CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 <u>Introduction.</u>

This chapter outlines the research design and methodology chosen for this study. Phenomenography was selected as the most appropriate qualitative method to determine the essential qualities required for the 21st century of a person beginning in the geomatics profession. The research identified the appropriate intellectual tools to plan teaching, and improve the efficiency, quality of education, and learning outcomes. Curricula was identified which addressed the needs of future professionals.

Qualitative research was considered more appropriate for this research project as it focused on the construction or interpretation of people's perceptions, rather than a description of their concepts i.e. the process (refer to 3.2.1). To reveal the different ways people see, understand and conceptualise the qualities of future professionals, pre-categorised criteria were considered too structured and restrictive (Kvale, 1983: 172 and 2.4.7). Such investigations would reduce arbitrary subjectivity, be constrained by imposed limits, and describe things as they are (reality), not as they appear. In addressing the needs of the future geomatics professional, there could be no researcher predetermined limits to, or non-acceptance of, the interviewee's responses. Such an approach could be accommodated by using a qualitative research methodology.

3.2 <u>Research Design.</u>

The relative advantages and disadvantages of quantitative and qualitative research have been thoroughly considered (Saljo, 1988: 35) and such a detailed comparison is consequently not part of this study. These different methodologies are not considered as being in conflict, but rather are equally applicable and valid in their own research domains. The formal requirements of experimental methods are believed to reduce arbitrary subjectivity and partly function as a *"methodological straight-jacket"* (Kvale, 1983: 172), testing a particular hypothesis rather that revealing the subjects' life-world understanding. Quantitative research methods have been used to determine the needs of the geomatics industry and were found to have some shortcomings (refer to 2.4.7). Hence, this particular research enterprise is best suited to qualitative methods which explore the nature of phenomena and characterise them: examples are peoples' ideas or actions. While qualitative research commences on the assumption that the characteristics are unknown, quantitative research is generally based on a reasonable knowledge of the characteristics being investigated so that the outcomes can be compared against one another or standards. For example, in this research a choice is to compare the relevance of existing curricula against the work place needs (quantitative method); or to discover the perceptions of the understanding and relevance of the curricula (qualitative method) based on exposure. Hence, qualitative research focuses on the construction or meaning, or differences in meaning, rather than description, a neutral

outcome (as are statistical data from either method). When used for research into human behaviour it can also be quantified in descriptive terms. Qualitative research is also appropriate where comparisons need to be made between some initial situation and a changed position following deliberate intervention this comparison is the byproduct of the research outcome. By not assuming any knowledge or differences in the research, and having arrived at an answer at that point in time, the outcomes can then be legitimately compared with a previous situation to ascertain the affects of the interventions or the people subjected to these interventions (Marton, 1992). By contrast, this research is not intended to discover the perceptions of individuals before and after completing a professional course to ascertain the changes bought about by that intervention. It aims to use the conceptions of 'worldly' experienced individual professionals to determine the construct of the interventions needed for curricula to address the needs of future professionals. Each of these contextual conceptions will concern *...the experienced meaning of a phenomenon within a unit of thinking* (Svensson, 1989: 530), which is an empirically based generalisation (conceptualisation process) made up of combination of concepts of the individual's experiences (refer to Figure 3.1). As conceptions exist in the real world, in terms of a mental act and exhibited by the individual doing something in a certain setting (Marton, 1981: 196), it is possible to isolate conceptions and look for similarities amongst the research population.

Before investigation of people's conceptions using a qualitative paradigm, the design of the total process must be established as... *qualitative research does not have the general acceptance that quantitative paradigms enjoy and, therefore, more attention must be devoted to a sound rationale than with more traditional proposals* (Marshall and Rossman, 1989: 114). Hence, qualitative research is designed around the soundness and the usefulness of the project to demonstrate validity of the methodological paradigm and the outcomes (refer to 3.2.5). Marshall and Rossman (1989: 145-149) discuss design criteria, such as defining the data collection technique; being explicit about the phenomena being investigated; identifying the breadth and depth of the research population; preparedness for public disclosure of data, data collection and analysis strategies; and controls for bias. To allay fears of validity and to enhance the measure of soundness and truthfulness, a pilot study is also recommended to 'test' the canons of truthfulness before commencing the data collection phase (Gerber, 1993: 45; Kvale, 1989: 78 and Marshall & Rossman, 1989: 145-149). Once the phenomenon is identified and the research methodology determined, the design of the undertaking can commence around the canons for attaining trustworthiness and value of the outcomes as the major considerations.

Of the qualitative research methods, phenomenography was considered the most appropriate methodology for this particular research subject. Phenomenography is used to study learning and thinking, mapping the qualitatively different ways in which people experience or think about different phenomena (Marton, 1981: 181; Marton, 1984a: 44 and 61 and Marton, 1988b: 178). This new (and valid) research method also has the advantage of adding to and confirming other research outcomes, hence strengthening the need for curriculum development.
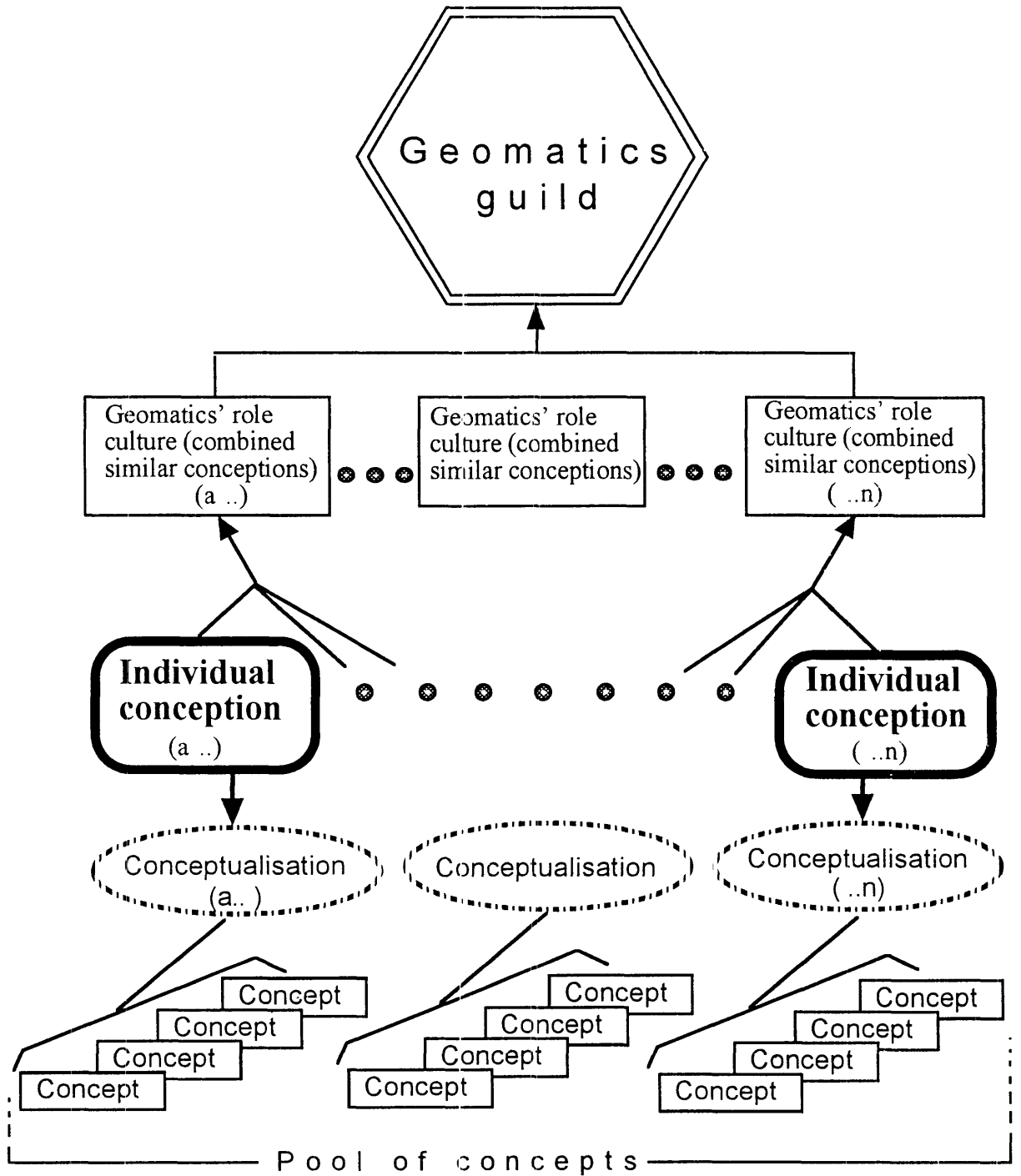
Note: The conceptions are formed in a lived world environment, where concepts change or develop, and vary among individuals depending on their own experiences. Hence, each element of the model is dynamic.

Figure 3.1 Defining the geomatics' guild - conception formation schema.

Phenomenography looks at the relations between human beings and the world around them, focussing on the perception itself (refer to 3.2.1). These perceptions, based on the intentionality relationship of the experienced life-world, providing an inseparable relation between the subject and the phenomenon, need to be discovered within a delimited and non-comparative context. While this type of investigation has been dealt with by other qualitative methods (usually as a first person epistemology, eg. phenomenology), phenomenographic research is considered, by its proponents, a specialisation of its own in this approach because of its unique focus on the meanings and variations in conceptions. The major research outcomes of phenomenography are: educational applications based on the outcomes which show the affects or non-affects of educational treatment. Alternatively, they elucidate learning developmental needs made evident from the identified shortcomings in understanding elicited from people's perceptions of the phenomenon under consideration.

3.2.1 Phenomenography.

Phenomenography is a form of 'rigorous qualitative analysis' generating a picture of the variation in human conception of phenomena through the categories systematically determined during the course of the research (Saljo, 1988: 45). It is about the different ways in which people may interpret a physical reality, regardless of whether such differences originate from differences between cultures, historical periods, experiences or age (Johansson *et al.*, 1985: 225). It is not trying to describe things as they are, but characterise them as they appear to people (Marton, 1988b: 181). This feature of phenomenography, by being ... *more interested in the content of thinking than in traditional psychology* (Marton, 1984b: 32), does not make statements about phenomena but about peoples' conceptions of them. Hence, the focus is on individuals' experiences, the content of their consciousness, and not the individual. In doing so, it places phenomenography between the natural science and social science spheres. Hence phenomenography, as ... *a research approach designed to answer questions about thinking and learning* (Marton, 1984b: 28 and 43), has a unique contribution to make on its own as an empirical methodological study of human experiences. It is also considered ... *a methodological approach that is compatible with a relatively broad set of theoretical perspectives that focus on people's conceptions of reality* (Saljo, 1988: 37). Then, phenomenography can be defined in terms that: *It aims to reveal the qualitatively different ways in which people see, experience, understand, and conceptualise various phenomena in the world around them* (Renstrom *et al.*, 1990: 556).

In describing the relations between the individual and various aspects of phenomena, regardless of whether those relationships are manifest in the forms of immediate experience, conceptual thought or physical behaviour (Marton, 1984b: 41), it aims for the factual variation (Marton, 1984a: 61) Hence, the fundamental important feature of phenomenography is to identify the ... *logical relations existing between conceptions of one phenomenon and conceptions of another phenomenon* (Marton, 1984a: 62), i.e. the 'outcome space'. By focussing on meanings and variations in conceptions (unique to phenomenography), the words of the people are presented as a collective, not analysed as a series of individual studies, providing a single massive portfolio which is analysed to

identify a limited number of qualitatively different conceptions.

Other features of phenomenographic research are that it:

(i) makes distinctions between conceptions (peoples' understanding) and categories of description (the capturing of the understandings) ... *that are relational, experiential, content-orientated and qualitative* (Marton,1984b: 33);

(ii) aims at minimising any interpretation on what is meant by having categories of conceptions (Dahlgren,1993);

(iii) doesn't deal with dualism of mechanisms of thinking and the data of the conceptions (as in cognitive psychology), but describes the structure of the whole consciousness (Dahlgren,1993);

(iv) displays knowledge through lived experiences and expressed as it is being lived (Gerber, 1993: 39);

(v) is an 'illuminating' methodology in that it is not providing statistical proof as an outcome;

(vi) is a second-order perspective orientation or experience (Saljo, 1988: 36); and

(vii) aims towards understanding and describing how people (in a context) construe significant phenomena in the world (Saljo, 1988: 36), i.e. the what of thinking - the meaning people see in and ascribe to what they perceive (Saljo, 1988: 37).
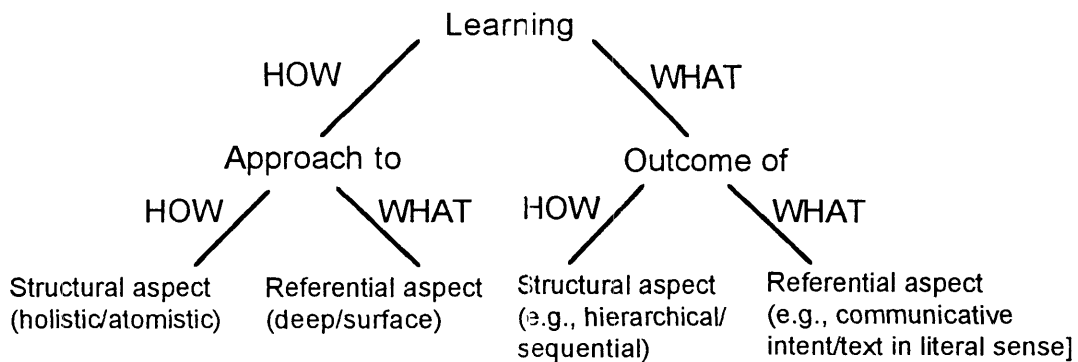
3.2.2 Underlying theory of phenomenography.

Peoples' way of learning represents relations between themselves and certain aspects of the world around them. Learning improvements should focus on the relationships as a whole and not on the individuals alone (Marton, 1988a: 53 and Saljo, 1988: 44). In Figure 3.2, Marton has depicted that what is learned (the outcome) and how it is learned (the process) are inseparable aspects of learning (Marton, 1988a: 53). Hence, there are two aspects of experiencing phenomena, firstly the act of experiencing or the *how* of the conception (noesis), and secondly, that which is experienced or the *what* (or meaning) of the conception (noema) (Marton, 1984a: 67). The qualitatively different ways in which some materials are understood correspond to qualitatively different ways in which the material is subjectively organised by the learner (Marton, 1988a: 60). Changes of meaning originate from an act of structuring - but this act presupposes a change of meaning; hence the dialectical interplay of these two aspects by the learner (Marton, 1988a: 60). Therefore, the referential (or meaning) and structural (the phenomenon-as-seen) distinctions of learning, which resembles the distinction between the noetic and noematic aspects of an experience (Marton *et al.*, 1993: 282), are dialectically intertwined with one another. To establish a structure (relationship between components) these components must be seen as related to one another and as parts of a whole (Marton, 1988a: 60).

Structural or organisational aspects of the process of conceptualisation can be holistic (approach to understanding something as a whole) or atomistic (a focus on details and sequence - not on the whole). The holistic approach to the phenomenon suggests a 'deep' referential consideration, an external (life-world) horizon , i.e. ... *relations a phenomenon is seen to have with other aspects of a greater whole of which the phenomena is a part*

(Marton, 1988a: 68). Then a surface or shallow consideration, which focuses on obvious meaning of each part, is an internal horizon aspect, i.e. ... *parts that a phenomena is seen to have and to the relations seen between those parts* (Marton, 1988a: 68)

Similarly, the two related aspects of the qualitative differences in the outcome of learning concern meaning (subjects understanding of the phenomenon- referential aspects), and structure (subjects understanding of how the phenomenon is organised - structural aspects). The outcome structural aspects (how the outcome is arranged) would be, for the holistic approach, thinking in a super-ordinate way, hierarchically linking the parts to each

Learning

HOW / \ WHAT

Approach to   Outcome of

HOW / \ WHAT   HOW / \ WHAT

Structural aspect   Referential aspect   Structural aspect   Referential aspect
(holistic/atomistic) (deep/surface)   (e.g., hierarchical/   (e.g., communicative
                                         sequential)   intent/text in literal sense]

(Marton, 1988a: 66)

FIGURE 3.2 Concept of learning.

other (implying understanding). For the atomistic approach, it is thinking about something in unrelated parts (a segmentation process) or sequential (both aspects on the same level). The referential outcomes would, respectively, manifest as considerations for what is signified or an overall intention, and the phenomenon taken in its' literal sense.

The underlying theory of phenomenography considers the meanings of individual thought, not distinguishing between immediate thought (foundation of their knowledge) or reflective thought (knowledge): the main focus is then in capturing the variation (in the phenomena or content) in meanings. As there are differences in people's way of conceiving, which are an entity in themselves and not part of other people's ways (Dahlgren, 1993), this focus is on all the groups' understanding and experiences (on one level) to find out the answers, or variations. The following comparative analysis then negates the focussing on specific phenomena and placing emphases (Marton, 1992). Marton has also found that these variations are always generalisable (even if the distribution may be different). This means that this generalisable knowledge in some dimension (context), wherever it was determined, is then present wherever the same practice occurs within the same context of that profession.

While phenomenography was originally considered atheoretical, the dynamic part of phenomenography now calls for a theory for change of conceptions (Dahlgren, 1993) or of awareness or consciousness, i.e. under what conditions do people feel there is a need for change. This is based on the premise that individuals are aware of everything (within the

totality of their experiences), but not aware in the same way. Their life-world is an experienced or lived world, never a world by itself, and constitutes the immediate and inseparable relation between the subject and the object: we are always intentionally related to the world and the world is always intentionally related to us (Sandberg, 1991: 3). Intentionality is therefore dynamic and each intentional experience is constituted by a number of subsidiary intentional experiences (these all co-exist within the act of conceiving a phenomenon). Then a conception, in a cognitive sense, expresses the meaning-bearing (intentional) relation between the structure of thought and content of the thought (about a phenomena) (Sandberg, 1991: 4). The importance then, and the essence of this study, is to understand conceptions so that phenomena are made intelligible, and hence are understood, and can be skilfully mastered.

As conceptualisations vary between individuals and between periods of time, phenomenography focuses on conceptions of reality and not individual differences, learning levels, etc. (Marton, 1981: 189). This is done in each context as understanding is not inherent and individuals are considered to act and reason in accordance with the situation they find themselves in, rather than on the objective (or matter-of-fact characteristics of the situation) (Renstrom et al., 1990: 556 and Saljo, 1988: 36). Then it is possible for anyone to have differing conceptions of the same phenomena in different contexts, meaning that conceptions are not characteristics of individuals but are characteristic ways of functioning. Hence, during data gathering interviews, the aim is to disregard interviewers' conceptions and gather the perspective of the interviewee (Dahlgren, 1993), so that we are able to identify and describe the categories and the intra variations. It is also the conceptions of reality, that we have acquired as participants in human communication, that characterises phenomenography as a scientific undertaking (Saljo, 1988: 38). Then, the two unique assumptions in the underlying theory of phenomenography, that distinguishes it from other similar techniques, are:
(i) conceptions of reality do not reside in an individual, they use particular conceptions of reality in a number of situations or to a number of problems, but they can't be assumed to adopt a particular perspective of reality (Saljo, 1988: 42); and
(ii) conceptions (abstractions of reality able to be formed into various 'provinces of meaning', not the experienced meaning of the phenomena) are conceived as relational phenomena rather than inherent qualities in the mind of the thinker or in the phenomena themselves (Dahlgren, 1993 and Saljo, 1988: 44).

Phenomenography is learning about people's experiences of the phenomena dealing with what is 'culturally' learnt and the individual's ways of relating to the phenomena (Marton, 1981: 181). This relational thinking is central to phenomenography , i.e. learning, thinking and understanding relationships between the individual and that which he/she learns, thinks about and understands (Marton, 1984b: 43). This methodology, then, aims at making a statement about people's ideas about the phenomena (not a psychological entity located in the individual), a second order (experimental) statement, rather than a first order perspective of making of a statement about the phenomena (Marton, 1981: 178 and 182). That is to say, people do not just perceive or experience; they perceive or experience *things* and hence descriptions of perception and experience [a qualitative action] are in terms of

their content. The second order statement is autonomous, as it is not arrived at by the first order perspective, and forms the base from which categories of descriptions start (Marton, 1981: 180 and 190).

Phenomenography, as a research specialisation, aims to map variations (special domains of knowledge) of the qualitatively different ways in which people experience, conceptualise, perceive, and understand the phenomenon and its aspects in the world around them (Marton, 1981: 181; Marton, 1984a: 44 and 61 and Marton, 1988b: 178), i.e. it is content orientated about the relations between a person and the world about them. What is considered is what is thought about and what is perceived. The actual situation or the individual is not under assessment. Different people may think about a certain aspect of reality in different ways (Marton, 1988b: 183 and 187). The mapping is done by sets of distinctive categories of description, each corresponding to a special conception of a certain phenomenon.

The first distinguishing feature of a phenomenographic research study involves the relational character. The second distinguishing feature is that descriptions are in the form of categories (the way, or possible different ways, of understanding) which are the research outcomes (Marton, 1988b: 181 and 194). The aim is to detected the structural description or the most distinctive characteristic of the conceptualisation of the relationship between the individual and the phenomenon (Marton, 1988b: 182). It was also found that each different case must be dealt with on its own terms (Marton, 1988b: 188). Phenomenographic research can concentrate on an aspect such as an interest for general learning; consider a content-orientated approach to the study of learning (Marton, 1988a: 189); or research the pure phenomenographic 'knowledge interest', focussing on the description of how people conceive of various aspects of reality (Marton, 1988b: 191). The meaning of peoples' experiences is always contextual, but while some content aspects are question related the other aspects are not (Marton, 1988b: 196). Hence, the methodology is substance orientated (Marton, 1981: 181) and the major outcomes, the categories of description (grouped common descriptions appearing at different situations), when grouped, provide a source for development:

> In empirical investigations, we often find variations in conceptions not only between, but also within individuals. Depending on the context, e.g. the question asked, they may exhibit qualitatively different conceptions of the very same phenomenon. The conceptions are thus frequently not characteristics of the individual, rather they are characteristic of ways of functioning. Instead of seeing conceptions as representing different groups of individuals, the ultra-individual variation found invites us to think in terms of an abstract system of description, a gigantic space of categories, in which the individuals move - more or less freely - back and forth.

(Marton, 1984a: 62)

3.2.3 Question development and interviews.

Kvale states that no general theory can be developed for the interview because, as a human discourse, the interview is generally complex and varied (Kvale, 1983: 172). However, the interview process does enable the interviewees to organise their own description, in their own words, of their own life-world experiences and opinions (Kvale, 1983: 172). All interviewer questions seeking elaboration are based on the interviewee's utterances and not on information gained from the literature review.

The first stage in phenomenographic research is to identify (in this case, from the literature review) the phenomenon to be investigated and confirm the applicability of this research method. The selection of a specific phenomenon to be exposed at the interviews is essential so as not to elicit a lot of irrelevant answers from the one question. From the literature review, it became apparent that the current geomatics industrial structure and educational philosophy, which has slowly evolved over the past seventy years, does not adequately address recent and emerging professional or societal needs. In order to synthesise the contemporary problems and perceived needs of the geomatics' industry, to determine an educational solution, the phenomenon requiring 'illumination' was perceived to be the essential qualities, for the 21st Century, of a person beginning (post graduation) in the geomatics profession.

The second stage is to develop the research question which will best assist the interviewees towards the phenomenon being investigated. Dahlgren (1993) and Renstrom *et al.* (1990: 557) explain that the formulation of 'prompting' questions (both the research question and those in response to the interviewee's utterances) should be done in a non-technical and open ended fashion [to provide the best platform for extracting the interviewee's understanding based on their lived experiences of a phenomena]. The introductory or entry question should be short and relevant to the investigation, but of significance and general interest to the interviewee (Dahlgren, 1993). It would normally be best arrived at following modification based on the outcomes of a pilot study that tested the results obtained from several variations of the research instrument.

The third stage is to establish the discourse used to gather data. This includes (Renstrom *et al.*, 1990: 557):
(i) identifying the research population so that the depth and breadth of participating individuals are suitable to provide data gathering validity;
(ii) identifying and arranging face-to-face or telephone interview place and times. This includes explaining the purpose of the interview and ensuring sufficient time is available for conducting the interviews; and
(iii) the acceptance, by the interviewee's, of having the interview recorded on magnetic tape in preparation for a verbatim transcription of the interview.

Phenomenographic methodology uses interviewing as the primary method of data collection (Marton, 1984b: 42). Where possible, the interviewing to assess the reality or perceptions of individuals is best conducted in the interviewee's own environment (Meyer

et al., 1990: 131-136). The technique requires the stating of a case or asking of an introductory opinion/value question, followed by asking further elaboratory questions (developed from the interviewee's explanations). This is conducted in an unstructured interview environment to obtain the persons' own ways of conceptualising and their own way of approaching, structuring and describing the phenomena (Marton, 1988b: 196 and Svensson, 1989: 532). The techniques and the direction the interview takes may vary, as the process is a discovery largely directed by the responses to the questions. Hence, this recursive technique can be described as conversational and treating each individual and their situation as unique. However, to unlock the source of the material being sought, the phenomenological reduction methodology principles, involving bracketing, focussing and describing the interviewee's experience of particular phenomena, are employed, exhorting that person to the limits of their understanding, i.e. to where nothing more can be added (Gerber *et al.*, 1992: 19; Kvale, 1983: 184 and Svensson, 1989: 532).

During the interview, all efforts are made to release each conception from the interviewee with as minimal influence or affect as possible on the conception (Dahlgren, 1993). However, in reality the interviewer does ongoing preliminary analysis, on the basis of the answers provided, while the interview is in progress. This mainly occurs because the interviewer needs to ask appropriate questions, and does not have preconceived categories of description, prior the interview and analysis stages, to which they would naturally precede or use to 'control' the interview. A further problem can be experienced when an interviewee remains within the interview situation and does not mentally expand or move to the aspect of reality (consciousness level) that this method is seeking. A very open but 'narrow' first question aims to overcome this possibility (Dahlgren, 1993), otherwise a suitable opening during the interview must be found to achieve the required 'thought' level.

General aspects to be considered in qualitative research interviews that will assist in eliciting valuable and truthful data are (Kvale, 1983: 174-179):

(i) The purpose of interview is to describe and understand life-world experiences through a theme-oriented and not person oriented approach.

(ii) The main task is to understand the meaning of what is said from the gathering of the maximum possible interviewee's nuanced descriptions of the different aspects of the phenomenon.

(iii) Obtain the interviewee's own descriptions (not the interviewer's interpretations) of specific phenomena and not general opinion.

(iv) Approach the phenomenon in an 'open' way , not with predetermined categories or structure, but focus on the central theme of the life-world experiences of the person.

(v) Seek clarification of ambiguities but positively adapt to changes caused by a persons 'enlightenment' during the interview.

(vi) The interview is an interpersonal exchange with the interviewer employing interpersonal skills while also assuming the 'role' of research instrument and method.

The interviewer should also be aware of the sensitivity of each participant and his or her situation, and endeavour to extract the data from the person by making the interview

appear a worthwhile, positive and enriching experience for him or her.

The interview is recorded on magnetic tape and transcribed verbatim in preparation for the analysis process. The other reason for taping the interview is that it minimises the distractions, allowing the interviewer to concentrate on formulating questions based on the utterances of the interviewee.

3.2.4 Analysis.

Phenomenography consists of a dialectic analysis in that meanings are developed in the process of bringing selected quotes [the data pool] together, from all the interviews, and comparing them. The process is determining the meaning of the categories, which in turn determines the quotes for inclusion or exclusion:

The process is tedious, time consuming, labour intensive, and interactive. It entails the continuous sorting and resorting of data. Definitions for categories are tested against the data, adjusted, retested, and adjusted again. There is, however, a decreasing rate of change, and eventually the whole system of meaning is stabilised.

(Marton, 1984b: 43).

Data analysis is not carried out on pre-categorised criteria and is therefore less algorithmic (tested against set criteria) than with more structured data (Saljo, 1988: 39 and Svensson, 1989: 532). A prerequisite to analysing the data is that the researcher must be acquainted with the subject matter, so that during the analysing process there is more meaning gained from questions such as: *How does the respondent construe the phenomena? What concepts does he or she use to explain it? What types of similarities with other phenomena are introduced? etc.* (Saljo, 1988: 41).

The transcripts of the interviewee's descriptions or explanations [which delimit and relate cause and affect] are analysed to ascertain the main similarities and differences concerned with the meaning of, and the relation between, cause and affect (Svensson, 1989: 532). The classifying of these descriptions is not just a process of sorting data, it is identifying the most distinctive characteristics and structurally significant differences that clarify how people define the phenomena. The categories of description originating from contextual understanding are de-contextualised and may be useful in other contexts. *It is the goal of phenomenography to discover the contextual framework within which various categories of understanding exist* (Marton, 1984b: 34). Hence, the data are analysed by the following stages (Marton, 1988b: 198):
(i) A selection process based on criteria of relevance. The phenomenon is delimited and interpreted in terms arrived at from the interview. The quotes themselves are delimited in terms of the context from which they were taken (as the same utterance takes on different meanings in different contexts) (Marton, 1984b: 42 and Marton, 1988b: 198).
(ii) From all the quotes an iterative interpretation between the two contexts (the original interview context and the pool of meaning context) allows a step by step differentiation

within the pool of meaning regardless of the origins of the meanings.

(iii) The utterances are grouped together on the basis of similarities and the groups delimited by the differences or contrasts.

(iv) Categories, defined in terms of core meaning, are formed from the groups. These are the concrete praxis of phenomenography and the reduced limited number of categories is usually 3 to 5 (Saljo, 1988: 42). These categories and organised systems of categories are then the most significant outcome of the research and represents the results of the analysis (Marton, 1984b: 35 and Svensson, 1989: 532): *they form a systematic attempt to account for the various ways in which people perceive these particular phenomena* (Saljo, 1988: 44).

Some other considerations when approaching an analysis are:

(i) The categories are formed as an ordered set, or structured to relate to one another.

(ii) The data should be approached in a way that allows the transcripts to be classified in terms of sets of categories of the descriptions you have aimed at. This can also give you frequency distributions and enable quantitative analysis work to be carried out: this is a standard research technique but not considered within the bounds of phenomenographic methodology.

(iii) Of the two approaches in collecting data, viz. data about experiences (concrete underlying mechanisms) and data about the experiences themselves, the latter is the preferred avenue for exploration.

(iv) Although the full exact transcript of each interview are used initially (Renstrom *et al.*, 1990: 557), all statements are of equal importance. Hence, it is important to identify the core parts of the initial dialogue and reduce it to important sections, save them, then move back and forward repeatedly to identify similarities or differences (Dahlgren, 1993 and Renstrom *et al.*, 1990: 558).

(v) It is advantageous, and usual, to start with a large number of categories and finally end up with a small number, working towards understanding at a somewhat deeper level where these people do not differ even though they choose different samples (Dahlgren, 1993).

(vi) The analysis's unique element aims at formulating the conception, without negotiating about its authenticity as expressed in the answer, by making a clear and communicative set of statements (Dahlgren, 1993).

(vii) It is the possible ways of thinking that are grouped, and not the descriptions, and the categories are the same as those which would be arrived at by other researchers (Renstrom *et al.*, 1990: 558).

3.2.5 Validity.

Whether used in a science or humanities environment, qualitative research methods are appropriate and as valid as quantitative research methods, which are to do with the extent (measuring) of a phenomenon, in the particular situation in which they are employed (Marton, 1992). With phenomenographic research methodology, there are two particular aspects about its validity. The first is that it has validity in that it is a process of discovery (ie. a research method that achieves its aims). Secondly, the replication of the categories

themselves should be achievable (Marton, 1988b: 183 and Laurillard, 1990: 3). Establishing validity must therefore commence at the beginning of the research: *The validity of this data-gathering approach was maintained from the framing of the key questions, through the interviews, to the analysis using the established approach known as 'phenomenological reduction' (i.e. the calculated movement to understanding the essence of ones understanding through a series of interconnected questions* (Gerber *et al.*, 1992: 19). As well, the questioning technique provides the interviewee with the prominent role. Unlike a questionnaire, the response alternatives, and limitations on the answer variations, have not been predetermined by the researcher, restricting any differences in meaning attributed to a specified response (Saljo, 1989: 39).

The validity terms associated with qualitative research, and hence phenomenographic research, are borrowed from quantitative research in the narrow sense to do with tests. A wider concept of validity - how valid are your results - is the logical relationship between the internal consistency. However, there has been found to be common perspectives of viewing phenomena from the descriptions evident in different disciplines and 'schools of thought' (Marton, 1981: 189 and 195).

In seeking validity the following can be considered:
(i) Support from the other empirical data others may have collected or from a broader theoretical framework.
(ii) A demonstration that the normal cannons of imperial research can be applied for this method, i.e. Is it new and public knowledge or is it able to have people refute your claims by means which you have an obligation to disclose?
(iii) A lengthy analysis and discussion about the nature of the variation between people (Dahlgren, 1993). For a single conception you may have to rely upon a comparison with other conceptions (some of the most important characteristic traits of phenomenographic research) (Dahlgren, 1993).
(iv) Have a second researcher test agreement by doing the analysis using the same data (Dahlgren, 1993).
(v) Demonstrate that the interviewee has been pushed to the end of understanding for each question, and that there were sufficient questions asked at the interview to fully discover the conceptions pertaining to the phenomena.

The outcomes validity and reliability depends on all, or either of the following:
(i) The delimiting of categories through writing judgmental instructions for co-judging. This provides a check of the communicability of categories; a check to see if the essential differences between categories are observable; and the relationship between statements and the categories system. An inter-judge reliability between 80%-90% is acceptable (Saljo, 1988: 45). However, Marton (1988a: 55) considers that, for a set of four categories, where a specification of the category of description has been used, the classification agreement between two independent judges should be 70% or better.
(ii) Compare with other studies to check validity (Saljo, 1988: 46).
(iii) Verify appropriateness of categories though their internal logic (Saljo, 1988: 26).

With regard to replication, the original findings are a process of discovery and do not have to be replicated, as it is considered as not a reasonable expectation. However, another researcher should be able to find or recognise the same conception or categories once it has been identified, and achieve a high degree of inter-subjective agreement concerning their absence or presence (Marton, 1984b: 35).

3.2.6 Research outcomes.

(a) Results.

Categories of description (abstractions of reality) are the primary and most important outcomes or results in phenomenographic research (Marton, 1984a: 63; Marton, 1984b: 33 and Renstrom *et al.*, 1990: 557). *'Lifting out' categories of description from the context in which they have been discovered makes it possible for us to apply them to other contexts and to see structural similarities between different kinds of entities* (Marton, 1984a: 63). Although phenomenographic outcomes are qualitative (what conceptions are held), quantitative ones (how many individuals hold these conceptions) are also sometimes achievable, although not really part of the methodology (Marton, 1981: 195).

Phenomenography, in describing variations in conceptions of phenomena and not the individual, is describing 'the outcome space' of possible ways of thinking about phenomena in a hierarchical or ordered degree of difficulty structure, or 'some more correct' than others list, which reflects increasingly complex levels of understanding (Dahlgren, 1993; Johansson, 1985: 246; Ramsden *et al.*, 1993: 303 and Renstrom *et al.*, 1990: 258). The logical interrelated relationships between the conceptions, and the hierarchical ordering, created by the various foci of the conceptions, are captured in the 'outcome space' of the conception (Gerber *et al.*,1992: 24) and hence embrace both the personal understanding of a concept and the solution methods by which such understanding is demonstrated. Consequently, these categories can supply diagnostic assessment information concerning contextual learning progress and a rational basis for curriculum design (Ramsden *et al.*, 1993: 314).

There are basically two methods of presenting the results, viz. label the categories of understanding and explain each category with supporting examples (a methodology used in the early developmental stages of phenomenography and employed in this study); or, from the beginning, discuss the relationships between categories. The latter is a dynamic contrasting of the categories to show the reader how you came to this conclusion (Dahlgren, 1993). However, supporting data should be provided in conjunction with the discussions and, somewhere, the categories should be labelled.

The results may be of research interest only or could be used to describe the impact of education programmes (eg. assessment affects). Specific educational research may produce insights that are applicable to educational practice but not necessarily relevant (importance) to practice (Marton, 1989: 8). However, the results are beneficial in that

they have been derived from a new method of research and provide an independent verification of other methodological results or new information. If it emerged that some of the views were in variance with what is generally accepted or believed in the industry or academia, there are implications for education and training curricula as well as other affected aspects of the profession.

(b) Outcomes relationship to educational practice.

Teaching and learning are communicative activities involving an attempt to change people's conceptions of reality in order to adopt the particular form of thought characteristic of that specialisation or discipline. The use of phenomenographic research has direct educational relevance in that it is providing the intellectual tools used in planning teaching and to improves the efficiency and quality of education and in learning (Dahlgren, 1993; Marton, 1984b: 44; Saljo, 1988: 44 and Bowden, 1990: 6): the future educational didactics and praxis. An interesting outcome of this type of research is that it is able to identify if the teaching of some phenomena succeeded in developing understanding of that phenomena (Renstrom et al., 1990: 567). It is the understanding that is important, as learning is a change in the way in which people understand, *rather than a quantitative accretion of facts and figures* (Ramsden, 1992: 82) or recall, which does not necessarily mean understanding (Marton, 1988a: 54). The notion of fundamental characteristics of learning (refer to figure 3.2) refers to the question of what is learned and how that which is learned is learned (Marton, 1984a: 46).

It is also notable that in phenomenographic methodology the categories are formed at the end of the analysis. The advantages for curriculum development for this research not only originates in discovering how people understand, think and learn about specific phenomena and concepts, but also of their conceptualisation of a discipline or industry as the phenomena (Marton, 1988b: 198).

Investigations of the empirical relationship between approach and outcome have repeatedly revealed strong positive correlations (Marton, 1988a: 71). For example, from an experiment:

(i) *the qualitatively different ways in which a certain material is understood corresponds to qualitatively different ways in which the material is subjectively organised by the learner* (Marton, 1988a: 59);

(ii) *...changes in meaning originate from acts of restructuring, but acts of structuring presupposes changes in meaning* (Marton, 1988a: 59), a dialectical interplay between the two activities; and

(iii) the components have to be seen as related to one another, i.e. as part of a whole, before a structure is established (Marton, 1988a: 59). What this means is that the differences in meaning correspond to differences in structure.

The conceptions of learning have two major components (refer to 3.2.2), the way of seeing what is learned (noema) and a way of seeing how it is learned (noesis) (Marton

et al., 1993: 296 and 3.2.2). People's conceptions are therefore also important to ascertain the individuals' learning level to enable curriculum development to reinforce, or change to, the methodologies and techniques that achieves the desired learning and conceptualisation level. The previously and generally accepted five conceptions of learning (Marton, 1988a: 71 and Marton *et al.*, 1993: 296) and a newly identified sixth conception level of learning and understanding, are outlined as follows (Marton *et al.*, 1993: 283):

(i) Quantitatively increasing one's knowledge (ready-made - learning to increase knowledge);

(ii) Memorising and reproducing (learning related to the anticipated reproduction, or application, of what is learnt);

(iii) Applying the acquisition of facts and procedures which can be retained and/or utilised in practice, i.e. apply some knowledge or procedure;

(iv) Understanding or the abstraction of meaning (having a view or discovering or grasping the meaning of phenomena, but is usually delimited to the study situation). The idea of a conception commences at this level (Marton *et al.*, 1993: 289);

(v) Seeing something differently (an interpretative process aimed at the understanding of reality but delimited in the world situation - outside this study situation); and

(vi) Changing as a person. The individual develops a new way of seeing a phenomenon dealt with in a learning situation which *implies a fundamental change from seeing oneself as an object of what is happening ('things just happen to you') to seeing oneself as an agent of what is happening ('you make things happen')* (Marton *et al.*, 1993: 293). Then, at this level, learning is not delimited in time or to a person's life-world experiences (Marton *et al.*, 1993: 292).

3.3 Research method.

3.3.1 Selection of the context.

As described in the research design (refer to 3.2.3), the first stage in conducting this phenomenographic research was to identify, from the available geomatics' educational literature, the phenomenon to be investigated and the limits to which the phenomenon was confined. From the literature review it became apparent that the geomatics' industrial structure and educational philosophy does not adequately address the needs of the profession, the beginning professional or society. It is also apparent that the educational model that would best serve the geomatics' industry would be a holistic applications approach rather than an individual discipline approach. Part of the solution lies with an academic, professional organisations and industry linked education and training model that would provide professionals with open learning opportunities for multidisciplinary flexibility. Positively ascertaining the 'future' needs of the industry would enable academics to place less emphasis on immediate practices and be more innovative. They could then look to the future and develop theory to strengthen the knowledge base of the profession and to better equip a graduate to meet the challenge of rapid change. In order to synthesise the contemporary problems and perceived needs of the future geomatics industry, the phenomenon requiring 'illumination' was

perceived to be the qualities and role of future beginning professionals.

It also became apparent from the literature review that the geomatics' industry isn't confined to the previously dominant cadastral surveying sector (the public accepted professional surveyor), but encompassed a range of groups (eg. cartographers, engineering surveyors, valuers, etc.): the common objectives of these groups are specifically aimed at providing spatially located geographic data from its' acquisition to its' dissemination and land management. The emphasis of the industry also appears to be shifting from acquisition to information management, suggestion a changing emphasis on professional activities, the status of different geomatics' sectors and educational needs, all leading to a coalescence of the various geomatics' profession guilds. Hence, to investigate a geomatics' phenomenon the investigation had to encompass experienced persons in all sectors and working environments within the industry.

3.3.2 Pilot study: selection of the best research question.

In order to develop the research question which would best assist the interviewer to approach people's consciousness of their experience of the phenomenon, several similar variations of an opening or 'prompting' question were formed. The questions were all non-technical, open ended, succinct and relevant to the investigation, but of significance and of general interest to the interviewee. The pilot study was then conducted to arrive at the best of the trial questions, firstly by noting how the interviewee responded to the opening question. The second 'test' was to allow the researcher to experience the type of interviewer follow-up questions that may be needed. Different interviewee's approaches to the opening question and utterances on their experiences were expected to vary considerably.

This pilot study was also deemed necessary to assess the validity to be gained from the opening question before commencing the final data collection phase. A different trial question was tested with each of the three candidates with follow-up interviews of two more candidates using the best trial question [and final question] variation determined from the initial pilot study interviews. The pilot study population came from the same locality but two different spheres of practice, viz. academia (two) and cadastral surveying (two principals of different small private practices and a single practising surveyor).

Each interview was arranged to be face-to-face in the interviewee's environment, recorded on magnetic tape and later transcribed. Only the opening question was planned and asked at the commencement of the interview. Spontaneous elaboration questions were asked, by the researcher at various stages of the interview, to have the interviewee clarify a statement and to encourage him/her to articulate the extent of understanding of that particular experience. Keeping in mind any difficulties experienced during the interviews, each transcript was analysed to determine which initial question most efficiently developed the following outcomes:

(i) the interviewee's illuminated his/her experienced phenomenon;

(ii) the interviewee's were able to organise their own description;

(iii) the question elicited mostly research relevant utterances;

(iv) the interviewee was able to be taken to the limit of their understanding;

(v) only minimal follow-up elaboration questions were required by the interviewer; and

(vi) no prompting questions or explanations were required from the interviewer.

The final opening question arrived at following the first three interviews, and confirmed after the second two were analysed, was:

WHAT ARE THE ESSENTIAL QUALITIES, FOR THE TWENTY FIRST CENTURY, OF A PERSON BEGINNING IN YOUR PROFESSIONAL FIELD?

The beginning professional was described to the interviewees as a first degree graduate entering the geomatics professional work force.

3.3.3 Research population.

The literature review revealed some educational structure, content and philosophical future direction variations (refer to Chapter 2) across Australia, similar to those in other countries such as Canada and the USA. Changes to the structure and operational practices in government geomatics' sectors throughout Australia, together with amalgamation and membership discussions in various geomatics' organisations, suggested some dissatisfaction and operational inadequacies over a range of the geomatics' sectors. Hence, it was considered necessary to distribute the candidate selection across as wide a spectrum of the geomatics' population in Australia as practical (refer to Tables 3.1 and 4.1). Due to the challenges in making physical arrangements in conducting face-to-face interviews, and the probability of gaining fully representative information in a geographically select region, the research population was mainly concentrated in one State (Queensland). To increase research validity and test if the outcomes of the investigation would be broadly representative and applicable, a smaller portion (38%) of the research population were widely distributed across Australia (refer to Table 3.1).

Forty interviewee candidates were contacted with the aim of securing the co-operation of at least thirty five. One declined, one was repeatably unavailable for interviewing and another withdrew at the commencement of the interview. In selecting appropriate participants, the following criteria were considered desirable:

(i) he/she was representative in their field of expertise and position;

(ii) he/she was experienced in their field;

(iii) he/she was in a work situation [although maybe in a comparable position in another organisation, or in a different State, from other participants]:

EMPLOYMENT SECTOR\STATE	QLD	NSW	ACT	VIC	TAS.	WA	TOTAL
ACADEMIC	2	1		1	1	1	6
PRIVATE	1C	1					11
CORPORATE SECTOR		1		1		1	3
LOCAL GOVERNMENT	2						2
STATE GOVERNMENT	5	1		1		2	9
COMMONWEALTH GOVERNMENT	1		2				3
OTHERS (a)	3						3
TOTALS	2 3	4	2	3	1	4	3 7

Notes:
1. QLD - State of Queensland.   VIC - State of Victoria.
    NSW - State of New South Wales.   TAS - State of Tasmania.
    ACT - Australian Capital Territory.   WA - State of Western Australia.
2. Some interviewee's also held executive positions within professional bodies or on statutory bodies.
3. (a) Others - eg. Key Centre establishment, Information Consultant, etc.

Table 3.1. Research population and distribution

(iv) he/she had a different geographic location to that of other participants;

(v) he/she held an executive position in a professional organisation or a statute authority;

(vi) he/she could preferably be interviewed face-to-face to enable body language to assist the interview process;

(vii) he/she was willing and available to be interviewed; and

(viii) he/she was willing to have the interview recorded.

3.3.4 Data collection procedure.

Having identified a likely research population for its' depth, breadth and maintenance of data gathering validity, each individual was contacted by telephone to:

(i) allow an explanation of the intention of the research to be given;

(ii) ascertain the willingness of the individual to participate;

(iii) confirm the acceptance, by the interviewee, of having the interview recorded on magnetic tape in preparation for a verbatim transcription of the interview;

(iv) give initial assurances of anonymity of the interviewee and his/her connection to the recorded material; and

(v) identify and arrange face-to-face or telephone interview place and time. This included explaining the format of interview and ensuring sufficient uninterrupted time would be available for conducting the interviews.

Each positive telephone contact was followed by a letter to confirm: the interview arrangements; the procedural format and purpose of the interview; the way in which the recorded utterances would be used, and to reaffirm the confidentiality of the recorded information.

Recording the interview on magnetic tape was essential to allow for a post interview verbatim transcription in preparation for the analysis process. It also ensured minimal distraction so that the interviewer was able to concentrate on formulating follow up questions, based on the responses of the interviewee, that would solicit further elaboration from the interviewee.

Whether the interview was conducted face-to-face (22 of the 37 participants) or by telephone, the interviewee was in his/her own environment and again made aware that the interview was being recorded. The interview commenced with the structured opinion/value opening question (refer to 3.3.2) and then the interviewee organises his/her own descriptions according to his/her own experiences. Here the interviewer framed a minimum number of elaboratory questions in an endeavour to exhort the interviewee to describe the full extent of his/her experiences of the phenomenon. The interview was planned to take from between a half and three-quarters of an hour (but generally each one extended close to one hour) but concluded only when the interviewees felt they could add nothing more.

3.3.5 Preparation of data for analysis.

a. Verbatim transcription

The thirty-seven tape recorded interviews were transcribed individually and stored as separate computer files. The total amount of data amounted to 277 single line spacing pages (approximately 166,000 words) and were checked against the respective recordings by the researcher for accuracy. Typographical errors and misinterpretation of the original words were amended.

A copy of each transcript was returned to the relevant participant acknowledging their contribution and confirming the anonymity of their recording. They were also asked if they would like to correct any transcription misinterpretations and complete any gaps where a word, or words, from the recording could not be understood. It was also emphasised that significant content or context changes would affect the validity of the data and were not required. The participants were also asked if they wished to make statements in addition to those points raised during the interview. One participant added further content which was at considerable variance with the interview information. Concerns about the use of this additional material detracting from the validity of the other utterances, or compromising the technique, meant it was basically only useful in forcing a closer analysis of the interview transcripts. In all, one participant made significant corrections; eight made minor or no corrections on the returned transcript; eight others indicated no changes; and the remaining twenty abstained from accepting the editing offer.

b. Researcher editing and content familiarisation.

Following the checking of the transcripts for accuracy by some of the participants: corrections were made only to any minor mistakes and not the basic structure or utterances; repeated phrases or repetition of 'ums! and ahs!' were edited out; and each transcript was reread to increase the researcher familiarity with the content.

3.4 Summary: Chapter 3.

Phenomenographic qualitative research was chosen for this investigation as it revealed people's perceptions regarding the necessary qualities of the future professional. Conceptions were developed from 'evidence' drawn from 'worldly' experienced (both of geomatics and geomatics clients) professionals to determine the construct of curricula interventions which will address the needs of these future professionals.

Phenomenographic research methodology is a form of 'rigorous qualitative analysis' to determine the different ways in which people may construe a physical reality. It is unique in that it focusses on meanings and variations in conceptions. It presents the words of the people as a single portfolio for analysis to identify a limited number of qualitatively different conceptions.

The literature review indicated that the geomatics' industrial structure and educational

philosophy did not adequately address the needs of the profession, the beginning professional or society. To synthesise the 'educational' problems and perceived needs of the geomatics' industry and determine a solution, the chosen phenomenon requiring 'illumination' was: *What are the essential qualities, for the 21st Century, of a person beginning in the geomatics' profession?* The question was formed as a non-technical, open ended, question. Its' aim was to draw relevant answers and act as a prompt to his/her consciousness with regard to the phenomenon.

A pilot study was conducted and used to 'test' the cannons of truthfulness and validly, to determine the best opening question and 'test' for the type of interviewer follow-up questions. It also verified that the question was of significance and of general interest to the interviewee.

The thirty-seven randomly selected candidates (with geomatics and geomatics client experiences) for the main study were distributed across a wide spectrum of the geomatics' population within Australia. Due to logistical difficulties in conducting face-to-face interviews, and the probability of gaining fully representative information in one region, the research population was mainly (62%) concentrated in one State. To 'internally' monitor the outcomes and their validity, a smaller portion of the research population were distributed across Australia. The adequacy of the population number was established from other researchers findings and, from the interview transcripts, appeared suitable.

A copy of the relevant interview transcript was returned each participant with the request to correct any transcription misinterpretation and complete any gaps where words from the recording could not be understood. The researcher then edited each transcript to remove minor mistakes without altering any meaning in the narrative, thereby enhancing the accuracy of the information.

The phenomenographic research study was categorised in relational characteristics and research outcomes descriptions to detect the structural description or distinctive characteristic of the conceptualisation, and link the relationship between the individual and the phenomenon. Each case was dealt with on its own terms as people's experiences were always contextual. The methodology enabled the categories of description to be grouped and the phenomena to be developed.

The dialectic analysis of data brought selected quotes into a data pool and entailed the continuous sorting and resorting of data. Definitions for categories were tested against the data, adjusted, retested, and adjusted again. There was, however, a decreasing rate of change, and eventually the whole system of meaning was stabilised. It was noted that in the phenomenographic methodology categories were formed at the end of the analysis.

To analyse the data, the researcher had to be acquainted with the subject matter but analysis started without pre-categorised criteria. The descriptions were analysed to ascertain the similarities and differences with the meaning, and the relationship between cause and affect. These were classified by identifying distinctive characteristics and structural differences of

people's definition of the phenomena, and the data analysed by a selection process based on criteria of relevance. The quotations themselves were delimited in terms of their context, grouped together on the basis of similarities and also delimited by their differences or contrasts. The categories, formed from the groups, were the concrete praxis of phenomenography and represented the results of the analysis.

The validity of phenomenography is implicit in its process of analysis and was reinforced by the replication of the categories by independent analysis. The interview technique provided validity by giving the interviewee a prominent role. The appropriateness of categories could be checked though their internal logic and from inter-subjective agreement by an researcher analysing the same data. Further support was gained from demonstrating that the interviewee was pushed to the end of his or her understanding for each question, and that there were sufficient questions to 'cover' his/her exposure of the phenomenon.

The variations in conceptions of phenomena were described through 'the outcome space'. This hierarchical structure reflected increasingly complex levels of understanding and the interrelated relationships between the conceptions. The 'outcome space' embraced both the personal understanding of a conception and the demonstrated solution methods which acted as a rational basis for curriculum design.

The importance and essence of this study was to clarify the conceptions of the essential qualities of a beginning geomatics' professional. The single portfolio of information, when analysed to identify the limited number of qualitatively different conceptions, would provide a necessary source for curricular development. In addition these phenomenographic research outcomes would provide an independent verification of other methodological results and also indicate the construct of curricula interventions which would address the needs of these future professionals.