylor 1947:13; 1967:27), his argument only held true as long as there was a market for the increased levels of production – a concern raised as early as 1906 by Veblen, and later by Gantt, as the problem of "overproduction" (Merkle 1980).

According to Probert (1989:128), *labour displacement* 'has been a central consequence of technological innovation since before the [first] industrial revolution'. In fact, she argued, 'industrial workers could never have come into existence if technological innovation had not rendered their labour unnecessary on the land', thereby progressively creating an entirely new category of worker – the industrial worker. Since the second industrial divide, *labour displacement,* a phenomenon that has also become known as *technological unemployment* (Markey 1983), has not been limited to production industries. For example, Applebaum (1993:63) observed that the automating and informating capacities of new technologies in the form of 'office automation and inventory control technologies have profoundly altered production in industries largely unaffected by earlier rounds of technological innovation'. She reports that 'accounts of paper-less offices, operator-less telephone systems, and teller-less banks figure prominently in descriptions of the new efficiencies to be achieved with these

technologies' (Applebaum 1993:63). Hill (1988) observed that an accompanying strategy was multiskilling or the upgrading of skills (cf. Williams 1992), but was of the view that this was either a temporary hiccup in a path towards skill replacement or a smokescreen for the job replacement which was occurring.

Similarly, Zuboff (1988) concluded from her research conducted at the Piney Wood Nuclear Reactor plant that *labour displacement* is a managerial expectation of new informated/automated technology adoption. She said:

> perhaps the most compelling reality that drives managers to a narrowly conceived emphasis on automation is the web of economic logic in which they must operate. Frequently expenditures for new technology can be justified only as a capital substitution for labour. It is often assumed that whatever was provided by the human contributor can be transferred to the automatic functioning of the machine system. A top manager at Piney Wood explained: "The signal to the organisation is, reduce the number of people." The traditional logic here is that if you begin with one hundred positions and bring in new technology, you should end up with seventy-five positions. The technology is used as a lever to reduce staff (Zuboff 1988:248-249).

Similarly, in his multiple case study of technological changes in a major North American aerospace and electronics manufacturing firm, Thomas (1991:184) observed that new technology proposals were commonly justified on the basis that 'increased productivity resulting in the elimination of direct labour' would occur (cf. Adler 1992). In fact, from his study of a number of firms, Thomas (1994:207) concluded that 'the idea of technology – and more specifically, the idea of automation as a labour-saving device – can itself become institutionalised'. Furthermore, organisations may introduce new technologies that are deliberately designed to deskill and eliminate human labour in order to ensure returns on their investments – that is, to recoup the costs associated with acquiring and operating the new machines from the savings in labour costs (Wajcman 1993; cf. Hill 1988).

In conclusion, appropriately selected and efficiently managed technologies contribute to *organisational longevity/survival*. Labour displacement is, more often than not, an intentional outcome of new artefact technology adoption, made necessary by the high cost of the technologies and the expectation that new technologies will result in some combination of improved organisational productivity, organisational efficiency and product quality. In a competitive market, these are favourable outcomes for organisations, but the pressure on managers to achieve them can exert pressure down the line on workers having to work harder and faster (cf. Johnstone 1999), and result in uncertainty amongst workers about their job

security (Littler 1988) and the future relevance of their particular knowledge and skills in the workplace (cf. Cockburn 1983).

The *division of labour* has been, and continues to be, an important principle of work organisation. However, it has undergone considerable transformation since the 1920s under the influence of the Human Relations School of researchers who sought to counteract the allegedly dehumanising aspects of Taylorist/Fordist work design principles (Mathews 1989). Under Taylorist/Fordist principles, the division of labour resulted in deskilled workers who performed a narrow set of repetitive, and often boring and/or alienating tasks (Wren 1994; Rueschemeyer 1986). However, the following subsection shows that the Human Relations School was influential in improving quality of work life in a number of ways, including job rotation, and job enlargement, as well as improving general working conditions. That said, there is evidence that some of the gains made in Australian working conditions during much of the twentieth century are being eroded by a combination of changes in labour relations legislation, the high cost of new technologies, and market competition (cf. Adler 1992).

Quality of work life

This subsection focuses on the goal of the organisation to alter characteristics of the human-technology interface specifically in relation to changes in the nature of work and the quality of work life of employees. The literature on the topic can be categorised as belonging to two related areas:

(a) where changes in quality of work life are by-products of rational strategies to improve organisational efficiency, productivity and/or product quality using new technologies, and
(b) where improvements in quality of work life result from the correction of substandard working conditions with new technologies.

Historically, the *division of labour* is generally regarded as having simplified work by comparison with the former structuring of work around the crafts, because employees were no longer required to have as many skills as craftsmen. However, workers were expected to become highly skilled (such that they could work faster and at a consistent level of quality output) at those tasks that they did perform. In current parlance, such workers could be classified as *specialists* (Rueschemeyer 1986), although they had only a few specialist skills.

Wren (1994:332) reported that, as early as 1776, 'Adam Smith warned 'that the division of labour could lead to an adverse impact on workers despite its economic advantages'. This "adverse impact" of repetitive, monotonous tasks and job simplification that led to worker boredom, was central to the concerns of the Human Relations School of researchers from the 1920s. There was growing recognition that the source of this problem was not necessarily (or

only) the machines, but the way that work was organised to operate them – in particular, the division of labour using Taylorist/Fordist principles. In other words, the three aspects of "technology", *artefacts, techniques* and *organisation* (after Winner 1977) were recognised as being problematic in various ways. By the mid-1940s, some employers had started to implement various "work humanisation" strategies to counteract "the problem of the repetitive job". For example, in 1950, Walker proposed an "innovative" idea – *job enlargement* – wherein the jobs of two or more machine operators were combined into a single job. He claimed that workers' jobs were enriched because of greater task variety and personal responsibility, and that this, in turn, led to higher quality products and less idle time for both workers and machines (Walker 1950). Enriched jobs, in turn, were correlated with increased *job satisfaction* (Herzberg 1966; Herzberg, Mausner & Snyderman 1959), and thence, more productive workers (Robbins, Bergman & Stagg 1997).

Other work humanisation strategies followed. For example, Mathews (1989) has enumerated a number quality of work life practices that resulted from the Human Relations School approach. Of interest here are: *job enlargement, job enrichment, job rotation,* and *the introduction of team and group work.* Mathews (1989:97) explained that *job enlargement* 'is taken to mean an increase in the number of tasks performed by the worker as part of a job'. It counteracts the division of labour by process (ie. task fragmentation) described by Smith (in Skinner 1970). *Job enrichment* 'is generally taken to mean the grouping of tasks of different quality, such as set up, maintenance and supervisory tasks, into a single job' (Mathews 1989:98; cf. Adler 1992). To some extent it counteracts the Taylorist principle of the separation of conception (ie. abstract knowledge) from execution (ie. practical knowledge) (cf. Piore & Sabel 1984). *Job rotation* 'is normally taken to mean the planned rotation of a worker through a number of tasks, all of comparable challenge and requiring comparable skill. It is a means of adding task variety to a worker's job without having to make any changes to the tasks themselves [and] has most frequently been implemented on assembly lines' (Mathews 1989:96).

However, the important thing to realise here, is that all of the aforementioned quality of work life practices are *work organisation techniques* which are not dependent on specific existing or new artefact technologies. In the absence of convincing evidence to the contrary, this suggests that, by and large, new or modified artefact technologies are introduced for the reasons discussed earlier as contributing to organisational longevity/survival, and that increasing awareness of the adverse impact of division of labour techniques applied to production using artefact technologies, has resulted in the application of various new (or, I

would argue, pre-industrial) *work organisation techniques* aimed at improving quality of work life.

It is hard to imagine that an organisation might deliberately introduce a new technology that would result in a deterioration in the quality of work life of the end-users, yet the emergence of the Human Relations School was a response to what was increasingly viewed as dehumanised work resulting from the way that work was organised around machines. There is ample evidence that division of labour principles, when applied to the operation of many artefact technologies, had a largely detrimental effect on quality of work life. However, a case can be argued that operating machines (or other artefact technologies) is not necessarily dehumanising work, but that the *choices* made by managers or others concerning how best to organise human labour so as to maximise machine, and hence, organisational productivity and efficiency, had historically resulted in dehumanised work. Mathews (1989:15) distinguishes these two factors as the '*technical* effect inherent in the machinery [and] the *social* outcome of the way technology [is] designed and installed'. By extension, this means that new artefact technologies introduced for rational economic reasons *could* result in improvements to the quality of work life of end-users, either as unplanned by-products of new technology adoption (Adler 1992; cf. Pacey 1983) or as a result of *strategic choice*.

Concerning quality of work life *per se*, there is a widely held view that the removal of mundane, repetitive and/or dangerous tasks, resulting to a large extent from *automation*, has improved the quality of work life by making jobs easier (cf. Littler 1988; Zuboff 1988). Such an argument reflects a one-dimensional view of what constitutes quality of work life. For example, it has already been mentioned that automating and informating technologies have transformed the nature and pace of work, generally to the extent that work is less physically depleting and more mentally demanding (Zuboff 1988; Williams 1992). However, for many workers, for example, Cockburn's (1983) hot metal compositors in the British newspaper industry, quality of work life (ie. enjoying the type of work and the working environment) involves doing physically demanding and possibly dirty work that was not necessarily mentally taxing. Hence, for people with this orientation, technological changes that remove the characteristics of jobs that they find satisfying, is viewed as reducing their quality of work life, and, as in the case of compositors whose work shifted to computer terminals in clean offices, demeaning their work (Cockburn 1983). From this perspective, quality of work life is "in the eye of the beholder"; that is, quality of work life to one individual might involve mainly physically demanding work, whereas to another it might mean having frequent opportunities for intellectual stimulation (cf. Aungles 1991).

There is now growing evidence that new technologies, whilst eliminating much of the hard physical labour that has traditionally been associated with production work, require more highly skilled workers than were required even into the early decades of the second industrial revolution (Zuboff 1988; Coombs 1985; Thomas 1991; Williams 1992; Adler 1992; cf. Bradley et al. 2000). This is largely because of the 'shift from a job-centred to a process-centred form of work organisation, which means that an individual's contribution has changed from one of providing skills to one of assuming responsibility' (Zuboff 1988:52 citing Blauner). In this connection, Zuboff (1988) suggests that the long-standing close relationship between effort and skill no longer exists, and hence *different skills* do not imply *less skilled*. These observations counter arguments that, in the not too distant future, programmable automation will completely eliminate the need for skilled human operators (cf. Adler 1992; Hirschhorn 1984).

There is also an argument that, despite technologies displacing workers by making their skills and/or labour redundant, new technologies (particularly informating technologies) have created employment opportunities via the creation of new and different types of jobs that require new and different skills (Littler 1988; Markey 1983).

Since the second industrial revolution, informating technologies have also been applied to non-manufacturing industries, such as communications, banking, insurance, and business services (Applebaum 1993; Mathews 1989). There is no empirical evidence to suggest that office automation technologies and inventory control technologies (predominantly computer work-stations) have resulted in the 'shift from a job-centred to a process-centred form of work organisation' (Zuboff 1988:52 citing Blauner) that Zuboff (1988) attributes to programmable automation of production. However, there is evidence that they have displaced labour, although not necessarily deskilled workers (Applebaum 1993). It is interesting that the majority of people using these technologies as their principal "tools" of employment (such as clerical workers and office administrative officers) are female, and how the male compositors in Cockburn's (1983) study, whose work was transformed from dirty, physically demanding production work to an office job at a computer terminal, felt that their work had been "feminised", and hence, made more demeaning.

These latter phenomena, along with the issue of what constitutes "skilled work", are among the themes of one or more perspectives on the labour process that focus on new technologies as a strategic choice to control the workforce. The three that are briefly explored in the following subsection are categorically non-functionalist perspectives: labour process theory, critical theory, and feminist theories. Their pervasive theme is the use of new technologies to

change the balance of power between individuals and organisational groups on the basis of occupation/profession, class, gender, and/or the actual or *de facto* ownership of capital. They are mentioned here because they provide examples of additional ways of looking at the goals of new technology adoption in organisations beyond what I have already discussed in relation to the altruistic/self-interest, organisational survival, and quality of work life goals.

Control of the workforce

Labour process theory's critique of technology

Despite the arguments presented in the preceding section, it has to be recognised that there are conflicting views about whether or not technologies destroy or create jobs, and/or skill or de-skill people (Aungles 1991; cf. Brewer 1986). Labour process theory represents the view that technology both destroys jobs and deskills people, ultimately degrading work. It begins with the premise that in societies where the capitalist mode of production is uppermost, the nature of the production process necessitates that human capabilities and needs are often compromised (cf. Williams 1992). From its extreme perspective, workers are seen as just another dispensable commodity in the production process and are often expected to work in ways that some would view as dehumanising (Mahony 1996).

Braverman (1974) has possibly been the most cited proponent in the western world during the last few decades of the Marxist-influenced thesis that in capitalists societies, social choices about both technology selection and the implementation of new technologies has resulted in the degradation of work (cf. Adler 1992). He argued against the *technological determinism thesis* that a given state of technology results in a given mode of social organisation (cf. Wajcman 1993), and countered it with the view that 'the mode of production we see around us, the manner in which labour processes are organised and carried out, is the product of the social relations we know as capitalist' (Braverman 1974:22). He argued that 'by substituting capital (in the form of machinery) for labour, employers merely seized the opportunity to exert greater control over the labour process' (Zuboff 1988:49; cf. Cockburn 1983). Employers, as *de facto* owners of capital (cf. Lash & Urry 1987), can not only prescribe the organisation, pace, mode and rewards of work, but they also construct the work roles, meanings and expectations of others by defining the nature and content of jobs (Fox 1980) as artefact technologies are progressively enlarged and perfected (Sabel 1982). Braverman (1974:113) saw the division of labour, when applied to production using machine technologies under Taylor's scientific management principle of 'the dissociation of the labour process from the skills of the workers', as central to the capitalist approach (cf. Cockburn

1983; Wood 1989) and, hence, to the degradation of work and the control and subordination of workers.

Critical theory of the Frankfurt School

Critical theory of the Frankfurt School is a post-Marxist perspective that is critical 'of the way that reason and social knowledge is subordinated to the needs of capitalism' (Bond & Bond 1994:24). It is of potential relevance to the phenomena explored in the present thesis because the Frankfurt School theorists regard social knowledge as having developed in response to the needs of capitalism by focusing on the needs of capitalism. This in turn, they argue, has driven the technological and scientific developments that have resulted in greater control over people, to the extent that control has become an end in itself (Bond & Bond 1994).

Feminist theories' critique of technology

The feminist critique of workplace technologies involves an exploration of the gender influences on the design and choice of technologies, the definition of *skill*, and the division of labour in specific types of work performed by males and females in a capitalist society. Broadly speaking, feminist perspectives on the technology-work relationship focus on the phenomenon of women as a subordinated class of people in a male-dominated society which seeks to exclude, subordinate and marginalise the role of women (Robbins & Barnwell 1998).

Using a feminist perspective, Cockburn (1983:8) has argued that the fundamental ideologies of patriarchy and capitalism can be considered as either a single factor in the gender-technology debate, or otherwise as interdependent but distinct factors in terms of the 'class relations of capitalism *and* the gender relations of patriarchy'. Mathews (1989:181) acknowledged the distinctive influences of both ideologies when he observed how Game and Pringle's (1983) proposition that the division of labour between males and females, as imposed through technology and reimposed through technological change, had added 'a gender perspective to technological change [which complemented] the class perspective brought by Braverman and other labour process theorists' (cf. Probert & Wilson 1993). For certain phenomena explored in the present thesis, this position provides a point of intersection of the *class* distinctions between professional and occupational groups under capitalism with the *gender* distinctions between single-gender-dominated professional and occupational groups under patriarchy.

In their analysis of the gender relations of artefact technologies, some feminist scholars have focused on the social construction of skills in terms of the perceived or actual distinctions between men's and women's work, and hence the technologies employed by each (Cockburn

1983). It has been argued that job status and remuneration are conventionally linked to the level of skill in a job (Probert & Wilson 1993; Cockburn 1983; Phillips & Taylor 1980) and that, historically, men's jobs are more likely than women's jobs to be categorised as being skilled, and hence, more valued, because they either produce some tangible product, or are regarded as dominantly rational, scientific or technical (Williams 1992; Wajcman 1991; cf. Oakley 1993; Lawler 1991; Williams 1992; Phillips & Taylor 1980).

When these views are confounded by employers' assumptions about 'the marginal attachment of women workers to the labour market' (Probert & Wilson 1993:13), the blurred boundary existing between technological and scientific knowledge (Wajcman 1991), and the arguably male-created notion that skill in the labour process is bound up with masculinity, technologies, and the use of tools (Williams 1992), it is not difficult to see how such gender-biased views on technological and scientific work, and hence, skilled work, could become entrenched.

Now, nursing is a dominantly female profession, and medical doctors in Australia are dominantly male (as explained in Section 2.8). As mentioned earlier, nurses are seen as *carers* while doctors are stereotyped as being rational, scientific, unemotional (Oakley 1993; cf. Davis & George 1988). These traits are allegedly an outcome of the parallel emergence of the medical and nursing professions during the 19th century, at which time the powerful institutions of the church, state, medicine and patriarchy defined nurses' social order, work role and meanings (Mahony 1996) – a state of affairs which, the feminist perspective would argue, continues, at least to some extent, today.

In conclusion, this subsection has discussed how new technologies may be adopted by organisations as a means of controlling their workforces for the purpose of social control/domination. However, much of Section 3.3.2 focused on the control of the workforce for the strategic intent of output control as a means of ensuring organisational longevity/survival. Attention has also been paid in this section to new technology adoption as a means of fulfilling the altruistic and self-interest goals of organisations and to the consequences for the quality of work life of workers of new technology adoption. All are categorically strategic choice goals. Implicit in all of these goals are the notions of *choice* and *consequence*, and that, by and large, the consequences are envisaged outcomes of the choices.

The following section is devoted to exploring a consequence of new technology adoption, changes in the job characteristics of the *receivers* of new technologies, that may or may not have been envisaged during the choice-making process. In particular, it explores changes in the technologies of *techniques* and *organisation* that are consequences of changes in

artefacts, which may, in turn, have consequences for the quality of work life of the receivers of those new artefacts.

3.3.3 Changes in job characteristics

It is important to preface my examination of this topic with the advice that my choice of the term, *consequence*, has the meaning of 'that which follows… upon something antecedent' (*The Macquarie Dictionary* 1997). It is neutral on the technological determinism/voluntarism debate and is intended simply to convey the notion that the adoption of a new technology preceded a change in some organisational structural characteristic that would not have been changed but for the adoption of that new technology.

Consequences such as deskilling, job enlargement, labour displacement, and the creation of new and different types of jobs, already discussed in this chapter, are highly relevant here but are not further explored. Rather, this section specifically examines ways in which the adoption of new artefacts can result in alterations to the characteristics (and hence, skill requirements and quality of work life) of a person's job in the areas of: *task variability, problem analysability, product variability,* and the *propensity of a job to technological innovation*.

Despite the fact that most of the empirical studies described earlier in this chapter were essentially about the technology-structure relationship, they also serve to highlight the variable nature of the human-technology interface and the nature of work, given certain characteristics of both the technologies and their products. For example, in the early 1960s, Woodward's (1980) work, originally published in 1965, acknowledged a variety of forms of production, from customised production (not unlike craft production) to heavily automated continuous-process production. Of interest to the present thesis is her conclusion that the more that products are custom-made and use non-routine technology, the less appropriate it is for work to be organised in a highly formalised and centrally controlled manner (Robbins & Barnwell 1998).

Perrow (1967) extended Woodward's work by investigating the technology-structure relationship in non-manufacturing firms by analysing the types of tasks that are performed in organisations at the level of the people actually carrying out the tasks. He suggested a typology for defining organisational characteristics that is 'conceptually independent of either goals or structure': *raw materials* (ie. things, symbols, or people that are transformed into outputs through the application of energy) and *tasks* (these being the techniques that effect the transformation) (Perrow 1979; 1967). He proposed that raw materials vary in a number of ways, such as their uniformity and their stability, while tasks may vary in various ways,

including 'the difficulty of learning them or executing them, their simplicity or complexity, whether they are repetitive or not, and whether they are well structured or ill-defined' (Perrow 1979:162). Based on his two-faceted typology, Perrow proposed two dimensions of this type of knowledge technology: *task variability* and *problem analysability.* At one end of the spectrum he saw *routine technologies* as having low task variability (ie. few exceptions) and easy-to-analyse problems (and thus, best accomplished through standardised coordination and control); and at the other end of the spectrum, *non-routine technologies* characterised by many exceptions and problems that are difficult to analyse. In between are *engineering technologies* and *craft technologies* – the latter being characterised by relatively difficult problems but with a limited set of exceptions. Perrow proposed that non-routine technologies were best accomplished by those with the greatest knowledge and experience, and in organisations that permit a higher level of employee autonomy than would be appropriate, for example, in the cases of routine technologies (Robbins & Barnwell 1998). Located possibly somewhere between Perrow's non-routine and craft technologies is Piore and Sabel's (1984) description of the skill of craftsmen whose work depends 'not merely in the possession of a sequence of specialised procedures, but on the ability to take on a novel job and respond with an appropriate set of tools and techniques… [that] it is the *flexibility* of response that [characterises] specialised craft production' (Piore & Sabel 1984:16; cf. Hirschhorn 1984).

The notion of flexibility of response is implicit in Galbraith's (1973) concept of *task uncertainty* which he described in terms of the amount of information processing required during task execution by "decision makers", who are not necessarily the individuals, like the craftsman, executing the task(s). Thompson (1967; 1987) explored *technological uncertainty*, analysing complex organisations in terms of the interdependence and sequencing of organisational tasks and the variability of products. At one end of the spectrum were serially interdependent technologies producing 'a single kind of standardised product, repetitively and at a constant rate' (Thompson 1987:270). At the other end is the *intensive technology* which 'represents a *customised* response to a diverse set of contingencies [where] the exact response depends on the nature of the problem and the variety of the problems, which cannot be predicted accurately' (Robbins & Barnwell 1998:166; Thompson 1967). Thompson (1967) explains that the most dramatic illustration of an intensive technology is a general hospital, because a patient's medical condition determines the combination and sequence of services that are required. From Thompson's perspective, the services provided within operating theatre services would be one phase of the sequence of customised services provided to a patient – a phase that I propose is, in itself, categorically an *intensive technology* (cf. Buchanan & Wilson 1996b).

One aspect of the technology-structure-skills debate that does not appear to have received much attention in the empirical literature is that of the *propensity of the labour process to technological change*. The concept of *task variability*, which has been given attention by the likes of Perrow (1979), deals with the complexity and variability within tasks, but not explicitly with the frequency with which those characteristics might change due to technological innovation. The dominant message of the empirical literature, with its emphasis on production technologies in manufacturing firms or information technologies in service firms, is that technological change generally occurs in a planned, system-wide manner affecting entire departments, divisions or organisations. Moreover, with the exception of post-implementation adjustments in any of the three technological elements (ie. artefacts, techniques or organisation), the period after implementation is usually stable insofar as there is likely to be a predetermined life cycle of the technologies of, at least, several years in which work will proceed in a fairly predictable manner. The implication for organisations and workers is that *organisational restructuring* is most likely to occur when new technologies are adopted (Buchanan & Boddy 1992). Hence, periods of system-wide technological change are often periods of uncertainty for workers because they are times when (a) the threat of job loss, redeployment, or job enlargement is greatest, (b) they need to be trained to use the new technologies, and (c) they often need to adjust to changes in the power relationships within their organisation (cf. Buchanan & Badham 1999b; Little 1988; Cockburn 1983).

In summary, this section on technological change in organisations has sequentially reviewed the literature relevant to four of the five research questions posed in Section 1.3. The focus has been on the goals and consequences of new technology adoption. The foundation for exploring these topics was laid in the latter part of Section 3.2 by my *mediated attribution perspective*. It argued that all new technology adoption, regardless of how minor it might seem, can be attributed with the power to transform organisational structure somehow, otherwise there is nothing new about it, and that, in so doing, characteristics of at least one person's job are altered, possibly in ways that were not envisaged during the decision process that resulted in the new technology being adopted. The remainder of this chapter is devoted to examining the nature and process of decision-making in organisations, this being the topic that is central to the fifth research question.

3.4 New technologies: Who chooses, and how?

This section revisits the topic of human agency/choice, bringing it to closure with a synthesis of the literature dealing with organisational decision-making and, in particular, with decision-making in professional organisations, such as hospitals, concerning the adoption of new

technologies. It explores the literature dealing with phases of the decision process and who the participants in the decision process are – the emphasis being on multiple-actor decision-making in organisations with a large operating core of experts/professionals. It extends its examination of the concept of strategic choice (Child 1972), introduced early in this chapter, to the political dimensions of organisational decision processes. It highlights how numerous choices/decisions made by many individuals, or groups of individuals, might precede *the* decision to commit an organisation's financial resources to any categorically strategic venture (Mintzberg 1973; cf. Heller, Drenth, Koopman & Rus 1988).

Much has already been written in this chapter about the various functional and strategic roles of managers in relation to choices of new technologies and strategies for their implementation. One theme of the chapter has been that top managers *initiate* and *control* the range of alternatives concerning what human-technology strategies are most likely to be successful in achieving their organisation's goals (eg. March & Simon 1958; Thomas 1994; McLoughlin & Clark 1994). It has been shown how managers are attributed with decisions about the strategic technical and operational goals of new technologies (eg. Thomas 1994; Guillen 1994; McLoughlin & Clark 1994; Wajcman 1993; Hill 1988; Piore & Sabel 1984), the choice of technologies (eg. Yates 1989; Zuboff 1988; Woodward 1980), and the structure of their organisation's labour force (eg. Cockburn 1983; Wood 1989). They are also attributed with exercising control over both workers and the production process (eg. Taylor 1947; Braverman 1974; Probert 1989) and overseeing the organisational change process (Whiteley 1995; Rundall, Starkweather & Norrish 1998; Buchanan & Boddy 1992). However, as subsequent discussion will reveal, the decision processes in professional organisations, such as hospitals, may be complicated by the *dual authority structures* of administrative and other professionals, that give the large numbers of professionals within an organisation's operating core legitimate access to those decision processes (Mintzberg 1998; Ashmos et al. 1998; Denis et al. 1996; Denis et al. 1991; Davis & George 1988).

But before exploring these issues, it is necessary to take a small backward step to examine some of the substantial body of literature that deals in general terms with decision-making in organisations.

3.4.1 Decisions and the decision process in organisations

Mintzberg Raisinghani and Théorêt (1976:246) define a *decision* as 'a specific commitment to action'. It might be a commitment to one or more actions, or to no action or change in the status quo at all (March & Simon 1958; Gore, Murray & Richardson 1992; Thomas 1994).

A decision represents a point in time when, after a process of investigating and weighing up alternatives, a *choice* is made about how to satisfy a previously identified organisational objective (cf. Simon 1971; Gore et al. 1992). The activities leading up to the choice and concluding with the commitment to action, is what Mintzberg et al. (1976:246) refer to as the *decision process*. This process involves the logic of *detecting* alternatives and *selecting* among them, and the behavioural aspects of *effecting* the preferred alternative(s) (Kuhn & Beam 1982).

Various types of decisions have been described. Gore et al. (1992) enumerated some of these as: Simon's (1960) programmed and non-programmed decisions, Drucker's (1967) generic and unique decisions, and Ansoff's (1969) strategic, administrative, and operating decisions. Mintzberg et al. (1976:246) use the term, *unstructured*, to refer to 'decision processes that have not been encountered in quite the same form and for which no predetermined and explicit set of ordered responses exists in the organisation'. Their use of the term, *strategic*, means that a decision is 'important, in terms of the actions taken, the resources committed, or the precedents set' (Mintzberg et al. 1976:246).

Concerning new technology adoption decisions, Langley and Truax (1994) have identified three process models: the *sequential*, *political*, and *serendipitous* models. The sequential type parallels generic decision processes, whilst the serendipitous model regards technological change as occurring as part of the organisation's routine 'in the natural course of events' (Langley & Truax 1994:621). The political model draws attention to the way that champions of a new technology 'convince top managers to accept their ideas through a process of persuasion, salesmanship and negotiation in which "approval components" such as personal credibility and political support carry as much or more weight than financial or strategic criteria' (Langley & Truax 1994:621). In so doing, it draws attention to the participation of multiple actors, and to the unstructured, political nature of, not only new technology adoption decision processes, but many decision processes in organisations.

Mintzberg et al's (1976) working definition of *unstructured decisions* is congruent with Drucker's (1967) unique decisions, as distinct from generic decisions which Drucker (in Gore et al. 1992) defined as being routine, dealing with predictable cause and effect relationships, using defined information channels, and having definite decision criteria. This definition immediately draws attention to the fact that the characteristics of *a* decision are largely the characteristics of the *decision process* involved in reaching that decision (cf. Hickson et al. 1986).

Mintzberg et al. (1976) describe three main phases of the decision process: (i) identification, (ii) development, and (iii) selection (cf. Simon 1971; Mintzberg 1973). The *selection/finalisation* phase may be signified, for example, by the minuting of the decision or by a contract being signed (Heller et al. 1988). A fourth phase, the *implementation* phase, was added by Heller et al. (1988) because they found that 'more time [was] spent on implementation than on any other phase' (Heller et al. 1988:9) due to the operational contingencies that need to be resolved after selection/finalisation (cf. Langley & Truax 1994; March 1994; Thomas 1994).

Decision processes that approximate the above linear process are most commonly *generic decisions* which, according to Gore et al. (1992), are frequently handled by rules and predetermined procedures. The process is often referred to as 'rational decision-making' (Gore et al. 1992:4; cf. March 1982). On the other hand, *unique decisions*, like Mintzberg et al's (1976) *unstructured decisions*, 'are novel and require judgement and creativity, since they are complex and are characterised by incomplete information and uncertainty' (Drucker 1967 in Gore et al. 1992:2). The associated decision process is far more complex, iterative and non-linear than generic decisions (cf. Mintzberg et al. 1976; Thomas 1994).

Mintzberg et al. (1976), Child (1972, 1997), Hickson et al. (1986), and many others focus on the decisions that they describe as "strategic". As previously stated, strategic decisions usually involve the commitment of an organisation's resources (Mintzberg et al. 1976) – in other words, they are 'investment decisions' (Strauss 1998:20) that support the strategic goals of the organisation. Their associated decision processes are commonly unstructured (Mintzberg 1976). The pervasive theme of the literature is that top managers are *ex officio* empowered to authorise/enact strategic decisions (eg. Child 1972; Hickson et al. 1986; Thomas 1994; Nutt 1998). Top managers are also attributed with the power to control what issues get onto the agenda (McKenna 1999; Thomas 1994), and to control the decision process either directly or indirectly via organisational structural and policy arrangements (Heller et al. 1988; Thomas 1994; Child 1972:13, citing Burns 1966).

However, it is recognised that numerous low-level decisions (ie. decisions made by people other than top managers) are taken during the phases that precede *the* decision being enacted (Mintzberg 1973; Thomas 1994; Child 1972). I propose that the very recognition of the political nature of organisational decision-making is persuasive evidence of this (eg. Child 1972, 1997; March 1982; Hickson et al. 1986; Davies & Ledington 1991; Thomas 1994; Pusić 1998). However, the scope and intensity of participation by stakeholders varies (cf. Ashmos & McDaniel 1996). For example, the studies conducted by Heller et al. (1988:8)

reported that 'a fairly clear picture [emerged] of a centralised chain of command with uniformly low levels of employee involvement particularly in the more important and complex issues'. However, the more heterogeneous the task environment (such as in hospitals), the less likely that this is to be the case (Ashmos & McDaniel 1996). For example, researchers have found that organisations that are dependent on the contribution of professionals/technical experts (Pusić 1998), whom Ashmos and McDaniel (1996) describe as critical task specialists, have a greater propensity to have them represented in the *dominant coalitions* (cf. Child 1972; Hickson et al. 1986; Pusić 1998) and, consequently, participating in decision-making at many levels within an organisation. When Child (1972:13) used the concept of *dominant coalition*, he stated that it 'does not necessarily identify [only] the formally designated holders of authority in organisations; rather it refers to those who collectively happen to hold most power over a particular period of time'. In so doing, he drew attention to the political nature of decision processes in organisations, as I now discuss.

3.4.2 Political dimensions of participation in decisions in professional organisations

Child (1972:2) defined the notion of *strategic choice* as 'an essentially political process in which constraints and opportunities are functions of the power exercised by decision makers in the light of ideological values'. Others, such as Clegg and Dunkerley (1980), Buchanan and Boddy (1983), and Thomas (1994), have been among those who, more recently, have recognised that the power to influence decisions, for example, concerning new technologies, is not limited to people represented in what Child (1972) referred to as the dominant coalition(s). Rather, many "promoters" or "champions" of particular technologies are not represented in the dominant coalition(s), and yet they can be very influential in an organisation's decisions. Some may not even be organisation members (cf. Hickson et al. 1986; Dunford 1992; Vecchio, Hearn & Southey 1992a). These issues were reinforced in a quite recent analysis of the political dimensions of organisational change by Buchanan and Badham (1999a), who concluded that there are usually numerous formally and/or self-appointed *change agents*, having one or more "change agency roles", who may be influential in the course of any given scenario of organisational change. However, their activities and influence are observable only when the temporal context of the decision process includes both the range of activities that precede an issue getting on the formal agenda, and those that follow (cf. Thomas 1994). For example, in the case of introducing new technologies, Thomas (1994:13, 31-32) proposed that this full range of activities includes 'the *identification* of problems to be solved and solutions to be attached to problems; [and] the *selection* among alternative technologies and, within a given technology, among alternative configurations'.

By emphasising the aspects of the decision processes that are associated with the identification of problems (or, perhaps, the identification of a solution to a yet unknown, unrecognised or even an imaginary problem) and the selection of technological solutions, Thomas (1994) has expanded and reinforced the political dimension of the *strategic choice* perspective to the extent that it 'acknowledges the relative capacity of different organisational groups [and individuals] to influence [and negotiate] the definition of organisational objectives and the technical means through which they are to be achieved' (Thomas 1994:19; cf. McLoughlin & Clark 1994). Implicit in this approach is a recognition of the potential diversity in the interests and perspectives of an organisation's stakeholders, and the possibility that various internal and external stakeholders might have differing interpretations on the use, value, and likely impact of new technologies (McLoughlin & Clark 1994; cf. Wajcman 1991). These, in turn, will influence, for example, what "problems" are identified for solution in the first place (Thomas 1994) and what stakeholders' needs will be given priority over others. Previous discussions in this chapter on topics such as the organisational goals of technologies, labour process theory and feminist theories, serve to reinforce this latter point.

Overall, the important issue, Child (1972:14) argues, is that 'the dominant coalition concept draws attention to the question of who is making the choice' and, hence, I propose, who are the *participants* in a decision process.

According to Heller et al. (1988), definitions of *participation* abound, but a prerequisite of participation is *access* to the decision process (Heller et al. 1988). Ashmos, Huonker, and McDaniel (1998:4) report that a common definition of *participation* is simply 'joint decision-making'. Heller et al's (1988) basic working definition emphasises *participation* as a process whereby employees are able to exert some influence over their work and the conditions under which they work. In this connection, they suggest that 'analytically, forms of participation can be divided into three overlapping categories: requisite, informal, and formal' (Heller et al. 1988:15). They propose that *requisite participation* 'is determined by the technology and organisation of work [that] is required to get the job done' (Heller et al. 1988:15), and that the distinction between *formal* and *informal participation* may be quite arbitrary, although with informal participation there are no explicit mechanisms involved (Heller et al. 1988). They propose that those studying *informal* participation approach it from two points of view:

> The first looks on participation as a *decision process* and is interested in how decisions are made. The second sees participation as a *resultant,* the extent to which

subordinates are *in fact* able to *influence* decisions (or, more frequently, the extent to which they see themselves as influencing decisions) (Heller et al. 1988:16).

Participation as a "resultant" is essentially what Hickson et al. (1986) were talking about when, in the context of their study of "top decisions", they concluded that participation in decision-making means that a participant has the power to actively influence aspects of the decision process and, hence, its outcome. Their conclusion draws attention to the distinction between an individual having *access* to the decision process (Heller et al. 1988) and the actuality of being influential, because having the power to influence a decision process does not mean that an individual will elect to use that power whenever he/she might (Heller et al. 1988; March 1994).

According to Heller et al. (1988), for any stakeholder in any situation, the power to influence is derived from his/her *ability* and *capacity* to influence, and enacted when his/her expressed preference(s) are accepted and become part of the final decision. Pusić (1998:85) sees this ability and capacity to influence decisions concerning, for example, the introduction of new technology, as 'technical competence [and] legitimacy of interests'.

Various strategies aimed at influencing decisions have been identified. For example, Thomas (1994:24-25) identified three that might be employed by any participant in the decision process. They are:

(1) *influencing decision premises* in advance of a formal choice by having or acquiring control over definition of the relevant constraints on decision alternatives,
(2) *influencing the considered alternatives* through control over the process of search, and
(3) *influencing the evaluation of alternatives* by restricting access to information about the array of possible solutions or the way that information can be interpreted.

Largely because of these political aspects of organisational decision-making, I have elected in the present thesis to use the term, *capacity*, to embrace both the notions of technical competence (ie. ability) and legitimacy of interest – the latter arising from various sources of power, such as position/legitimate power, expert/knowledge power, or control of an organisation's resources (cf. Dunford 1992). I then use the term, *opportunity* to refer to *access*, which refers to any occasion, formal or informal, during which an individual might deliberately or even unwittingly influence a decision process.

Significant in the present research is March's (1994) contention that the multiple actors in any decision process are categorically *decision-makers.* Hickson et al. (1986) refer to them as constituting the *decision-set*. They observed that 'the decision-set is those interest units from

among the overall organisational "coalitions" of interests which influence a decision …the visible face of the power that materialises – metaphorically – in each decision making process, changing expression from process to process' (Hickson et al. 1986:59). In other words, not only can there be many decision-sets active in an organisation at any time, but the membership of each is dynamic – contingent on the topic of the particular decision process at the time. This type of complexity highlights 'the relative capacity of different organisational groups [and individuals] to influence [and negotiate] the definition of organisational objectives and the technical means through which they are to be achieved' (Thomas 1994:19; cf. McLoughlin & Clark 1994).

As alluded to in Section 3.4.1, a number of researchers have undertaken longitudinal studies to explore the multiple-actor decision process in a variety of organisations (eg. Hickson et al. 1986; Heller et al. 1988; Thomas 1994; Langley & Truax 1994) from the *identification* of problems to be solved and the *selection* among alternative solutions, to *implementation* of the decision. These studies serve to reinforce that participants 'are not limited to the higher echelons of management' (Thomas 1994:214; cf. Child 1972).

Thomas (1994:214-216), for example, concluded:

> The [decisions] may, in fact, originate at some distance removed (in time and space) from the top of the organisation. Such choices and the activities that go into the framing of alternatives *prior* to the formal decision represent a critical part of the process of technological change that is all but invisible when one begins, as the strategic choice perspective does, with the formal decision to proceed with a change. [Furthermore] the "sub-strategies" employed by different actors in the choice process are not just passive filters, nor can they be easily reduced to simple self-interest or structurally defined objectives. Instead, …organisational actors – both in formulating proposals for change and in choosing how to respond to changes initiated by others – engage in no less complex a process of interpretation than do those to whom a strategic choice perspective pays greatest attention (ie. top decision makers).

What is evident from Thomas' study is that many of the "organisational actors" to whom he refers, are categorically *critical task specialists* (Ashmos & McDaniel 1996), that is, professionals or technical experts (Pusić 1998) who carry out the core technology of the organisation (Ashmos & McDaniel 1996; cf. Buchanan & Boddy 1983). Critical task specialists characteristically make up the operating core of professional organisations, such as engineering or accounting firms, or hospitals (Mintzberg 1998; cf. Denis et al. 1996; Buchanan & Wilson 1996).

The increasing technological complexity of many organisations is being accompanied by increases in the relative numbers of specialists/professionals functioning in the operating core of their organisations (Pusić 1998). Consequently, more people have legitimate access to an organisation's decision processes, which, because of these and other organisational structural characteristics, are increasingly complex, ambiguous, and uncertain (Ashmos & McDaniel 1996; Ashmos et al. 1998; Pusić 1998; Mintzberg 1998; Denis et al. 1991; March 1982, 1994). Stakeholders' access to the decision process, either individually or as part of a coalition of interests, tends to be on the basis of expertise and varying degrees of professional autonomy (Mintzberg 1998; cf. Ashmos et al. 1998).

In professional organisations, such as hospitals, the decision process is further complicated by the dual authority structures (Denis et al. 1991; Denis et al. 1996; Ashmos et al. 1998) of administrative and clinical professionals and the very large numbers of professionals within the hospital's operating core. Ashmos et al. (1998:3) summarised this well when they stated:

> The nature of complexity facing most hospitals is different from that faced by typical organisations. While most contemporary organisations face uncertain environments with an increasingly complex array of factors for managers to consider in making strategic decisions, hospitals face an additional and perhaps more fundamental type of complexity. The expertise and values required to deliver a hospital's fundamental service are not the property of the hospital but are embedded in clinical professionals who deliver health care services.

Furthermore, according to Ashmos and McDaniel (1996:103), critical task specialists such as doctors and nurses 'play a different role in the decision process [to managers], depending on specific decision content and organisation strategy' (cf. Ashmos et al. 1998). Denis et al. (1991:71) made an important point when they stated that 'part of the hospital's implicit strategic orientation …emerges spontaneously as the accumulation of autonomous activities pursued by individual professionals [and] hospital administrators may only have indirect influence on these choices'.

The important point is that although managers and clinicians have different roles in hospital strategy formulation and decision-making, one group cannot, by and large, act independently of the other (Denis et al. 1991). According to Mintzberg (1998:296), 'the important collective decisions of the professional organisation seem to be most influenced by collegial and political processes'. Elaborating, he posits that 'many strategic issues come under the direct control of individual professionals, while others can be decided neither by individual professionals nor by central administrators, but instead require the participation of a variety

of people in the complex collective process' (Mintzberg 1998:293). However, despite the duality of authority in professional organisations, Child's (1972) conclusion about 'the power of structural initiation' (Child 1972:16), as summarised by Thomas (1994:214) in the words, 'what distinguishes those at the top…is the power they possess to *enact* their [preferences] as plans and directives', has not been discredited (cf. Mintzberg 1998).

In recognition of the complexity of decision-making in organisations and, despite the volume of *decision-making* research to date, Ashmos and McDaniel (1996:103) have recommended that there is a 'need for more complex models of participation than are normally used in decision-making research'. Extensive research by this author suggests that there appears to be no theoretical framework that reflects the *decision roles* of stakeholders in multiple-actor decision processes in organisations (cf. March 1982; Hickson, Butler, Cray et al. 1986; March 1994; Ashmos et al. 1998; Mintzberg 1998), particularly those in which there is a large, professional operating core (cf. Mintzberg 1998; Robbins & Barnwell 1998).

3.5 Conclusion

This chapter concentrated on reviewing the empirical literature that provides the theoretical foundation of the dominant paradigm conclusions of the present thesis. It commenced by exploring the broader theoretical influences on ways of thinking about *choices* in, and the *consequences* of, new artefact technology adoption in organisations. In so doing, in Section 3.2, it offered a *mediated attribution perspective* as a possible basis for organisation theorists to develop an integrated approach that accommodates both the technological determinism *and* human agency perspectives, unshackled from the broad philosophical debate concerning determinism and voluntarism.

It explored the environment-technology-structure debate, and introduced the concept of strategic choice as a precursor to the subsequent exploration of the literature dealing with the reasons why organisations adopt new artefact technologies, the consequences of new technology adoption for both organisations and stakeholders, and the notion of participation in the decision process. The chapter concluded with a synthesis of the literature dealing with organisational decision-making that showed that decision-making concerning new technology adoption in professional organisations is not a simple matter of top managers making decisions and enacting them. Rather, many stakeholders with diverse vested interests and possibly conflicting goals and expectations of organisational change are participants in various ways in the decision processes within their organisations.

The following chapter details the specific methods employed in this research. It explains the rationale for the ten-year study timeframe and the selection of research sites, informants and data types. It describes how the various quantitative data were collected, collated, and analysed to culminate, in Chapter 5, in the study's secondary (*positivist*) paradigm conclusions. It also describes how the various qualitative data were collected and collated, and how the techniques of inductive analysis and deductive analysis were employed either during or after data collection, to culminate, in Chapter 6, in the study's dominant (*naturalistic*) paradigm conclusions. It concludes with an examination of the characteristics of the research that demonstrate the rigour of the investigative process and the trustworthiness of the findings reported and discussed herein, and an overview of the ethical aspects of the research.

Chapter endnote: The use of terms such as, *craftsman*, *workman*, *tradesman*, and *man* (the latter used in reference to a human individual), are not intended to exclude individuals of the female gender. They were introduced into this thesis in quotations from the literature, and their use has been perpetuated for the purpose of internal consistency, except in cases where non-gender specific terms could be substituted whilst not altering the original text or intent of the author concerned.

Chapter 4
Study Design and Methods

4.1 Introduction

The thesis thus far has provided an introduction to the research topic and a defence of both my choice of the *naturalistic paradigm* as its dominant paradigm, and the application of a *mixed methods, mixed methodology case study design* as an appropriate means of investigating the "research problems". It has overviewed the aspects of the Australian health care system that are relevant to this research. It has also provided a synthesis of the literature that presented various theoretical perspectives on the technology adoption and diffusion process in the industrial and business sectors, the role of technologies in the labour process, and aspects of the human-technology interface. In so doing, it was highlighted how extensive searching has found no research to date that has attempted to study any of these phenomena in relation to new intra-operative artefacts.

This chapter provides a detailed description of the research methods, that is, the techniques used to collect and analyse the data, along with a justification of the chosen methods. I commence by explaining the logic behind the ten-year study timeframe and the selection of the surgical procedures for detailed study, and how the principles of purposeful sampling and representativeness were applied to the process of determining what should be the geographic boundaries of the study and, thence, the study sites.

One section of the chapter is dedicated to describing the various criteria that were used in selecting the study's four distinctive categories of informants (operating suite nurses, sterilising department technical aides, procedural specialists, and top health service managers). Another two sections detail the various types of qualitative and quantitative data (unstructured and semi-structured interviews, documents, archival records, work time study, survey, and direct observation) that were collected at each of the five hospitals, why and how they were collected, and what methods were applied to their analysis during the research process and/or after data collection was concluded. I also briefly explain how I applied the qualitative analysis computer software, HyperRESEARCH™ to the deductive analysis of interviews.

The reliability and validity of the qualitative data are addressed both in respect of the reliability of informants' short-to-medium-term memories and other data collection methods. The issues of credibility, transferability, dependability and confirmability are central to the trustworthiness of the qualitative data, and no less to the quantitative data, so I provide

evidence to demonstrate that my research process has been rigorous and that the data reported in this thesis are bona fide. I then explain why and how I maintained a detailed diary-cum-reflexive journal throughout the full period of this research journey, and how this document serves as an audit trail which adds to the trustworthiness of this study.

The chapter ends with an overview of how the ethical issues implicated in the research process were handled, first in relation to my applications to conduct research at the various hospitals, secondly in relation to the informed consent of informants, and finally in relation to the maintenance of hospital and informant anonymity.

4.2 Study Design

4.2.1 Time boundaries of the study: July 1988 – June 1998

> For almost any topic that might be chosen, specific time boundaries are needed to define the beginning and end of the case (Yin 1994:24-25).

The ten year period identified for analysis in this thesis, commencing in July 1988, was selected for several reasons, but the most significant was the introduction in late 1989 to Australia of the "landmark" surgical procedure of laparoscopic cholecystectomy (Hirsch 1994). Section 2.5 discussed the significance of this event and how it marked the beginning of a rapid diffusion of new and often different ways of operating on a multitude of organs of the human body using, although not limited to, minimum access technologies.

Other timeframe considerations included the likelihood of success in identifying sufficient hospitals and informants who would satisfy the selection criteria, concerns about the reliability of informant memory recall over a longer time frame, and the potential to access the necessary organisational records. Concerning the latter, the mandatory archival period for organisational records at hospitals in NSW is only seven years, so there was no guarantee that the records I needed from ten years previously would still be accessible. Consequently, one of the factors that influenced site selection was the availability of the necessary records for the first three months of the study period.

4.2.2 "Sampling" principles in naturalistic research

The National Health and Medical Research Council (Commonwealth of Australia 1995c:21) synthesised the following four sampling principles from the qualitative research paradigm literature:

1. the sampling design must be kept flexible enough to evolve as the study progresses,

2. sampling units (people, situations or communities) are selected serially in that what comes next depends on what came before,
3. often selection continues to a point of "saturation", "redundancy" or when no new information is emerging, and
4. sampling includes a purposive search for "negative" cases in order to ensure greater breadth and strength to the developing theory.

These principles, combined with principles outlined in Section 1.7 about the conduct of collective case study research, underpin the sampling strategies (described in detail following) concerning the selection of surgical procedures, study sites (hospitals), informants and health services data in the present research.

4.2.3 Selection of surgical procedures

Chapter 2 introduced the procedures selected for detailed study, so it remains for this section to explain the rationale behind their selection. From each of four high volume surgical specialities, I sought to select one high volume surgical procedure that had either been introduced since 1988 or had adopted new intra-operative artefacts since 1988. The rationale for this was that any changes occurring in such representative high volume procedures had the potential to have a substantial impact on an OTS. I also ensured that the selected procedures would provide at least one example of the types of technologies described by Richardson et al. (1991) as *replacement technologies*, *alternative technologies* and *complementary technologies*. The discussion in Section 5.3 includes an explanation of how this latter criterion was satisfied.

Initially, I used some data collected in my 1996 research (Johnstone 1997) for the purposes of selecting four high volume surgical specialties. Based on OTS nurses' dominant three speciality areas of practice (N=1154), the study identified that the four highest volume surgical specialities were:

- General surgery (n = 249)
- Orthopaedics (n = 241)
- Gynaecology (n = 197)
- Flexible endoscopy (n = 84).

These results were consistent with my analysis in 1991 of the surgical casemix at the metropolitan private hospital at which I was employed (Johnstone 1991), and so, drawing mainly on my tacit knowledge of the relevant issues, I proceeded to identify several potentially suitable surgical procedures in each of these four specialty areas. Six procedures

were finally selected because the two involving either alternative or complementary technologies necessarily encompassed two procedures, one in general surgery and the other in gynaecology surgery. This way, comparisons could be made between the not-yet-obsolete 1988 technologies and 1998 technologies. Their selections were confirmed on the basis of their relatively high incidence within Australia (Commonwealth of Australia 1998a), as explained in Section 2.5.4. The procedures are:

1. Open cholecystectomy (via laparotomy) compared to laparoscopic cholecystectomy
2. Flexible colonoscopy
3. Dilatation of the cervix and Curettage of the uterus (ie. D&C) compared to D&C with hysteroscopy
4. Total knee replacement.

4.2.4 Guiding principles in site selection

According to Erlandson et al. (1993:54), 'a utopian setting is non-existent [but] some sites are better or more suitable than others'. They suggest that researchers 'should seek the best site(s) possible within the boundaries of his or her resources, and [that] the primary guides for site selection are the specific research topic, problem and questions' (Erlandson et al. 1993:54).

In Section 1.7.2, I discussed how Yin (1994) proposed that the case study researcher should go about site selection as a positivist researcher would approach multiple experiments. However, I determined that certain distinguishing characteristics of hospitals demanded that I should select sites on the basis of the *representativeness* criterion, because my principal goal was *not* to make comparisons between different sites, but to analyse most of the data from all sites collectively in order to draw some overall conclusions. Hence, I applied principles not unlike stratified sampling (DePoy & Gitlin 1994) to site selection, to ensure that, as much as possible, both the sites and the informants working at each of the sites were categorically "representative of their respective populations". Consequently, the principle of *representativeness* guided me in respect of both the types and number of hospitals I selected, so that in the final analysis, if between-method data triangulation demonstrated congruence between multiple sources and types of data, I would have a stronger case for the transferability and, hence, generalisability of my findings than if case selection had been purely opportunistic.

Marshall and Rossman (1999) advise that researchers need to be realistic about selecting sites, and propose that *realistic* sites are ones where (a) entry is possible; (b) there is a high probability that a rich mix of the processes, people, programs, interactions, and structures of

interest are present; (c) the researcher is likely to be able to build trusting relations with the participants in the study; and (d) data quality and credibility of the study are reasonably assured. My consideration of these criteria was as follows:

(a) Entry to each hospital was possible only after I had first gained the support of both the hospital manager and operating suite manager, and secondly after approval to conduct my research had been granted by the relevant institutional scientific advisory committee and/or research ethics committee.

(b) Selecting hospitals that were highly likely to have a rich mix of processes, people, programs, interactions, and structures of interest is reflected in the principles of *representativeness* and *purposeful sampling* that are implicit in the details provided in Section 4.2.6 (following).

(c) My capacity to form trusting relationships with participants in my study was of great importance in the operating suite and sterilising departments where I was engaged for most of my data collection activities. My "insider status" (Cooney, Dimitriadis, Hiley et al. 1999) resulting from my years of experience as an OS nurse, was not hidden from anybody. This was important, in the first instance, for practical reasons, because an "outsider" would most likely have had considerable difficulty in gaining access. Then, if access had been granted, the outsider-researcher would have needed a lot of orientation in all aspects of OTSs and to be fairly constantly supervised during most of the time spent interacting with, and observing staff at work. It was also important because, not unlike many workplaces, operating suites have certain cultural characteristics that would be difficult for an outsider to very quickly identify and adjust to – both in terms of acceptable codes of behaviour and the language used by staff (cf. Salaman 1974; Denison & Sutton 1991; Lawler 1991). Erlandson et al. (1993:87) regard, as imperative, the need for a researcher and informants to have a common vocabulary, because 'terminology and nuance need to be as clear and mutually understood as possible' in both interviews and informal communication. I believe that my clinical and managerial background in OTSs not only ensured clear communication with staff, but gave me ready acceptance by them. This was evidenced, for example, by the way that I was spontaneously included in tearoom conversations on both work and non-work related issues. This spontaneity extended to the dialogue that occurred during the many hours I spent observing people at work in the operating rooms, where staff engaged me in conversations about what I was doing, and were happy to joke with me – a behaviour that was often also extended to me by the surgeons and other members of the surgical team. There was an openness about the conversations of staff that I felt was consistent with the tone of the conversations I had

experienced over many years in the operating suites in which I had worked – an openness that made me feel that staff were not trying to avoid talking about sensitive or controversial topics when I was present. My OTS background was also an important factor during interviews, because informants were able to talk about specialist clinical and related issues just as they would with a colleague. Cooney et al. (1999) hold that when the researcher is an "insider", (s)he needs to be recognised as an informant to the research. It is for this reason that **Figure 1(c)** (in Box 7) shows "the researcher as an insider" as one of the sources of evidence in the present research.

My capacity to form trusting relationships with participants was of less importance where other informants were concerned. However, my insider status as a Fellow of the Australian College of Health Service Executives (ACHSE) seemed to give me ready acceptance by the top health service managers whom I interviewed. I believe that their awareness of my professional status within the ACHSE influenced them in respect of the level at which they pitched their responses to my interview questions, possibly because they assumed that I had an operational appreciation of the issues that they raised during the course of their interviews.

I did not have face-to-face contact with the procedural specialist informants because I interviewed them by telephone. They knew only that I was a doctoral research candidate and a lecturer in health services management. However, in the course of the interview they became aware that I was an experienced OS nurse. On that revelation, they promptly stopped trying to use lay terms as substitutes for medical terminology, and conversed freely with me in much the same way as other procedural specialists did during my conversations with them in the operating suite.

(d) The last of Marshall and Rossman's (1999) criteria – data quality and the credibility of the study – cannot be demonstrated by way of some descriptive statement. That the present thesis satisfies these criteria should be increasingly apparent from my rigorous attention to detailed description and justification of the study's methodology, logic, theory framework and methods, and the trustworthiness of my reporting, analysis and interpretation of the data. These issues are treated in more detail in Section 4.10.1.

4.2.5 Geographical boundaries of study

My first decision concerning site (ie. hospital) selection related to the geographic boundaries of my study. Should it be an international study? Should hospitals be selected from various Australian states, or could I restrict my attention to hospitals within a single state without compromising the study's quality/rigour? A number of logistical and structural factors were

considered in connection with the aforementioned advice of Erlandson et al. (1993), Yin (1994), and Marshall and Rossman (1999), with the result that I decided that I would conduct a single-state study involving a number of hospitals within NSW. Because this is my state of residence, this overcame potential logistical problems inherent in conducting fieldwork across many states. However, structural factors were more influential in the decision.

Various organisational structures exist within the health care systems of Australia's states and territories and, consequently, there is no uniform system of categorising hospitals, classifying health care workers, or reporting on employee productivity. Hence, in a national study it would have been difficult to ensure that the selected hospitals were, indeed, representative in terms of geographic location or the size and scope of the OTSs provided by each hospital. Furthermore, between-hospital comparisons on quantitative measures would have been unnecessarily complicated, and possibly compromised in quality, because of between-state differences. The results of my earlier exploratory study (Johnstone 1997; 1998; 1999) validated my decision insofar as that study found no significant between-state differences in the perceptions of operating theatre services nurses in NSW and Victoria on certain techno-socio-institutional issues – issues that have also emerged during the present research. In this way, I concluded that a single-state study involving NSW hospitals was appropriate and sufficient for the purposes of the present thesis.

4.2.6 Selection of study sites (hospitals)

Having determined the geographic boundaries of my study, I then needed to devolve a strategy for determining how many hospitals to include and what hospitals to select. Guided by the advice of Marshall and Rossman (1999), Yin (1994), Erlandson et al. (1993) and Patton (1990) concerning site selection logic appropriate to naturalistic research, I determined that I should purposefully select a sufficient number of geographically dispersed and categorically different hospitals that would maximise my opportunities to learn as much as possible about the issues that are central to my research (Erlandson et al. 1993; Commonwealth of Australia 1995c). I also needed to have the potential at each hospital to follow up emerging insights – both typical and divergent – in the course of the data collection process (Erlandson et al. 1993). In this connection, my need for relative freedom of movement between OTSs and various administrative areas of the hospital was made explicit in my various applications to conduct this research.

In Chapter 2, **Table 2(a)** identified the four categories of NSW acute public hospitals from which one "representative" hospital ended up being selected for study. I started the process of selecting specific hospitals for study by referring to publications, such as the *Hospital and*

Health Services Year Book (1997), *The Australian Hospitals Directory* (1998) and the *NSW Public Hospitals Comparison Data 1996/97*, to obtain classification and statistical information about a range of hospitals, and the names and contact details of top managers.

Initially all public and private acute hospitals within NSW had an equal probability of being selected for study, but several other decisions needed to be made concerning site selection. First, what should my inclusion criteria be? How many hospitals should be studied, and of these, how many should be private hospitals? So, based on my established principles of *purposeful sampling* and *representativeness*, I decided to exclude private acute hospitals having less than 50 beds because of the difficulties I would likely encounter in obtaining sufficient data on the selected surgical procedures. I also decided to exclude the smaller acute public hospitals and the paediatric specialist hospitals that together accounted for less than 20 per cent of all acute public hospital separations during the selection year of 1996/97. This approach was not dissimilar in principle to the method employed by the project team that was commissioned to report on development in MAS within Australia (Commonwealth of Australia 1996).

A further consideration was the fact that acute public hospitals accounted for over 70 per cent of all NSW acute hospital separations, compared to less than 30 per cent in the private sector (calculated from NSW Health 1998b; 1998c). This suggested to me that numeric representativeness could be achieved by selecting one private hospital for every 2 or 3 public hospitals. However, numeric representativeness is not a sufficient basis for determining the mix of hospitals because there are a number of qualitative factors, such as representation from various geographical locations within NSW, along with hospital size and scope of surgical services, that needed to be taken into consideration. I determined that this decision needed to be taken in concert with my decision concerning the total number of cases that I should study.

I was finally guided on this matter by Yin (1994:50) who advised that 'it is a matter of discretionary, judgemental choice', and by the advice of Erlandson et al. (1993) to prefer information richness over information volume. Erlandson et al. (1993) also advised that a researcher should seek the best site(s) possible within the boundaries of his/her resources, guided always by the specific research topic problem and questions.

The outcome of these preliminary deliberations was a plan to study seven hospitals. Two would be private hospitals, one of which would be located in Sydney and the other in regional NSW. The other five would be public hospitals, with a representative from each of the categories A1, B1, B2, C1 and C2 (refer to **Table 2(a)**) which accounted for about 88 per

cent of NSW acute public hospital separations, from various locations throughout metropolitan and regional NSW. However, this proved an impractical plan and, in hindsight, an unnecessarily large-scale, ambitious plan.

Time considerations aside, the impractical nature of this preliminary plan became evident as I endeavoured to satisfy my second goal in site selection. This was to select hospitals that had the greatest potential to provide me first, with the data that I required, and secondly with data that were as free as possible from confounding by organisational change that was unrelated to technological change in surgery. Hence, based again on the principle of purposeful sampling, I excluded hospitals from my study if they did not satisfy the following three criteria:

1. "organisational stability" (defined following) during the period of interest, and
2. the likelihood of obtaining organisational activity data for all of the proposed sample time periods, and
3. sufficient numbers of operating theatre services staff who could satisfy my inclusion criteria (detailed in Section 4.3.1).

For the purposes of this research, "organisational stability" was deemed to exist if:

- a hospital had not relocated geographically during the ten years from July 1988, and
- there had been no increase or decrease in the number of fully equipped operating rooms in the operating suite during the ten years from July 1988, and
- there were no plans for the hospital to relocate or to undergo any major organisational change (such as a merger with another hospital), or to commence capital expansion of operating theatre services before the year 2000.

I was able to confirm "organisational stability" by making a telephone call to the hospital's executive manager. At the same time, I investigated whether or not each hospital was likely to have the range of organisational activity data that I required (as previously explained). If the organisational stability criterion was satisfied and I was reasonably confident about my potential to access the necessary organisational data, I sought to ascertain whether any barriers to entry to the hospital as a research site might exist (Marshall & Rossman 1999) by asking the executive manager whether he/she would be prepared to support my research. If notional support was given, I sought permission to contact the OTS manager so that I could obtain a profile of staff to determine whether there were sufficient who satisfied the criteria for selection to warrant me submitting a formal application to conduct research at that hospital.

In all, approaches were made, over a period of several months, to twenty-one hospitals. Three of the original target group of seven hospitals ended up in the final group of five identified

(but randomly assigned a code A, B …E for confidentiality reasons) in **Table 4(a)**. All of the sixteen hospitals that were approached but were not included, dropped out of contention on the basis of failure to satisfy one or more inclusion criteria.

Table 4(a): Characteristics of hospitals included in study

Hospital ID	Location	Public or Private	Hospital classification as per Table 2(a)	Average available beds	% of separations as surgical
A	Regional/Rural	Public	B2	180	28.0%
B	Metropolitan	Public	C1	145	28.4%
C	Metropolitan	Private	n/a	60	98.0%
D	Capital city	Public	A1	> 700	22.0%
E	Capital city	Public	B1	> 270	22.4%

Sources: NSW Health (1998d); *The Australian Hospitals Directory 1998; Hospital C internal report.* (Note that the exact number of available beds in sites D and E are known to the researcher, but have been expressed as >700 and >270 to ensure the anonymity of those hospitals).

The final five hospitals comprise one acute metropolitan private hospital and four acute public hospitals with one each from categories A1, B1, B2 and C1 that combine to account for just over 80 per cent of NSW acute public hospital separations. The selected four public hospitals (Hospitals A, B, D and E) undertook almost 11 per cent of all surgery performed in their combined categories and 8.8 per cent of all surgery performed in NSW public hospitals during the selection year, 1996/97. The surgical separations at the private hospital (Hospital C), which, incidentally, has a similar catchment population and range of visiting procedural specialists to Public Hospital B, have been estimated (from hospital data and NSW Health 1998b) to represent about 1.5 per cent of all NSW private hospital surgical separations during 1997/98. The two capital city public hospitals (Hospitals D and E), one of which is a principal referral hospital attached to a university medical faculty, are located in non-adjoining area health services in quite distinctively different socio-economic local government areas. The regional/rural specialist referral hospital (Hospital A) is located many hundreds of kilometers from any of the other four hospitals.

4.3 Selection of Informants

Informants to this study are categorically either formal or informal. The *formal* group of sixty-seven informants are within-hospital stakeholders in new intra-operative artefact adoption who were interviewed during the course of this research. They are members of one of four occupational or professional groups: operating suite nurses, sterilising department technical aides, procedural specialists and executive/top health service managers. A summary of their representation at each hospital is provided later in **Table 4(b)**.

The total number of *informal* informants can only be estimated. They are all of those clinical and non-clinical health services personnel with whom I talked either within or outside the OTS at each of the five study hospitals, or whom I observed in the course of their work within OTSs during the more than six hundred and fifty hours I spent in the field. They probably number several hundred individuals, and the process of collecting data about them or from them can best be described as impromptu and opportunistic.

This section outlines the criteria used to identify potential *formal* informants and the strategies employed to recruit them. Section 2.8 detailed the characteristics, including the gender mix, of the four distinctive groups of informants. However, in recruiting them, I made no attempt to achieve any type of within-group gender representation. Rather, informant selection, based on the various inclusion criteria outlined following for each group, was essentially a case of recruiting those who first consented and/or were available for interview at each site until either data saturation was achieved or there were no more eligible or willing informants at a particular site. As it happened, an approximation of within-group gender representativeness was actually achieved.

4.3.1 Operating theatre services staff

Two categories of OTS staff are *formal* participants in this research: OS nurses and SD technical aides. The criteria for their selection as informants, and the strategies employed in recruiting them, are now outlined.

Operating suite nurses

OS nurses performing one or more of the three roles – instrument nurse, circulating nurse and nurse manager – were potential informants. They were invited to participate only if they satisfied the following inclusion criteria:

(a) their current job description in the operating suite included responsibilities associated with the use, maintenance and/or management of intra-operative artefacts, and

(b) they were working in their current operating suite during 1988, although not necessarily in the same capacity as they currently were, and they had worked in their current operating suite for a total of at least six years since July 1988; **or** they had a specialist role within their current operating theatre suite that was deemed to be relevant to this research.

This information was obtained via the *Operating Theatre Staff Profile* form, exemplified in **Figure 4(a)**, that was authorised by the hospital's executive manager, completed by OTS staff and returned to me prior to site selection. A brief letter of introduction to my research topic and the interview process (available in the Research Protocol) accompanied the staff

profile form on which the staff were requested to record their name, position title, and how many years they had worked, since 1988, in their current department. They were also asked to indicate whether or not they were working in the department at some time during 1988, and whether or not they would be willing to be approached by me to be interviewed. (The shaded areas of the form were not completed during this preliminary phase, and then later only by those who were interviewed, at which time they were allocated a participant ID code.) Some nurses who had not completed this form later offered to be interviewed after they had met me during the course of one of my site visits. I informed the OTS manager of those nurses whom I wished to interview, and (s)he then scheduled interviews when it was possible to release them from their normal duties. Sometimes on the day, one of the managers would suggest someone who was available and willing to be interviewed.

Figure 4(a): Sample of Operating Theatre Staff Profile form

Participant ID	Position title	Total years in dept. since 1988	Working in dept. in 1988? Y/N	Gender M/F	Willing to be interviewed? Y/N	Interviewed Y/N	Participant signature

My aim was to interview a minimum of three operating suite nurses at each of the five selected hospitals. By the conclusion of my fieldwork, a total of thirty-one operating suite nurses were interviewed – approximately twice the expected number. Three were male and twenty-eight were female – roughly equivalent to the gender mix of OS nurses within NSW.

A number of factors influenced the final numbers of OS nurse informants, but overall more nurses were interviewed in the larger operating suites. For example, at the largest hospital (Hospital D), where nurses work in one of four specialist sub-units within the operating suite or in the separate unit dedicated to endoscopy, I interviewed two nurses from each sub-unit and two nurses from the endoscopy unit, resulting in ten nurse informants at this site alone. Most nurses were interviewed because they could reflect on changes occurring within their current operating suites since 1988, but a few were interviewed because of their extensive experience in the field and their current specialist role within the suite. The latter were typically very experienced operating suite nurses who were working in another operating suite in 1988 but had been employed for at least three years in their current role that was highly relevant to the surgical technological issues I was exploring. Interviews from both categories of OS nurse informants were not differentiated during data analysis.

Sterilising department technical aides

The criteria for the selection of SD technical aides were similar to those for OS nurses detailed in (a) and (b) in the preceding section, except that the criteria specified "sterilising department" instead of "operating suite".

Information about potential informants was obtained using the same *Operating Theatre Staff Profile* form as was used for the nurses, and interviews were scheduled using the same strategy in collaboration with the informant's manager, who was either the manager or senior technical aide in the sterilising department or the OTS nurse manager. My original goal was to interview at least one technical aide at each of the five hospitals, and by the conclusion of my fieldwork I had interviewed a total of seven. Two were male and five were female. I interviewed one in each of the three smaller hospitals and two at each of the two larger public hospitals. With only two full time technical aides working in the sterilising departments of the private hospital and the smallest of the public hospitals, one such informant at each actually constituted 50 per cent of potential informants. All of those interviewed had worked continuously in their current job for at least ten years and, consequently, had the capacity to reflect on the changes that had occurred since 1988.

4.3.2 Procedural specialists

I had not included procedural specialists as *formal* informants when I prepared my original study design, and I was about ten months into my fieldwork when emerging evidence of the importance of their roles and responsibilities in the new intra-operative artefact adoption decision process, combined with their end-user status, led me to determine that they should be interviewed. They proved a very challenging category of informant to recruit. Sixteen ultimately became significant informants. All were male. Each practised in one or more of the four specialist areas of gynaecology, general surgery, orthopaedics and GI endoscopy represented by the six surgical procedures explored in detail in the present thesis.

I sent information packages containing an invitation to be interviewed to a total of sixty procedural specialists who were accredited to practise within the study hospitals. I had been informed by the OS nurses that each would satisfy my selection criterion of having been practising in his/her area of specialisation for at least ten years, although not necessarily at the study hospitals. The majority of invitations had no response, and I was successful in recruiting only five procedural specialists in this way. In order to achieve informant coverage of each of the four speciality areas with a minimum of two procedural specialists able to reflect on each, I recruited two procedural specialists from my local area within regional

NSW. One was an orthopaedic surgeon whilst the other actively practised both general surgery and GI endoscopy. Hence, seven procedural specialists were formally interviewed.

In addition to these seven, field notes were made on substantial *informal* interviews/conversations with another nine procedural specialists. These interviews took place within the operating suites of the study hospitals as the opportunities presented themselves during extended breaks between procedures. Two informants were specialist physician endoscopists, three were general surgeons, two were gynaecologists and two were orthopaedic surgeons. These interviews took place mostly in a staff tearoom and sometimes in an operating room, and they came about when the procedural specialists involved followed up my request to be an observer in their operating rooms with an inquiry about some aspect of my research. Consequently, I had opportunities to ask them many of the questions that were included in the formal interviews, and although their responses were not tape recorded, I promptly notated the content of these conversations.

4.3.3 Executive/top health service managers

Top health service managers were invited to participate if they had the *ex officio* opportunity to influence decisions made about human and/or financial resourcing of the hospital's operating theatre services. My principal goal in interviewing them was to explore what influenced their thinking in relation to resource allocation decisions, made individually or as part of a team, that impacted directly on the acquisition of surgical artefacts and/or OTS staffing levels. Having obtained a copy of the organisational structure at each hospital and area health service, I made a direct approach to those managers whom I considered were likely to satisfy my selection criteria. If they qualified, and consented to an interview, they usually left it to their secretaries to schedule it. I had envisaged interviewing three top managers at each of the five study hospitals, but Hospital C had only two managers who qualified to be interviewed, and the CEO of Hospital D declined to be interviewed.

Their position titles included Chief Executive Officer (CEO), Deputy CEO, Hospital Manager, Corporate Services Manager, and Corporate Secretary. Thirteen were interviewed and, although the clinical/non-clinical background of each informant was only revealed to me during interview, it turned out that the four female informants had clinical (nursing) backgrounds prior to moving into management positions, whilst none of the nine male informants did.

4.4 Formal informants at each hospital

Table 4(b) summarises the representation of the formal informants in the study from each hospital according to occupational/professional group.

Table 4(b): Summary of numbers of formal informants by occupational/professional group

	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E	Hospital V	Group totals
Operating suite nurses	7	4	3	10	7	n/a	**31**
SD technical aides	1	1	1	2	2	n/a	**7**
Procedural specialists - formally interviewed	1	1	0	2	1	2	**7**
Procedural specialists - informally interviewed	1	2	2	1	3	n/a	**9**
Executive/top managers	3	3	2	2	3	n/a	**13**
Hospital totals	**13**	**11**	**8**	**17**	**16**	**2**	**67**

4.5 Informant unique identifiers

As previously mentioned, each hospital was randomly assigned an alpha character A, B, C, D or E. Hospitals are reported throughout this thesis as, for example, Hospital A or site A. The local hospital used as a control for validating the work process time study data, as well as a source of two interviews with procedural specialists, is referred to as Hospital V.

The Informant ID (for example, BX002) is made up of three parts:

1. The first alpha character (A, B, C, D or E), which represents the unique identifier for the hospital at which (s)he works or is associated
2. The second alpha character (X, Y or Z) distinguishes operating theatre services staff (X) from top managers (Y) and procedural specialists (Z), and
3. Three numeric characters which were sequentially allocated in the order in which informants in each category were interviewed at each hospital.

4.6 Site visits

At least three visits of between three to six days were made to each of the five hospitals during the sixteen months in 1998/99 when the bulk of data collection was undertaken. This constituted over six hundred and fifty hours of "engagement in the field". Most data collection occurred in a manner that can best be described as opportunistic. It was necessary for me to keep informed about both the procedures scheduled for each day in the operating suite or endoscopy unit and any subsequent changes to operating lists, because I needed to be available for work process time study data collection whenever the operations of interest and

the associated perioperative work were occurring. This meant that I was frequently on site by 6.30am when nurses would be undertaking preparatory perioperative activities, and I often did not leave the operating suite until after 9pm. Interviews, data collection from organisational records, and other data collection activities were completed on an ad hoc basis, both within the operating theatre suite or in other locations in the hospital, when I was not otherwise engaged with the time study data collection and other observational activities.

The bulk of the fieldwork at individual hospitals was completed within a timeframe of fifteen weeks but sometimes follow-up telephone calls were made or letters were written seeking clarification of some issue or other. Usually, data collection activities were in progress at two hospitals at any one time. This provided opportunities to investigate issues emerging from one site at another in a continuous process of data validation.

The following sections outline what are the various qualitative and quantitative data that were collected, how they were collated, stored and analysed, and what steps were taken to optimise the reliability of data.

4.7 Qualitative data collection, reliability, and analysis methods

4.7.1 Direct observation and interaction with OTS personnel

Yin (1994) has advised that a useful source of evidence in a case study is the direct observations made by the researcher during field visits to each site. These observations have the potential to inform the researcher of some relevant behaviours or environmental conditions that would be unlikely to emerge from other formal data sources.

During the course of my fieldwork, and particularly when I was undertaking the time study data collection activities, I had many opportunities to observe OTS personnel during the course of their work and to engage in informal conversations with them. Some of these people were formal informants but most were not. They included procedural specialists, anaesthetists, surgical registrars, nurses, technicians, clerical staff and porters – people whose interest in my reasons for "being there" generated many enlightening conversations – all of which added to the richness and completeness of the data. Whilst I recognise that for some of these people I represented a convenient "sounding board" for them to vent their personal opinions on a number of issues, I found that it was possible to further investigate some of the issues raised in the course of subsequent formal interviews, or in subsequent observations or conversations with other informal participants. In a number of instances, these types of informal leads proved most useful in bringing to light some relevant data that otherwise would most likely have been remained undisclosed.

A most fruitful source of informal data came from my conversations with people when they were having their meal or refreshment breaks in the tearoom. One peculiarity of operating suites is that times for refreshment breaks are unpredictable, because a surgical team is committed to an operation for its duration, and breaks can be taken only after a procedure is completed. This means that there are often people are in the tearoom, and that the mix of people there at any one time can be free of friendship groups or cliques. Hence, I could wander in at any time and quite easily gain entry into conversations. In the course of such a conversation, a nurse might be talking about an event that occurred during the course of an operation in which (s)he was involved, and I might ask a question such as, "does it normally happen like that?" The responses often served to clarify and/or confirm some matter that had been mentioned in an interview, and I suspect that the people with whom I was talking generally had no idea that my question was anything more than a matter of passing interest to me.

Observations and informal conversations were recorded in my field notes along with the general perceptions about my experiences at each site, and promptly transcribed into my research journal. Overall, these data (represented in **Figure 1(c)** Boxes 5 and 6) were analysed inductively. They contributed to the continuous iterative data collection process to the extent that data thus collected served either as a validation of data already accumulated from formal interviews, or influenced the line of questioning – given an appropriate cue by informants – to verify data or obtain a richer picture of some phenomenon.

4.7.2 Interviews as a source of data

Dexter (1970) described interviews as *conversations with a purpose*. Interviews allow a researcher and an informant 'to move back and forth in time; to reconstruct the past, interpret the present, and predict the future' (Erlandson et al. 1993:85).

As a source of evidence in case studies, Yin (1994:85) proposes that interviews are essential because:

> most case studies are about human affairs. These human affairs should be reported and interpreted through the eyes of specific interviewees, and well-informed informants can provide important insights into a situation. They also can provide shortcuts to the prior history of the situation, helping you to identify with other sources of evidence. However, the interviews should also be considered *verbal reports* only. As such, they are subject to the common problems of bias, poor recall and poor or inaccurate articulation. [For this reason], a reasonable approach is to corroborate interview data with information from other sources.

This statement highlights the value of interviews as a source of data whilst alerting the researcher to the risk of obtaining biased or inaccurate data and, hence, the importance of verifying the data thus derived with data from other informants or other sources of evidence. Herein lies one of the strengths of the case study method – its dependence on multiple sources of evidence converging in a triangulating fashion on the same set of facts or findings (Yin 1994). However, just because other evidence triangulates with the evidence emerging from interviews, it does not mean that the interview data are necessarily valid and reliable. Morse (1999), for example, proposes that interview technique plays an important role in ensuring validity and reliability. She suggests that interviewers need to avoid asking questions in a manner that "leads the witness". Instead, they should ask "open-ended" questions and employ an "uncovering approach" – a technique of asking a general question and then asking for examples or, otherwise, turning an informant's response to a question or proposition into another question, thereby obtaining clarification and/or confirmation about the meaning of the original statement. I endeavoured to follow this advice in the conduct of interviews and also in my informal conversations with other operating suite personnel.

'Interviews may take a wide variety of forms, ranging from those that are very focused or predetermined, to those that are very open-ended, and nothing is set ahead of time' (Erlandson et al. 1993:86). I employed semi-structured and unstructured (informal) interviews, because both formats gave me scope to ask probing questions about issues for which no clear pattern had yet emerged. This is congruent with Fetterman's (1989:49) explanation that 'questions typically emerge from the conversation. In some cases they are serendipitous and result from comments by the participant [but] in most cases, the [researcher] has a series of questions to ask the participant and will wait for the appropriate time to ask them during the conversation [if possible]'. The key difference between semi-structured and unstructured interviews is that, in the former case, the interview is guided by a set of basic questions in which the wording and sequence of the questions is flexible, whilst the unstructured interview process is 'similar to and yet different from an informal conversation [in that] the researcher and respondent dialogue in a manner that is a mixture of conversation and embedded questions' (Erlandson et al. 1993:86).

Using these techniques, I was able to work towards saturation on numerous themes, whilst also being able to move on to other lines of questioning as I was given appropriate cues by informants. Saturation might have taken only a few interviews when the data triangulated with data from other sources, but sometimes many more interviews were required to achieve unambiguous and convincing explanations of some issues. This overall process is consistent

with Erlandson et al's (1993:114) suggestion that after each interview the researcher should ask him/herself, "what did I learn from this informant that will shape my questions for the next one?"

None of these strategies, however, can totally overcome the problems raised by Yin (1994) of informant bias, poor recall and poor or inaccurate articulation, but I propose that an astute researcher will recognise these occasions when they are weighed up against the body of converging data. Morse (1999), for example, believes that note-taking during interviews can introduce bias, and hence, compromise data reliability, because the informant observes when the researcher is taking notes, could assume that "this is what the researcher wants to hear", and responds accordingly. Audio tape-recording interviews, as I have done, overcomes this potential source of bias, and also results in everything that was said being captured *verbatim* for analysis later. Being freed from note-taking, I found that I was able to think clearly about what the informant was saying, and this helped me to better remember the cues that the informant had given to me to redirect questions on issues of specific interest at a later time in the interview. However, the issue of poor informant recall relates to the reliability of informant longer-term memory – a matter that I now discuss.

4.7.3 Informant memory

Long-term memory can be reliable (Clark 1999), and researchers have proposed various strategies that can enhance the quality of what is recalled, and to distinguish 'valid memories from mere fantasies or reflections of what others have told us' (Meacham 1995:43).

Conway and Rubin (1993:104) have reported that:

> a striking feature of *autobiographical memory* (ie. memory for the events of one's life) that has emerged from a number of independently conducted research programs is that autobiographical memory is highly structured and that within this structure there is no specific type of knowledge which can be easily singled out as being *a memory*. Rather, memories are compilations, constructions, or compositions of knowledge.

Memory researchers have explained the characteristics of memory using various frameworks. For example, Cohen et al. (1993:50) cite Tulving's (1972) distinctions between two kinds of long-term memory, *episodic* and *semantic memory*. Tulving, contrary to the views of many others, considered that episodic memory was synonymous with autobiographical memory. Other researchers have identified three levels of structure that appear to contribute to the constructions of a person's *autobiographical knowledge base*. They have referred to them as

lifetime periods, *general events*, and *event specific knowledge* (Conway & Rubin 1993:104). For example:

> The term "lifetime periods" was used by Conway and Bekerian (1987) …to refer to extended periods in a person's autobiography such as *when I lived with "X", when I worked at "Y", when I was at secondary school,* and so forth. Conway and Bekerian (1987) found that lifetime periods were far more effective cues to memory retrieval than a range of other cues and that lifetime periods constituted effective primes for memory retrieval (Conway & Rubin 1993:104).

I employed the *lifetime periods* strategy to commence all my interviews because of my desire for informants to be able to initially recall aspects of their work from ten years earlier. For example, in the unstructured interviews with OTS informants, I commenced by asking them, "could you start by telling me about how they came to work in operating theatres, and when and why you started to work in this hospital?" With the procedural specialists, the opening few questions in their semi-structured interviews asked them about their length of experience, where they had practised, and what motivated them to specialise in their specialty area. Similarly, the top managers were asked about their professional background. This technique of starting an interview as you would a conversation with a new acquaintance has been encouraged by Erlandson et al. (1993). Then, during the course of all interviews, *general events*, which were part of organisational memory or general history, served as useful triggers for memory retrieval and as means of validating the content of what was recalled. Cohen et al. (1993:50) refer to this aspect of memory as the *spacio-temporal context* of autobiographical episodic knowledge that 'usually includes details about the particular time and particular place in which objects and events were experienced'.

Concerning the reliability of memory recall, Meacham (1995:43), whose primary interest was in the social construction of memory within the family as a therapist's tool, proposes that 'when two or more individuals, each constructing narratives that are meaningful to their own lives, find that there is an intersection of their interpretations of past events, …others can have greater confidence in the transcontextual meaningfulness of the memories of those events' and, hence, the credibility of those memories. The extension of this principle to interviews conducted for research purposes is that sufficient interviews need to be conducted at each site to achieve this "intersection of interpretation of past events", which I suggest is equivalent to what naturalistic researchers refer to as data convergence.

A factor that Meacham (1995) and Morse (1999) propose can compromise the quality of memory recall is if it occurs under conditions of relative inequality of power between

informant and interviewer – an issue that also has an ethical dimension (Commonwealth of Australia 1995c). I believe that my declaration of my "insider status" relevant to each of the informant categories should have given each informant a point of identification with me such that it should have negated, or at least minimised any perception of inequality between us. That is not to deny that some informants, despite being volunteers, might have experienced some apprehension about being interviewed by someone whom they had only recently met, but apprehension such as this is not evidence of any relative power inequality that would diminish the credibility of the interview data.

4.7.4 Conduct of interviews

In previous sections I have detailed who are the informants in this study, and how and why they were selected for interview. I have also overviewed the nature and purpose of interviews, and the characteristics that make interviews reliable sources of data. Now I will briefly outline how the interviews (represented in **Figure 1(c)** in Boxes 1, 13, 14, 15 and 16) were conducted with each category of the informants.

Operating suite nurses

An unstructured interview format was used amongst OS nurses. They had not been made aware of the specific "change" issues that were of interest to me. Rather, they had been informed that my intention was to explore changes in their work since 1988, and that I would start the interview with a question about how they came to be an OS nurse. The rationale for this was that I wanted to avoid directing the attention of informants to the specific technology issues which provided the catalyst for this research. Based on my previous research (Johnstone 1997; 1998; 1999; 2000), I expected that these issues would emerge, and when they did, the weight attributed to them by informants would be important data. The remainder of the interview flowed out of the informant's response to this opening question. Most interviews were completed within one hour. All interviews were conducted in a private room within the operating suite, and were audio tape-recorded.

Sterilising department technical aides

Interviews with technical aides were undertaken using the same unstructured approach as was used among OS nurses. All interviews were completed within one hour, were conducted in a private room within the sterilising department, and were audio tape-recorded.

Procedural specialists

My principle purpose in interviewing procedural specialists was to explore their reasons for adopting new intra-operative artefacts and the factors that were influential in them doing so. A semi-structured interview format was used because it provided the means of ensuring that these issues were explored, and because it allowed further investigation of these and other phenomena as they arose. The procedural specialists had prior knowledge of the eleven questions, provided in Appendix B2, that provided the framework for the interview. All of these interviews, of between thirty to forty minutes duration, were conducted by telephone, and were audio tape-recorded.

Executive/top managers

A semi-structured interview format (see interview template in Appendix B1) was used with top managers for the same reasons as it was used amongst procedural specialists – to ensure that particular issues were explored, whilst being sufficiently flexible to investigate emergent issues. Informants had prior knowledge of the overall purpose of the interview but did not know any details of the interview questions in advance. During the course of their interviews, informants completed a short questionnaire containing eight Likert-scaled questions (see example in **Figure 4(b)** following), after which they were asked to explain why they had scaled their responses to the eight questions in the way they had. The tape recorder was turned off while the questionnaire was completed. Most interviews were completed within one hour, although two interviews extended to about ninety minutes with the consent of the informants concerned. All interviews were conducted in the manager's office, and were audio taped-recorded.

4.7.5 Text transcription of audio tape-recorded interviews

As soon as practicable after interviews were conducted, the audio tapes were delivered to an administrative assistant, unknown to any of the informants, who transcribed each interview to text and stored it as a word-processed computer file. The transcribed interview texts and the original audio tapes were returned to me and, after copying the files into my computer, the back-up computer disks containing the files and the audio tapes were securely stored. Upon receipt of the interview text files, I reviewed them for syntax and spelling accuracy, listened to segments of the original recordings to fill in any gaps that the transcriber had been unable to interpret (usually medical terminology), and replaced any identifying names of people or places with bracketed words such as [Name] or [this hospital]. Interview transcripts were then ready for member checking.

4.7.6 Member checking of interviews

Stake (1995:171-172) defines *member checking* as the technique of 'presenting draft materials to actors for confirmation and further illumination', and regards it as an important method of assuring that data are trustworthy (cf. DePoy & Gitlin 1994; Stake 1995). Erlandson et al. (1993) expand this definition to include both formal and informal strategies that should occur continuously throughout the naturalistic research process. They enumerate five areas in which member checking is often conducted, two of which I used in the course of data collection. First, member checking conducted during the course of an interview involves techniques that verify meaning or interpretations of both what the informant is saying and of data gathered in earlier interviews. I propose that the technique that I employed in the course of all of my interviews, whereby I rephrased significant statements of informants into questions which required them to confirm or otherwise clarify their intended meaning, is consistent with this approach. Secondly, Erlandson et al. (1993:142) suggest that 'member checking may be conducted in informal conversations with members of the organisation', a technique that I described earlier in relation to the role that direct observation and interaction with other OTS personnel played in the research process.

Furthermore, Farrar (1999) refers to "member checks" in relation to informants checking their interview transcripts, and in this study, all informants (except three procedural specialists who indicated that they did not wish to check their interviews) were sent a copy of their interview transcripts for member checking as soon as practicable after data collection at each site had been concluded. This process started with interview transcripts being printed and despatched to informants in individual sealed envelopes marked as "confidential". In some cases, individually sealed envelopes of OTS staff interviews were bulk mailed to the OTS manager with a request to distribute them appropriately. Otherwise, they were individually addressed to informants at their respective hospitals.

A letter of explanation and thanks was attached to each interview transcript. Informants were asked to read the transcript and then do one of the following (extracted from letter):

1. If you are satisfied that it is an accurate transcription of the interview, would you please complete the lower portion of this form and return it to me in the enclosed Reply Paid envelope, but <u>retain</u> the copy of the interview transcription for your information.
2. If you believe that the transcription contains some errors, and/or you would like some text to be deleted, could you please write the necessary changes on the interview text and return it to me in the enclosed Reply Paid envelope. I will return the revised copy of the interview transcript for your examination at a later date.

Only five of interview transcripts required minor editorial changes and were subsequently returned to informants for a follow-up check. The signed confirmation slips of all but five of the sixty-four interview transcripts sent to informants were returned. Two of the latter were OS nurses who had resigned their positions before I could send their interview transcripts to them.

4.7.7 Analysis of interviews

In Chapter 1, a conceptual map of the inductive and deductive reasoning applied to this research was presented in **Figure 1(a)** and explained. Three elements in that conceptual map relate to the analysis of the interview data, and reveal that all interview data were analysed *inductively* both during the course of each interview and soon afterwards in their entirety as a means of informing further data collection – a method consistent with the explanation described earlier of the researcher as "human instrument" (Erlandson et al. 1993).

In many types of naturalistic research, interviews are also formally analysed using some form of 'predetermined (but generalist) accounting schemes' (Miles & Huberman 1994:61). So, for example, after member checking of the unstructured OTS staff interviews had been completed, I applied a *deductive logic* using some coded themes developed *a priori* from the literature in connection with the research questions. The reasons for selecting these approaches are explained in the following two sections, where details of the steps employed in the analysis of, first, the interviews with the top managers and procedural specialists and, secondly, the interviews with OTS staff, are outlined.

Analysis of semi-structured interviews

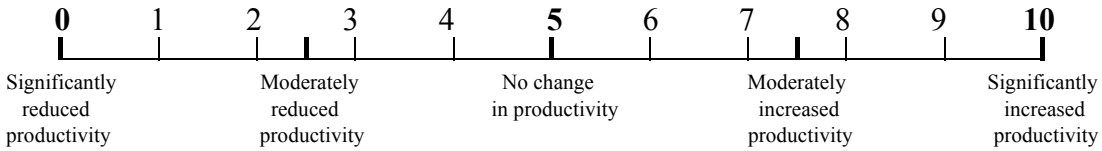
The semi-structured interviews with top managers and procedural specialists were subjected to content analysis on a question-by-question basis and subsequently analysed for emergent themes. However, I was selective about the questions that I analysed in detail because quite a number of the predetermined questions were included only as a means of getting to the questions I really wanted to ask. I was most interested to identify whether each category of informants were saying similar things about their respective roles in the new intra-operative artefact adoption process and their expectations of the outcomes of new intra-operative artefact adoption. I also wanted to ascertain whether procedural specialists were saying similar things about their role in the surgical process by comparison with the role of the instrument nurse. Responses to other questions were also examined for reinforcing or otherwise contradictory evidence. Sometimes word or phrase searches of one group of interviews was undertaken. All of these interviews were formatted for analysis using the

HyperRESEARCH™ qualitative analysis software, primarily so that I could subsequently extract all of the text that I had coded, for example, as being the responses of an entire category of informants to a particular question, or text identified by a word or phrase.

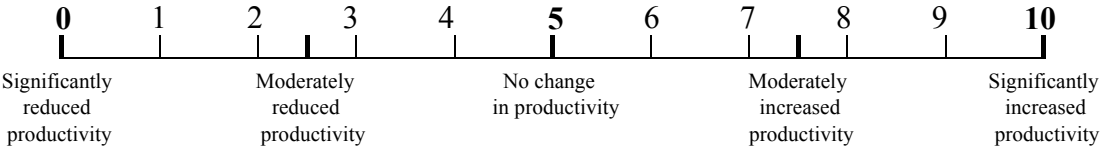
During the course of interviews with top managers, they were asked to complete a set of eight Likert-scaled questions. The four pairs of questions dealt with managers' expectations and perceptions of the actual impact of the "expanding use of high technology surgical instruments/equipment" on (a) OTS employee productivity, (b) OTS throughput, (c) OTS cost-efficiency, and (d) the quality of work-life of OTS staff. The possible ranges on the eleven-point Likert-scale were from "significantly reduced" at zero, to "significantly increased" at 10, with "no change" represented at the mid-point of 5. An example of these questions is shown at **Figure 4(b)** and the entire questionnaire is included in Appendix B1.

Figure 4(b): Sample Likert-scaled questions included in interviews with executive managers

26. Could you indicate on this Likert scale what you **(might have) expected to be** the overall effect of the expanding use of high technology surgical instruments/equipment on **employee productivity** in the operating theatre over the last ten years.



27. Could you indicate on this Likert scale what you think **has been** the overall effect of the expanding use of high technology surgical instruments/equipment on **employee productivity** in the operating theatre over the last ten years.



The resulting data have been analysed using quantitative methods – descriptive statistics to identify trends, and *t*-tests to test for statistical differences ($p = 0.5$; $df = 12$) between the *expected* and *actual* impacts in each of the four domains. Informants' explanations of why they scored each question as they had (elicited during their interviews) provided additional insights.

Analysis of unstructured interviews

About 45 hours of interviews, representing over 70 per cent of recorded interview time in the present research, were with OTS staff. I have already explained how interviews were analysed inductively both while they were conducted (evidenced by the decisions I made continuously about what topics raised by informants were probed and those that were not), and afterwards when I sought to identify the main "messages" being conveyed to me by informants. However, I was guided by Miles and Huberman's (1994) advice that one way to deal with large volumes of qualitative data is to analyse them *deductively* using themes developed *a priori*. They suggest that this approach is the best defence against overload because it makes the coding process much more focused.

The set of themes used was the result of several revisions that occurred between the time that I developed a notional small set of themes from the literature (prior to undertaking the interviews) and when, after preliminary inductive analysis undertaken during reading and re-reading the interview transcripts, the deductive analysis was commenced.

Following Miles and Huberman's (1994) principles of coding and pattern coding, and influenced by the structural characteristics of the HyperRESEARCH™ qualitative data analysis computer software, I started with five "level 1" themes (T1…T5) – one for each of the five research questions that were identified at the beginning of the thesis. They are:

T1: Nature of the technologies employed in surgical production (code: NAT TECH).

T2: A goal or purpose of employing a new technology in surgical production (code: TECHNICAL GOAL).

T3: Work-related consequences of new surgical technology adoption (such as the characteristics of the work, design of the labour process, and the characteristics of the workplace) (code: NATURE OF WORK).

T4: Volume of the work. This refers to the labour intensity of work generally, or specifically associated with the technologies employed in surgical production (code: VOL WORK).

T5: Formal or informal participant in the decision process concerning new surgical technology adoption (code: DECISION ROLE).

At the outset, numerous level 2 and level 3 themes were developed deductively from the literature for themes T1 to T4. The initial set was unmanageably large, so many sub-themes were progressively eliminated as a result of the post-interview inductive analysis. The complete set of themes, their definitions, and codes can be found in Appendix D1, and an

explanation of the level 2, and in two instances, level 3 themes in T1 to T4, is in Appendix D2. However, one example is given here.

In T1, nature of technology (NAT TECH), there are six level 2 themes. They are automating capacity, complexity, propensity to innovation, quantity of technology, degree of uncertainty (using the standardised-customised continuum), and variability (using the routineness-variability continuum). The third level coding adds the dimension of the strength of the level 2 factors (ie. low, moderate, or high). Hence, for example, when a level 3 code (eg. LO = low) is applied to the concatenated level 1 and level 2 codes for degree of automation (code: AUTO), a low level of automation would be coded as NAT TECH_AUTO_LO.

The frequencies with which chunks of text were coded in each interview were summarised in *data accounting sheets* (Miles & Huberman 1994; explained in Appendix D3), which provided graphical displays of the relative concentrations of themes in each category. This technique helped me to avoid the temptation to treat the coded chunks of qualitative text data as frequency distributions. Overall, the conclusions drawn from the deductively analysed interviews were derived inductively – in conjunction with triangulating evidence from other sources – from the identification of themes with the greatest concentrations in the data accounting sheets.

Importantly, the themes that emerged as the dominant ones provided the basis for determining much of the content of Chapter 6 and, hence, the literature reviewed in Chapter 3, consistent with the 'circular process of data collection, data analysis, and design review' (Lincoln & Guba 1985, cited by Erlandson et al. 1993:70-71) that characterises naturalistic research (as summarised in **Figure 1(a)**).

The coding of the interview texts and the collation of results were undertaken using the computer software application, HyperRESEARCH™, which is now described.

4.7.8 Text coding of themes using the computer software, HyperRESEARCH™

HyperRESEARCH™ version 1.65 computer software is described by its producer as a 'content analysis tool for the qualitative researcher'. I have used this software in a *Microsoft Windows NT™* environment to undertake the analysis of the interviews in this research. It is described as allowing the researcher to (Research Ware 1997, 1-1):

- Code any amount of data any number of times
- Retrieve and manipulate portions of coded source material
- Test propositions about the data on any code or combination of codes using Boolean searches

- Test hypotheses about the overall meaning of [their] data using artificial intelligence, and
- Print or export the retrieved data to a word processor, spreadsheet, or statistical package for more in-depth analysis.

These and other features persuaded me to use it as a tool to code and then collate the coded interview data. For example, it gave me the option to analyse the data with or without an *a priori* set of themes, as well as the capacity to run automated searches within any selection of interviews using synonyms of key words. For the most part, the unstructured interviews with OS nurses and SD technical aides were analysed using themes that were derived and refined over the course of the research process, whereas the semi-structured interviews with the procedural specialists and top managers were analysed using, primarily, the themes that were identified *a priori* and reflected in their respective predetermined interview questions.

The software was also relatively uncomplicated to set up and use, it captured and coded only the chunks of selected text (as opposed to the full sentence or paragraph(s) containing the selected text), was very computer keystroke-efficient when coding, and yet sufficiently powerful for the task. Importantly, I was in control of the coding decisions just as I would have been using techniques described by Miles and Huberman (1994), and others, in relation to the use of coding cards, multi-coloured highlighter pens and comments in the margins of printed text. However, the power of the software was that once the coding was completed, the software produced any reports I wanted. Three report formats were used most frequently. One counted the occurrences of codes applied in the analysis of individual interviews, and the data thus derived were transferred into data accounting sheets. The second summarised the location and codes of all coded text in an interview, and the other extracted specified coded chunks of text from selected interviews. All reports could be printed on demand.

The steps involved in preparing the interview text for analysis, coding, and subsequent analysis using the HyperRESEARCH™ software, are detailed in Appendix D3, and various sample reports, along with one complete interview transcript, are available in the Research Protocol.

I had originally envisaged using the proposition testing facility of the HyperRESEARCH™ software, but after developing and testing several propositions I decided not to proceed with it. I chose, rather, to derive my interim conclusions in this phase of analysis from the inductive analysis of the relative frequency of themes. The main reason for this decision concerned the way that HyperRESEARCH™ performed the proposition testing function. For example, an interview might have ten chunks of text coded with the same code, and one

chunk coded with another, but if I had written the proposition to stipulate "AND NOT" the code of the latter, it would test "false". The human analyst can readily see the weight of evidence from the former and would likely conclude that a single occurrence of the latter is insufficient to negate the weight of evidence provided by the ten coded chunks of text. However, the software enacts a strict interpretation of the proposition testing rules predetermined by the researcher – rules that cannot be designed to reflect such human logic.

It is also important to mention a strategy that I employed as a means of strengthening the reliability of my deductive analyses of interviews. I employed an independent research assistant to code ten OTS interviews which she selected at random – two from each hospital – from my computer file list of interviews. The research assistant had been unknown to me prior to her engagement in this activity. When she returned the coded interviews, she reported her impressions of the interviews' key "messages" to me, after which I informed her of my research goals.

I had previously coded two interviews from separate hospitals as a means of pilot testing and refining my use of the HyperRESEARCH™ software, and had already set up a *study* with the complete set of *codes* available. After selecting the interviews that she would code, I copied the files for her to install on her computer. She was briefed on how to use the HyperRESEARCH™ software and was given a set of my definitions of the themes. On return of these ten coded interviews, I compared the frequencies of themes identified by the research assistant in each interview against my own results, with the result that inter-coder reliability was about 75 per cent (Miles & Huberman 1994). Upon examination, I concluded that some of this latter variation was due to the research assistant applying a code to smaller chunks of text, such that she might code two chunks where I combined the two chunks with some intervening text into a single coded segment. The process that I have just described concerning the role played by the research assistant is what Yin (1994) would call evaluator triangulation – a technique whereby congruence of the evaluations of two independent evaluators can strengthen the trustworthiness of the analysis.

4.8 Quantitative data collection, storage, and analysis methods

A range of quantitative data were collected from various sources and in various ways. These were:

- the perioperative time study activities which I undertook with some assistance from OTS staff during my site visits
- archived hospital records (principally staff rosters and the *OTS Surgical Register*)

- hospital inpatient data collections of both the Commonwealth and NSW Departments of Health
- Operating Room Service Weights data from the Commonwealth Casemix Unit, and
- the survey questionnaires administered to the top managers during the course of their interviews.

I have already discussed the last of these data types, so the following sections outline the relevance of the others to the present thesis, and detail how the data were collected, stored and analysed.

4.8.1 Time study of perioperative human labour input into selected procedures

The six representative high volume procedures selected for detailed analysis have already been identified. Perioperative work time study of each of these procedures aimed to quantify the total perioperative human labour input to their production. Initially, I had discussions with OTS staff to identify all of the perioperative activities that contributed to each procedure. This exercise was difficult because some activities might concurrently contribute to two or more procedures and, furthermore, some could occur weeks before an operation was performed. Next it involved logging the time (in minutes) that each activity took to complete. To assist in this process, I purchased three stop watches which had the capacity to be stopped and restarted so that at any time when the worker was not engaged in the activity of interest, the clock could be stopped, and after the task was finished, the accumulated time recorded. Sometimes all three were in operation, timing the pre- and post-operative work within an OR.

In the *sterilising departments*, the collection of instrument processing time study data (represented in **Figure 1(c)** Box 4) was undertaken by various technical aides. They used data collection forms that I customised for each sterilising department after I had observed the work flow and discussed various logistic issues with a senior staff member. (An example is available in the Research Protocol.) It was feasible for SD staff to log their own work times because the stages in instrument reprocessing are clearly delineated and individual staff are typically responsible for completing all of the work for one or more reprocessing stages. Up to six independent examples of each activity contributing to each selected surgical procedure were collected at each hospital, and I periodically did checks for data reliability by observing staff during data collection and talking informally to them about what they were doing.

As an additional check for the reliability of the data that I had not personally collected, I subsequently observed and logged every activity contributing to the perioperative workload associated with one complete example of each of the selected procedures at a hospital in my

region that was not one of the study sites. This was possible because, after obtaining approval from the hospital's manager, the OTS manager was informed of the procedures of interest and I was notified whenever one was scheduled.

In the *operating suite*, I undertook the majority of the perioperative time study data collection (represented in **Figure 1(c)** Box 8). This was necessary because the discontinuous flow of the work contributing to the surgical process, combined with the need for nurses to give their full attention to their work when a patient is in the operating room, meant that it would have been impossible for them to log times as they completed their work. The only activities they were able to log were those that they completed when no direct patient care was involved. For example, they were sometimes able to log times associated with assembling the equipment and instruments in readiness for a procedure, or checking the inventory of joint prostheses when they are received from the biomedical company prior to joint replacement surgery.

The unpredictable nature of operation scheduling (cf. Buchanan & Wilson 1996b) meant that it was difficult for me to be in the right place at the right time to capture all the operating suite perioperative time study data pertaining to complete cases but, over time, I was able to build a database containing at least two examples, and up to six examples, of each distinct activity contributing to the production of each of the selected procedures at each of the five study hospitals. I undertook the same check for the reliability of these data at the "control" hospital in my region as I had for the sterilising department data. For example, it was necessary for me to spend almost fifteen hours between the operating suite and the sterilising department over the two days that I collected the perioperative data for a total knee replacement.

In view of my interest in change over ten years, my capacity to quantify only current perioperative human labour input to each procedure presented a problem but, fortunately, not one for which a satisfactory solution was unachievable. This problem was overcome by virtue of the fact that the "old" 1988 technologies associated with two of the surgical procedures that I selected for detailed analysis were not obsolete, and that the perioperative activities associated with them are unchanged. This was confirmed via informal conversations with OTS staff. These two procedures are open cholecystectomy and D&C, and this issue of non-obsolescence was an important additional influence on their selection for detailed study. As fate would have it, only one open cholecystectomy was performed during my hospital visits, and after discussion with numerous nurses, the procedure of abdominal hysterectomy using conventional techniques was used to estimate a *de facto* perioperative human labour input within the operating suite for an open cholecystectomy. However, sufficient examples of the

sterilising department component of perioperative human labour input to open cholecystectomy were collected by the technical aides during the periods between my site visits.

Perioperative time study data were initially recorded manually at the time of observation in my field notes or on the sterilising department reporting sheets. Details were promptly recorded in my computer in my word-processed reflective journal and/or my custom-designed spreadsheets for each hospital. They were stored electronically, systematically "backed up" on floppy disks, and later analysed using the computational capabilities of the computer's software.

These data were analysed to produce: (a) average minutes of perioperative human labour input to each of the six procedures at each hospital and (b) grand mean minutes of perioperative human labour input to each procedure.

4.8.2 Health services data

Another quantitative component of this research involved the collection and analysis of relevant organisational data for three sample quarterly periods: July-September 1988; April-June 1993; and April-June 1998, in order to compare the results at each of the five hospitals as a means of data reliability checking, and to identify trends in surgical activity and staffing levels.

Hospitals

First, various general data about each study hospital and NSW public hospitals were obtained for the years, 1988/89, 1992/93 and 1997/98, primarily from publications of the NSW Department of Health (Department of Health NSW 1989; NSW Health 1994a; 1994b; 1994c; 1999a; 1999b). These data are reported to the NSW Department of Health by hospitals' Medical Records Departments whose role it is to retrospectively collate principal diagnosis and procedural data from patients' medical records. Corresponding NSW data for private hospitals have not been published, although limited data pertaining to the latter part of the study period were available. These data (represented in **Figure 1(c)** Box 17) were reported in Section 2.4 as part of the study context:

- average number of available beds
- annual inpatient separations
- annual surgical separations.

The raw data were entered into a computerised spreadsheet and later analysed to calculate the proportion of NSW public hospital surgical activity (on each of the above three measures) represented by the four public hospitals in this study.

Intraoperative data

Analysis of the *OTS Surgical Register*, which contains hand-written individual records of surgical activity in the operating suite, was undertaken at each hospital for each day of the three sample quarterly periods to obtain:

- number of all cases (ie. procedures/operations)
- total operating (ie. intra-operative) minutes for all cases
- numbers of each of the six selected procedures
- total operating minutes for each of the six selected procedures.

A custom-designed reporting form was used to manually record the above data (examples are available in the Research Protocol) which were then promptly entered into a computerised spreadsheet and later analysed to calculate, for each sample quarterly period (represented in **Figure 1(c)** Boxes 9 and 11), the overall:

- total number of cases
- mean operating time for all cases
- total number of each of the six selected procedures
- grand mean operating time for each of the six selected procedures.

These measures of *direct* human labour input were then combined with the perioperative work process time study data (ie. the *indirect* labour component), to calculate various measures to compare the perioperative workload minutes with intra-operative time for each of the six selected procedures, including:

- mean total intra-operative human labour input
- mean total perioperative human labour input
- mean total human labour input
- the ratio of mean total operating time to mean total perioperative human labour input. (I have named this measure the Perioperative-Intraoperative Ratio, or *PI Ratio*).

Staffing data

Archived operating suite, sterilising department and, where applicable, endoscopy unit rosters, were analysed for the three sample quarterly periods at each hospital (represented in **Figure 1(c)** Boxes 10 and 12) to obtain levels of OTS staff, measured in full time equivalent (FTE) staff employed by the hospital, contributing to *surgical production* (as defined herein).

Hours worked by non-clinical staff, such as clerical personnel and porters, and miscellaneous personnel (such as the radiographers and perfusionists at Hospital D) were excluded, whereas the hours worked (including overtime) by nursing staff and SD technical aides were included in the data.

These data were entered into the same spreadsheet as the intra-operative data and, together, they were later analysed to calculate for each sample quarterly period at each hospital:

- mean OS case minutes per FTE for each sample quarter
- mean number of OS cases per FTE for each sample quarter.

National Operating Room Service Weights

In Section 2.6.3, a background to the operating room component of surgical DRGs, the National Operating Room Service Weights (NORSWs), was given. There I explained how total operating theatre services budgets could soon be calculated on the basis of their total annual case volume (***V***) and their average OR case/service weight (***W***) at $(973)*VW* per annum. I propose now to introduce the methods I used to analyse my results relating to the perioperative and intra-operative human labour input to each of the six selected procedures in connection with their respective national casemix-adjusted NORSWs and estimated human resource costs. First, I explain why it has been necessary to aggregate the NORSWs for each of the procedures, and then I explain how I have employed these aggregate weights to evaluate the reliability of the NORSWs in estimating OTS human resource costs.

Method employed in deriving OR service weights measures for selected procedures

Table 2(h) revealed how the six procedures I have examined in the present thesis have been assigned eleven AR-DRG version 4.0 codes to reflect the variability that can occur in the treatment (and hence, the costs) of similar illness conditions. However, for the purposes of this analysis, all similar procedures have been grouped (resulting in six categories – one for each of the procedures of interest) and their various data aggregated to produce *grand mean* values for each of the following variables for the six procedures (represented in **Figure 1(c)** Box 3):

- Estimated SD human labour cost component of the NORSW
- Estimated OS human labour cost component of the NORSW
- OR service weight.

All *grand mean* values have been calculated using the same conventional mathematical logic, which is explained in Appendix A7.

Human resource cost estimates of the National OR Service Weights under scrutiny

The technique I have employed to test the reliability of the estimated human resource costs component of the NORSWs is to:

1. adjust the 1995 estimated grand mean human resource costs (being the sum of the SD and OS components) for each procedure to reflect the lower 1998 mean total OR cost (CDHSH 1995a), and then
2. calculate a measure of the potential funding/budget per minute of OTS total human labour input to each of the six procedures based on the grand mean total human labour input for each procedure (as derived from my perioperative and intraoperative data) and the mean OR human resource costs calculated as per (1).

The results derived in (2) will then be compared, in order to draw the secondary (*postivist*) paradigm conclusion of the thesis. The proposition that the NORSWs do not accurately reflect the actual operating theatre services' human labour requirements of the six selected procedures will be confirmed if (a) the estimated costs per minute of total human labour input are substantially different between procedures, and (b) there are substantial differences between the *PI Ratios* (described earlier) calculated for each procedure.

4.9 Mixed method data analysis procedures

In Chapter 1, I defended my selection of the mixed methodology case study design and the mixed methods I employed throughout the present research. I also synthesised the deductive and inductive reasoning involved in the research process in a conceptual map, presented as **Figure 1(a)**, and claimed that my dominant paradigm conclusions were reached in an overall inductive manner. The data analysis methods employed throughout reflect the overarching case study principle of multiple sources of evidence converging on the same set of facts or findings (Yin 1994) (ie. predominantly between-methods data triangulation). Moreover, the various data have been analysed deductively and/or inductively (as previously explained), but with the view to the conclusions emanating from one source of evidence being supported and strengthened by similar conclusions from other types of data.

4.10 Assuring rigour in case study research

How can a naturalistic researcher be confident that (s)he has undertaken rigorous research that will stand up to the scrutiny of others? Erlandson et al. (1993:29) observed that 'valid inquiry in any sphere ...must demonstrate its truth value, provide the basis for applying it, and allow for external judgements to be made about the consistency of its procedures and the

neutrality of its findings or decisions'. They note that Guba and Lincoln (1981; 1989) referred to these combined qualities as "trustworthiness".

4.10.1 Trustworthiness

Mention has already been made of *trustworthiness* on several occasions in this chapter. It was first mentioned in relation to the consideration of the potential to obtain credible and reliable data from the selected sites. It was then mentioned in relation to member checking of interviews and, finally, in relation to inter-coder reliability in the analysis of interviews as a means of countering any potential criticisms of researcher bias (Salner 1999). I have also explained the steps I have taken to validate quantitative data, such as in the time study data collected by staff.

However, it is important to identify other ways in which this research's trustworthiness can be demonstrated, and a useful framework to do this is provided by Erlandson et al. (1993) when they identify and discuss four elements of trustworthiness in naturalistic research: credibility, transferability, dependability and confirmability (cf. Lincoln & Guba 1985; Dick 1999).

Credibility relates to 'the degree of confidence in the "truth" that the findings of a particular inquiry have for the subjects with which – and the context within which – the inquiry was carried out' (Lincoln & Guba 1985:290). Among the strategies that are recommended, and which I have used during the course of this research, are: prolonged engagement, persistent observation, triangulation, referential adequacy materials, peer debriefing and member checks (Erlandson et al. 1993). Most of these strategies, except peer debriefing, have already been discussed, or are otherwise self-evident in the detail presented herein. However, the peer debriefing criterion should be satisfied by the fact that the present research has been carried out under the watchful eyes of two academic supervisors, and that numerous presentations have been made both at seminars involving academics and fellow research students and at professional conferences. Moreover, one conference paper, presented in the USA, was double-blind refereed and published in the conference proceedings (Johnstone 2001) and another has been accepted for publication in a refereed professional journal in Australia (Johnstone, in press).

An interesting additional perspective on ways of strengthening credibility was offered by Farrar (1999) when she suggested the value of including the interview text transcriber's interpretation of what the informants are saying. Although this is not categorically "peer debriefing", I had at least five informal conversations with my interview text transcriber during the course of this research for this specific purpose. These conversations, plus the

previously mentioned feedback from the research assistant who coded some interviews, provided valuable reinforcement that I was not just hearing what I hoped to hear.

In general terms, *transferability* relates to the extent to which a study's findings can be applied to other contexts or with other informants at a later date. Although it is held that the results of naturalistic research cannot be replicated elsewhere, Erlandson et al. (1993:32-33) argue that the thick description that is generated should 'enable observers of other contexts to make tentative judgements about applicability for their contexts and to form working hypotheses to guide empirical inquiry in those contexts'. They suggest that the transferability criterion should be satisfied if a researcher samples in a purposeful way and provides a thick description of the "sending context". I propose that the details provided in this chapter concerning purposive sampling and the representativeness of sites and procedures, combined with the pervasive environmental characteristics of the Australian health care system, described in Chapter 2, give this study a degree of transferability beyond that which is customarily attributed to naturalistic research.

The *dependability* of an inquiry relates to its capacity to be 'replicated with the same or similar subjects in the same (or similar) context' and produce the same findings (Lincoln & Guba 1985:290). In naturalistic research, this criterion is generally regarded to equate with both the *reliability* and *trackability* of the research process. This means that the methods of investigation were appropriate to the task, and that the researcher has made it possible for an 'external check to be conducted on the processes by which the study was conducted' (Erlandson et al. 1993:34). Crawford, Jenkins and Murray-Prior (1999) argued that this is all the more important in a single researcher study (such as the present research). These criteria are partly satisfied by means of compliance with the *transferability* criterion, but *dependability* is also enhanced by an audit trail, such as is provided by a researcher's journal that provides supporting documentation and a running account of the research process. Details of the personal journal that I have kept on this "research journey" are detailed in the following section.

In positivist research, *confirmability* is inextricably tied to the *ontological* assumption that reality is *objective*, and to the *axiological* assumption that the research's outcomes are free from investigator bias – a matter comprehensively discussed in Chapter 1 (cf. Lincoln & Guba 1985; Cresswell 1994; Stake 1995). However, in naturalistic research, the researcher needs to be able to demonstrate the confirmability of the data themselves (Lincoln & Guba 1985). This is achieved using the techniques that have been described in relation to *dependability* – in particular, the *trackability* of data, which is now discussed.

4.10.2 The personal journal as an audit trail

It is generally recommended that in case study research, the research report should be accompanied by 'a companion volume that includes items …such as original interview notes, actual survey responses, member-checking forms, peer debriefing notes, reflexive journals, photographs, audio tapes…' (Erlandson et al. 1993:166; cf. Cresswell 1993) – what Yin (1994) refers to as a case study database.

Its principal purpose is that it serves as a "chain of evidence" for the external observer to adjudge the reliability of the information and the conclusions contained in the case study report. For example, it would provide details of the circumstances under which evidence was collected, and make it possible to follow the derivation of the evidence from the initial research questions via explicit links to the data collected, and the conclusions drawn (Yin 1994). Erlandson et al. (1993) cite Lincoln and Guba (1985) who regard the reflexive journal component of this "companion volume" as 'a kind of a diary in which the investigator on a regular basis records information about him- or herself. The journal provides information about the researcher's schedule and logistics, insights [and] the reasons for methodological decisions' (Erlandson et al. 1994:143). They argue that it supports the credibility, transferability, dependability and confirmability of the study, and is an important part of the study's audit trail.

About fifteen months prior to my formal application to conduct this research, I commenced the activity of recording my ideas about the research problem, along with details of literature I had read and people with whom I had spoken. These were all factors that influenced my tentative research design early in 1997. After the research process officially started, entries in my diary-cum-reflexive journal became more frequent and voluminous, recording details of my thoughts and activities during the full period of the research and much of the thesis writing. It contains details of all my steps in the research process, and includes commentary on experiences such as frustration with institutional research committees, successes and difficulties experienced in the field, annotations of more literature I had read, details of periods of personal confusion about how to handle the body of existing literature on the topics relevant to this thesis, discussions with my academic supervisors, and my reflections on how the research process was progressing. This often resulted in new questions to be answered and revised data collection strategies.

My diary-cum reflexive journal is a word-processed document of 223 printed pages, which is one of three companion volumes providing the audit trail for this research. The second volume is a 300 page word-processed document that contains my *verbatim* transcriptions of

selections from the literature that I regarded to be most likely relevant to my research, interspersed with my academic critique and reflective comments. The other volume, the "Research Protocol", contains samples of the quantitative data collection instruments, the member-checking form, the full text of an interview, samples of reports generated by the HyperRESEARCH™ software, and other supporting documentation. These three volumes are available for inspection on request.

4.11 Ethical considerations

> Ethical considerations should always be at the forefront of naturalistic research. The first element common to every protocol is the researcher's respect for the person and group under study. Ethical issues surrounding interviews include the researcher's motives and intentions as well as the study's purpose, the protection of respondents through the use of pseudonyms, establishing beforehand who has the final say over the study's content, and sensitivity to time and the number of interviewees involved in the study... Almost all strategies for data gathering have ethical dimensions (Erlandson et al. 1993:89).

Cognisant of the above issues, the guidelines of the National Health and Medical Research Council's (NH&MRC) *Statement on Human Experimentation and supplementary Notes, 1992 (and amendments)*, and the NH&MRC's guidelines contained in the volume, *Ethical aspects of qualitative methods in health research'* (Commonwealth of Australia 1995c), the key ethical considerations involved in this research are now identified and discussed. The first is the issue of institutional support, the second, informed informant consent and, finally, the issue of hospital and informant confidentiality.

4.11.1 Institutional support

This research was approved by the Macquarie University Research Ethics Committee on 27th March 1998. Subsequently, formal applications to conduct research at each of the five hospitals were made to the appropriate bodies, but only after I had undertaken those activities described in Section 4.2.6 concerning the selection of sites. In one instance (Hospital D) it was necessary for my application to pass through a scientific advisory committee prior to its consideration by the area health service's research ethics committee. At the other end of the spectrum, approval to conduct research at the private hospital was granted by the hospital's executive committee. Applications were submitted and support granted over a period of eleven months, during which time research was conducted at those hospitals that had given their support early in this process.

4.11.2 Informed consent

Participant information and consent forms were prepared for each category of informants: operating theatre services staff (Form X), top managers (Form Y) and procedural specialists (Form Z) (examples are available in the Research Protocol). Minor modifications were made to the text of Forms X and Y connected with Hospital D at the request of the relevant institutional committee which stipulated that the letterhead of the area health service should be included on the consent forms used there.

Informants X and Y read and signed two copies of the *Participant Information and Consent Form* immediately prior to their interviews. They retained one form and the other was later filed in my locked filing cabinet. A different strategy was employed with the procedural specialists because interviews were conducted by telephone. Letters seeking consent to be interviewed were sent over a period of two months to sixty procedural specialists. (An example is available in the Research Protocol). Details of the interview questions and an original copy of the Participant Information and Consent Form Z were attached to this letter and each recipient was asked to indicate his/her willingness to be interviewed by faxing the signed consent form to me, as well as providing details of times that the interview could possibly be scheduled. Participation in the telephone interview was deemed to confirm the consent granted at an earlier date.

4.11.3 Confidentiality issues: hospitals and informants

The anonymity of hospitals and informants has been assured by the use of the system of coding described earlier in this chapter. However, despite the need for anonymity, it is necessary to ensure that an external auditor could track the data to their sources, so the following details explain how this has been achieved.

At the commencement of each side of the audio tapes upon which interviews were recorded, I voice recorded details of the informant code and the date and time of the interview. At the conclusion of their interviews, operating theatre services staff and executive managers signed the staff profile form (see **Figure 4(a)**) to confirm that they had been interviewed, and witnessed the writing of their unique informant code on both the staff profile form and the casette of the audio tape on which his/her interview was recorded. This procedure was not possible in the case of the procedural specialists who were interviewed by telephone, but the same coded identification procedure was applied to the audio tapes of their interviews.

The details completed on the staff profile form provide the link with the participant information and consent forms that were signed by informants X and Y immediately prior to interview. In the case of informants Z, their informant codes were written on the signed

consent forms that had been previously faxed to me. Hence, an audit trail exists between the coded interview tapes, the transcripts, and individual informants and their consent.

Finally, a text processor, unknown to any of the informants, was employed to transcribe all of the audio taped interviews. Details of the steps taken to ensure confidentiality of interview texts were described earlier in this chapter. All audio tapes have been securely stored.

4.12 Conclusion

This chapter has detailed the specific methods employed in this collective case study research. It has explained the rationale for the selection of sites, informants and data types, and the ten-year timeframe for analysis. It outlined the various approaches to, and stages of, data collection from multiple sources, data collation and data analysis, culminating in between-method data triangulation. It has also explained why I selected the qualitative analysis computer software, HyperRESEARCH™, and how I applied it to the analysis of interviews, the results of which are not the final outcomes of the study, but rather another source of convergent data. I then discussed the characteristics of the present research that contribute to its rigour, including a brief examination of the reliability of informant memory, and the role of my diary-cum-reflective journal and other companion documents in providing an audit trail of the entire research process. The chapter concluded with an overview of the ethical aspects of this research.

The following chapter is the first of two chapters in which I report on the collation, analysis, and interpretation of data. Its conclusions represent the secondary (*positivist*) paradigm outcomes of the present thesis. The chapter starts by describing the study sites and the six procedures selected for analysis. It describes the technologies used in the intra-operative and perioperative phases of producing these procedures, and analyses the volume of human labour input, along with the changes that are the consequences of new intra-operative artefact adoption between 1988 and 1998. It presents a synthesis of the quantitative results that constitute part of the multiple sources of evidence converging on the dominant (*naturalistic*) paradigm outcomes of this research (presented subsequently in Chapter 6). Finally, it offers an interpretation of the aforementioned results in conjunction with my analysis of the Australian National Operating Room Service Weights for the six procedures.