The geometrical characteristics of oriental carpets: An examination of cultural diffusion.

by

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The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

This thesis considers cultural diffusion in the context of oriental carpets. Geometrical symmetry and its classification are an important feature. Literature review covers a wide range of relevant concepts from the disciplines of anthropology, sociology and psychology and includes consideration of aspects from the work of Boas [1938, 1940, 1948], Burton [1992], Levi-Strauss [1963], Jung [1959] and Koffka [1935]. The published work of Woods [1935, 1936], Washburn and Crowe [1988], and Hann [1991, 1992], from the area of geometrical symmetry and its classification, is also considered in some detail and further conceptual development proposed, including a range of concepts relating to the classification of two-colour counterchange patterns. The principle emphasis in the research is on the analysis of patterns and motifs with respect to their symmetry characteristics.

Data were collected from 1,000 Persian and Anatolian carpets, and similarities and differences are highlighted. Case studies are presented of the Pazyryk carpet (the oldest known complete pile-woven carpet, held in the Hermitage Museum, St. Petersburg) and the Ardabil carpets (the only dated pair of Safavid carpets, one held in the Victoria and Albert Museum, London, and the other in the Los Angeles County Museum of Art, Los Angeles). The geometrical characteristics of each carpet are examined, compared to the results of the larger survey of Persian and Anatolian carpets, and a discussion is developed relating to cultural diffusion.

Table of Contents

Section		*page number*
Acknowledgements		i
Abstract		ii
Table of Contents		iii
List of Figures		viii
List of Tables		xi
Chapter 1	Introduction	1
Chapter 2	Review of Associated Literature	4
2.1	Introduction	4
2.2	Perspectives from the discipline of anthropology	4
2.2.1	Definition of the term 'culture'	7
2.2.2	Constituents of culture	11
2.3	Perspectives from the discipline of psychology	14
2.3.1	Carl Gustav Jung	15
2.3.2	The Gestalt school	16
2.3.3	Perception	20
2.4	Symmetry	22
2.4.1	Definition of symmetry analysis	23
2.4.2	Symmetry analysis, its interpretation, and perception	24
2.4.3	The application of symmetry analysis principles	26
2.5	Summary	28
Chapter 3	The Fundamentals of Symmetry and Counterchange	29
3.1	Introduction	29
3.2	The basic symmetry operations	30
3.2.1	Translation	32

3.2.2	Rotation	33
3.2.3	Reflection	35
3.2.4	Glide-reflection	36
3.3	Finite figures	38
3.4	One-dimensional patterns	40
3.5	Two-dimensional patterns	45
3.6	The fundamentals of counterchange symmetry	48
3.7	Finite counterchange patterns	52
3.8	Two-colour one-dimensional counterchange patterns	56
3.8.1	Two-fold rotation in the plane	56
3.8.2	Screw rotation	57
3.8.3	Mirror rotation	57
3.9	Two-colour two-dimensional counterchange patterns	60
3.10	Higher order colour counterchange patterns	66
3.11	Summary	70
Chapter 4	Symmetry Classification of Surface Patterns on Representative Samples of Turkish and Persian Carpets	72
4.1	Introduction	72
4.2	Data collection and justification	72
4.3	Results	74
4.3.1	Number of borders	75
4.3.2	Classification of borders	79
4.3.3	Classification of central field	83
4.3.4	Presence of counterchange within the sample	88
4.3.5	Classification of border counterchange	89
4.3.6	Classification of central field counterchange (all-over)	92
4.4	Summary	95

Chapter 5 The Pazyryk Carpet 99

5.1 Introduction 99
5.2 The context of the carpet's discovery 100
5.2.1 The known chronology of carpet manufacture 100
5.2.2 The kurgans of the Pazyryk valley, and their construction 102
5.2.3 Preservation aided by environmental conditions 111
5.2.4 Evidence of previous grave robbery 113
5.2.5 Context of the carpets discovery and its importance 114
5.3 The design structure of the Pazyryk carpet 117
5.3.1 Borders of the Pazyryk carpet 119
5.3.1.1 Symbolism contained within the medallion border 119
5.3.1.2 Presence of other motifs 123
5.3.1.3 Horses and human figures 124
5.3.1.4 Main star border 127
5.3.1.5 Animal borders and their interpretation 128
5.3.2 The central field of the Pazyryk carpet 130
5.4 The end-use of the Pazyryk carpet 131
5.5 The material structure of the Pazyryk carpet 136
5.6 The origin of the Pazyryk carpet 139
5.7 Cultural aspects of the Pazyryk carpet 146
5.8 Summary 153

Chapter 6 The Ardabil Carpets 155

6.1 Introduction 155
6.2 The Ardabil shrine and its heritage 156
6.2.1 The Islamic heritage 159
6.2.2 The Safavids 161
6.2.3 The Ardabil shrine 164
6.3 The Ardabil carpets 166
6.3.1 Brief history of the Ardabil carpets 168
6.3.2 Material construction of the Ardabil carpets 172

6.3.3	Design construction of the Ardabil carpets	179
6.4	Symbolism	180
6.4.1	Structural symbolism within the Ardabil carpets	183
6.4.2	Pictorial symbolism within the Ardabil carpets	187
6.4.3	Details of the carpets inscription	193
6.5	Origin of the Ardabil carpets	197
6.6	Location of the carpets at Ardabil	201
6.7	Summary	206
Chapter 7	Geometry of the Surface Decoration of the Pazyryk and Ardabil Carpets	208
7.1	Introduction	208
7.2	A comparison of the borders	209
7.2.1	Borders contained within the Pazyryk carpet	210
7.2.2	Borders contained within the Ardabil carpet	214
7.2.3	A comparison of the borders contained within the two carpets	217
7.3	A comparison of the central fields	219
7.3.1	Central field of the Pazyryk carpet	220
7.3.1	Central field of the Ardabil carpet	220
7.3.3	Comparison of the central fields of the two carpets	227
7.4	General classification of the overall symmetry exhibited by the two carpets	228
7.4.1	Overall symmetry exhibited by the Pazyryk carpet	228
7.4.2	Overall symmetry exhibited by the Ardabil carpet	228
7.4.3	A comparison of the overall symmetry of the two carpets	229
7.5	Summary	229
Chapter 8	Discussion and conclusions	231
8.1	Review of general aims	231
8.2	Discussion and conclusions	232

8.2.1 Diffusion and culture 232
8.2.2 Diffusion and the development of art forms 233
8.2.3 Diffusion aided by population 236
8.2.4 Sources of diffusion 238
8.2.5 Diffusion in the context of the Pazyryk and Ardabil carpets 239
8.3 Avenues for further research 241

Bibliography 243

Appendix 4.1 259
Appendix 4.2 262
Appendix 4.3 264
Appendix 4.4 266
Appendix 4.5 267

List of Figures

		page number
Figure 3.1	Translation	32
Figure 3.2	2-fold rotation	35
Figure 3.3	Reflection	35
Figure 3.4	Footprints in wet sand	37
Figure 3.5	Glide-reflection	37
Figure 3.6	Examples of finite designs - cn figures (motifs with rotational properties only)	39
Figure 3.7	Examples of finite designs - dn figures (motifs with rotation and/or reflection properties)	40
Figure 3.8	Schematic illustration of the seven primary classes of border patterns	43
Figure 3.9	Examples of border patterns from traditional carpets	44
Figure 3.10	Schematic illustration of the seventeen primary classes of all-over patterns	47-48
Figure 3.11	Examples of two-colour counterchange patterns for *cn* motifs	53
Figure 3.12	Examples of two-colour counterchange patterns for *d'n* motifs	54
Figure 3.13	Examples of two-colour counterchange patterns for *dn'* motifs	55
Figure 3.14	Two-fold rotation in the plane	56
Figure 3.15	Screw rotation	57
Figure 3.16	Mirror rotation	58
Figure 3.17	Fundamental cells of the seventeen two-colour counterchange border patterns	59
Figure 3.18	Fundamental cells of the forty-six two-colour counterchange all-over patterns	63-66
Figure 4.1	Structure of an oriental carpet	75
Figure 4.2	Graph showing frequency of borders in Persian and Turkish carpets	78

Figure 4.3	Graph showing the classification of Persian and Turkish carpet borders	81
Figure 4.4	A graph showing the central field classification of Persian and Turkish carpets within the sample	85
Figure 4.5	Graph showing the classification of colour counterchange within the borders	91
Figure 4.6	Graph showing the central field counterchange (all-over)	94
Figure 5.1	Location of the Pazyryk valley	103
Figure 5.2	Plan of the Pazyryk group of barrows	105
Figure 5.3	Plan of Pazyryk barrow 5	106
Figure 5.4	Section of barrow 5 and its burial shaft	108
Figure 5.5	Disposition of objects within barrow 5	109
Figure 5.6	Vertical disposition within horse chamber of barrow 5	110
Figure 5.7	Design structure of the Pazyryk carpet	118
Figure 5.8	Knot structure of the Pazyryk carpet	138
Figure 6.1	Map showing location of Ardabil	157
Figure 6.2	Photograph of the shrine at Ardabil	158
Figure 6.3	The Ardabil carpets	167
Figure 6.4	Comparison and technical analyses of the London and Los Angeles Ardabil carpets	172
Figure 6.5	Plan of the main buildings of the Ardabil shrine	203
Figure 7.1	Pazyryk carpet (with significant borders and central field indicated)	209
Figure 7.2	Medallion border exhibiting p111 symmetry and associated symmetry group	211

Figure 7.3	Border of horses and riders	211
Figure 7.4	Lotus flower border and associated symmetry group	212
Figure 7.5	Lotus flower border exhibiting colour-counterchange	213
Figure 7.6	Elk or deer border and associated symmetry group	214
Figure 7.7	Ardabil border 1	215
Figure 7.8	Ardabil border 2	216
Figure 7.9	Ardabil border 3	216
Figure 7.10	Ardabil border 4	217
Figure 7.11	Central medallion of the Ardabil carpet and *d8* classification	221
Figure 7.12	Central medallion of the Ardabil carpet and *d4* classification	222
Figure 7.13	Separation of layer structure of Ardabil carpet	225
Figure 7.14	General symmetry characteristics of the Ardabil carpet	226

List of Tables

page number

Table 3.1	Characteristics of the seventeen two-colour one-dimensional patterns	60
Table 3.2	Table of the forty-six two-colour two-dimensional patterns	67-69
Table 4.1	Number of borders within Persian carpet sample	77
Table 4.2	Number of borders within Turkish carpet sample	77
Table 4.3	Classification of borders in Persian carpet sample	80
Table 4.4	Classification of borders in Turkish carpet sample	80
Table 4.5	Classification of the central field - Persian carpets	84
Table 4.6	Classification of the central field - Turkish carpets	84
Table 4.7	Presence of counterchange in Persian carpet sample	88
Table 4.8	Presence of counterchange in Turkish carpet sample	88
Table 4.9	Occurrences of counterchange in Persian carpet sample	89
Table 4.10	Occurrences of counterchange in Turkish carpet sample	89
Table 4.11	Classification of border counterchange - Persian	90
Table 4.12	Classification of border counterchange - Turkish	91
Table 4.13	Classification of central field counterchange (all-over) - Persian	93
Table 4.14	Classification of central field counterchange (all-over) - Turkish	93
Table 6.1	The Safavid Dynasty within Iran	158

Chapter 1 Introduction

This thesis is concerned with cultural diffusion, and is focussed on examining the symmetry characteristics of motifs and patterns on a range of pile-woven carpets.

Symmetry classification of design has its origin in the discipline of geometry, and has been closely associated with various scholars from the spheres of the physical sciences and mathematics. Of importance is the work of Woods [1935, 1936] who provided a series of four papers which did much to influence the work of subsequent scholars, such as Washburn and Crowe [1988], and Hann [1991, 1992]. The conceptual developments presented in this thesis build on these more recent publications. Also of importance is various literature from the disciplines of anthropology (including Boas [1938, 1940, 1948], Burton [1992], Bernardi [1977], and Levi-Strauss [1963]), archaeology (including Rudenko [1953, 1968]), psychology (including Jung [1959], Wertheimer [1945], Koffka [1935], and Kohler [1929]), sociology (including Lewin [1936, 1951] and Giddens [1993], as well as further work from the field of geometry (including Coxeter [1942, 1961], Grunbaum and Shepherd [1986], Shubnikov and Belov [1964], and Shubnikov and Koptsik [1974]).

Diffusion is a feature of concern to past scholars such as Boas [1938, 1940, 1948] and Boardman [1994], and is concerned with the spread of various aspects of culture, such as technology, decorative styles and beliefs. The concept is a major concern in the discipline of anthropology.

The principal focus is the utilisation of symmetry concepts to further understand the cultural characteristics associated with the design of oriental carpets.

The thesis is divided into consecutive sections, each intended to supplement and build on the previous. With the above considerations in mind the objectives of this thesis are:

(i) To review a range of important principles from the areas of anthropology,

psychology and geometry. This is to provide a background for the research and draws inspiration from a number of avenues including anthropology, psychology, and geometry. The principal concern is with culture, and its constituents, symmetry and its analysis, with particular importance placed upon its ability to be utilised as an analytical tool. The work of Washburn and Crowe [1988], Hann [1991, 1992], and Reinhardt and Welters [1999] is used as inspiration. The intention of this chapter is to introduce the principles that will be utilised in the remainder of the research and introduce some important principles believed to play an important role in the understanding of the subject.

(ii) To review the principles of symmetry, and to explain how these are used in the classification of motifs (finite figures), border patterns (one-dimensional patterns), and all-over patterns (two-dimensional patterns). In order to understand these a number of fundamental features need to be introduced, those of translation, rotation, reflection, and glide-reflection. Particular attention is directed to two-colour symmetry, an area of study which has been approached previously by only a small number of scholars, including Hann and Lin [1999], Washburn and Crowe [1988], Schattschneider [1986], and Woods [1936].

(iii) To apply symmetry classification to a sample of Persian and Anatolian carpets, and to discuss aspects of the diffusion of motifs and patterns from the two sources.

(iv) To introduce, describe, and illustrate the Pazyryk carpet (held in the Hermitage Museum, St. Petersburg,) and the two Ardabil carpets[1] (one held in the Victoria and Albert Museum, London, and the other held in the Los Angeles County Museum of Art, Los Angeles). The focus is on the symbolism associated with the design of each, as well as the debate surrounding certain controversial aspects of their

[1] Although there are two Ardabil carpets, for the purpose of the examination of the design structure, only the Victoria and Albert Museums' Ardabil will be examined. The design on both carpets is identical, although the Victoria and Albert Museums' piece is more complete, therefore only this carpet will be analysed.

production and origin.

(v) To conduct a detailed geometrical analysis of the decorative elements of each of the above carpets and to address questions of diffusion of the decorative elements between the two relevant historical periods, an iron-age period of around 500B.C.E, and the Safavid period (1501-1722C.E.) (See footnote 15, page 99)

The general intention of this thesis is to examine the process of diffusion, utilising symmetry analysis as a tool to aid in this analytical study.

Chapter 2 Review of Associated Literature

2.1 Introduction

When considering the study of pattern, symmetry, and design, culture is seen by many scholars, such as Hamilton [1987], Washburn and Crowe [1988], and Vermeersch [1977], as being an inherent determinant. In other words, pattern types used by a certain group, are widely influenced by the culture of the producer. When debating the relationship between culture and design, there are many possible avenues and routes that can be followed, particularly in the realms of cultural anthropology, archeology, and psychology. A review is made in this chapter of the relevant literature (and associated concepts) from these disciplines, with the objective of furthering the understanding of the wider subject of pattern in the decorative arts, and its relationship to culture.

With the above considerations in mind, the objectives of this chapter are to examine the concept of 'culture' and, through the review of literature from relevant disciplines, identify related concepts which are considered to be applicable to the symmetry analysis of patterns. Emphasis is placed on the study of perception and, in particular, the relevance of various models of thinking proposed by the Gestalt school of psychology.

2.2 Perspectives from the discipline of anthropology

In order to facilitate the understanding of this research it is necessary to introduce a range of perspectives from the discipline of anthropology. Prior to this, a brief review of anthropology as a realm of study is presented.

Anthropology as a discipline is wide ranging in nature and, in the past, has

been classified as a division of archeology, or as a social science, but is now accepted as a scholarly division in its own right. Anthropology in the widest sense is the study of humans, and associated areas. The *Oxford Dictionary* defines anthropology as, "the study of human kind, including the comparative study of societies and culture, and the science of human zoology and evolution." [Pearsall, 1999, p.56].

Anthropology therefore appears to be interrelated to the study of anything inherently human. Levi-Strauss [1963] a notable participant in the discipline, introduced a range of terminology. One such term was 'ethnography', which as a sub-set or component of anthropology, is concerned more with the study of groups, and man as a group and 'culture' member. Levi-Strauss used the term 'ethnography' as follows:

> "...ethnography consists of the observation and analysis of human groups considered as individual entities. Ethnography thus aims at recording as accurately as possible the respective modes of life of various groups." [Levi-Strauss, 1963, p.2]

He further differentiated two separate fields of anthropology: social anthropology, and cultural anthropology. Social anthropology is the study of man in a social sense, including institutional membership, etc. Cultural anthropology is the study of man in a cultural sense, (highlighted in Section 2.2.1 below). Levi-Strauss differentiated the two fields of study, when he stated that, "Social anthropology is devoted especially to the study of institutions considered as systems of representations, cultural anthropology, to be the study of techniques which implement social life." [Levi-Strauss, 1963, p.3]

Burton [1992], in an interview with Aidan Southall, stated that anthropology is concerned with the observation and development of theories, interpretation of other cultures, and the explanation of differences. Southall attempted to explain the meaning of the term, and made the following statement:

> "Its commitment in practice to participant observation and in theory to the reflexive and reciprocal interpretation of cultures to one another may require us to draw upon any field of human knowledge according to its context. If viewed as a normal scientific enterprise, this is impossible and can never be fully achieved. Yet, it is the relentless commitment and effort to achieve which makes an indispensable contribution to the future of women and men in culture and society." [Burton, 1992, p.80]

It can be seen that anthropology is dynamic, constantly changes and adapts to outside pressures; it is the ongoing study of culture without static definitive or definite conclusion.

Levi-Strauss cited the views of Radcliffe-Brown [1949, cited by Vermeersch, 1977, p.17; 1952], who believed that anthropology was not just the study of man, but also associated inter-relationships. His main argument was that human beings were connected by an unlimited series of social relations, and that anthropology was more a study of culture, and not just man as an individual, or the society he is within. This view further fuels the argument that anthropology stands on its own as a field of study, and cannot be classified as just another sector of sociology; it is in fact a social science of its own.

Levi-Strauss [1963] also cited the work of Tylor [1874]. The opinions of the latter correlated with those of Radcliffe-Brown, by placing emphasis on the study of culture and civilisations. Levi-Strauss gave indicators to understanding the meaning of the term 'anthropology', when he stated,

> "What then, in fact, is anthropology? For the time being we shall merely say that it proceeds from a particular conception of the word or from an original way of approaching problems, both discovered during the study of social phenomena which are not necessarily simpler than those appearing in the observers own society, but which are so remote from them that they throw into relief certain general features of social life which anthropology makes its business to study." [Levi-Strauss, 1963, p.347]

Giddens [1993] stated that 'anthropology' allowed for the wider study of man through a comparative imagination, and was dependent upon the historical

studies of past cultures. He believed that the subject of anthropology had developed through a comparison of the observer's society with societies from the past. Giddens in essence maintained that anthropology was a field of study concerned with the behaviour of humans. Therefore anthropology is the study of man, his behaviour, culture, and society. Giddens explored further the nature of the subject when he stated:

> "...anthropology (the study of traditional societies)...The anthropology dimension of the sociological imagination is vital, because it allows us to see what a kaleidoscope of different forms of human social life exists. In contrasting these with our own, we learn more about the distinctiveness of our specific patterns of behaviour. The historical dimension of the sociological imagination is equally fundamental: we can only grasp the distinctive nature of our world today if we are able to compare it with the past." [Giddens, 1993, p.19]

For the purpose of this research, anthropology is defined as the study of humans, their behaviour, culture, society, and the interaction between the constituent parts.

The next section introduces the concept of 'culture', and reviews various definitions of the term. Subsequently the constituent components of culture are identified and discussed.

2.2.1 Definition of the term 'culture'

Although defined in various ways by a wide range of scholars, a common theme appears to perpetuate. Generally speaking, culture is considered to comprise the set of ideologies, rules and beliefs, given to an individual to allow conformity to a certain group of individuals. Making reference to the work of Tylor [1874], Hamilton defined culture as, "...that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society." [Hamilton, 1987, p.3] Culture is therefore not a simple concept,

but a multi-faceted entity which affects large groups of people.

Another observer, Bernardi [1977], gave a more wide-ranging definition and placed emphasis on relationships rather than the independent and individual nature of man put forward by Hamilton. Bernardi maintained that culture was concerned with behaviour rather than the constraints placed on a individual by a society or group, and defined the concept in terms of human activity:

> "...a manifold variety of relationships directed towards the entire universe. Man's behaviour reflects those relationships and their variety. Though the nature of man is found to be the same through space and time, man's behaviour is extremely varied. The way in which man defines his relationships to the universe is called culture." [Bernardi, 1977, p.75]

Vermeersch [1977] reviewed the use of the term in the work of various authors including Radcliffe-Brown [1949, cited by Vermeersch, 1977, p.17], Miller and Dollard [1941, cited by Vermeersch, 1977, p.12], Wilson and Kolb [1949, cited by Vermeersch, 1977, p.12], Young [1934, cited by Vermeersch, 1977, p.16], Benedict [1934, cited by Vermeersch, 1977, p.16], Kluckhohn and Kelly [1945, cited by Vermeersch, 1977, p.16], Davis [1948, cited by Vermeersch, 1977, p.14], and Bose [1929, cited by Vermeersch, 1977, p.19], and argued that culture was not a single entity, but was in fact a combination of various components. Like Hamilton, Vermeersch emphasised the strong relationships between the different components.

It can be seen therefore that a definition of 'culture', will vary from scholar to scholar, and from discipline to discipline. Many scholars have provided definitions placing emphasis on different constituent features associated with culture. For example, Bose [1929, cited by Vermeersch, 1977, p.19], emphasised the importance of interaction and the ability, or the simple nature of culture to be passed from generation to generation. This suggests that 'culture' is not static, but is in fact constantly changing and adapting to the pressures placed upon it. Culture and cultural systems constantly adapt to outside influences, such as alteration to

population density, natural disasters, culture contact, etc.,. Culture is a feature that has the ability to change dependent upon the outside factors acting upon it. Hamilton noted this, and stated that,

> "...culture is assumed to be dynamic (not static) and systematic (the parts are interrelated, dependent on, and interactive with one another). Further, it recognises that any cultural system exists in both a physical and social environment, either of which may require changes of the cultural system." [Hamilton, 1987, p.5]

Koffka adopted a similar view to Hamilton, and maintained that 'culture' was heavily influenced by external factors operating upon it. However he believed culture to be constituted of a number of individual features, all inter-related, but also independent, and constantly changing. He commented,

> "Our total social framework is composed of a great number of special parts, which find their expression in language, customs, traditions, laws, modes of thought, styles of artistic creation, fashions, and so forth... they are all interdependent, although the degree of interdependence between any two may vary considerably and not even be constant during the history of development." [Koffka, 1935, p.676]

From these, and similar statements it can be seen that culture is in fact best considered as a number of small constituent parts, all interrelated, and integrated under the heading of 'culture'. This view concurs with those of Ogburn and Nimkoff [1940, cited by Vermeersch, 1977, p.17], and Willey [1929, cited by Vermeersch, 1977, p.17], as well as Mead [1956] who proposed that culture was tightly enwrapped with tradition, and was a constituent of the development of traditions, and the passing of tradition from generation to generation.

The general consensus, particularly evident in the work of Young [1934, cited by Vermeersch, 1977, p.16], and Kluckhohn and Kelly [1945, cited by Vermeersch, 1977, p.16], is that culture is concerned with behaviour, and in particular that it provides a set of rules that create guidelines by which the behaviour of a group is conditioned. Culture is therefore best viewed as the behaviour of an individual that

makes him or her acceptable to the larger group or population.

The definition of culture given in the '*Concise Oxford Dictionary*' concurs with that of Tylor, Hamilton and Vermeersch, and stresses the importance of customs, achievements, etc., "...the arts and other manifestations of human intellectual achievement regarded collectively. A refined understanding or appreciation of this. The customs, institutions, and achievements of a particular nation, people, or group." [Pearsall, 1999, p.348]

Reber [1995] extended many of the previously accepted definitions, and placed importance upon the fact that culture is in fact a learnt feature of rules and norms, that allows an individual to function acceptably within a society or group. He placed emphasis upon the fact that culture is learnt, it is not genetic and is therefore an outside feature. Reber [1995] stated that culture is,

> "The system of information that codes the manner in which the people in an organised group, society, or nation interact with their social and physical environment. In this sense the term is really used so that the frame of reference is the set of rules, regulations, *mores* (Social norms and customs that provide the moral standards of behaviour of a group or a society. [Reber, 1995, p.470]) and methods of interaction within the group. A key connotation is that culture pertains only to non-genetically given transmission; each member must learn the systems and the structures." [Reber,1995,p.177]

With the above consideration in mind, and in the context of this thesis, culture is defined as the norms, customs, language, beliefs, art, laws, and other rules of society, that are acquired or learnt by an individual in line with their membership group, to allow them to function acceptably within their selected group or society.

Although not a physical object, culture is critical for the functioning of civilisation and society. Hamilton elaborated as follows: "Culture is a conceptual, analytical construct. One cannot see culture, yet culture is critical to human functioning and survival since it represents a non-biological means of adaptation which other animals are without." [Hamilton, 1987, p.3] The constituent

components of culture are considered further below.

2.2.2 Constituents of culture

Many scholars have offered an explanation of culture formation, and the constituent elements. Bernardi [1977], for example, identified four basic constituent features of culture which are continual and integrated, and without which culture could not exist. The four factors listed by Bernardi are *anthropos*, *ethnos*, *oikos*, and *chronos*. The usage of each of these terms is explained below.

The first feature of culture identified by Bernardi was *anthropos*. He drew on the work of Durkheim [1895,1897,1912], Fortes [1945] and Radcliffe-Brown [1949, cited by Vermeersch, 1977, p.17; 1952], and maintained that the individual is the most important feature of culture. *Anthropos* [Bernardi, 1977, p.75] relates to the individual, for without the individual to transmit culture, or to learn, culture cannot exist. Culture requires a medium for transport (or transfer), and the individual is this medium. Culture is constantly changing, and therefore dynamic, so the individual is required to transmit these changes. Bernardi and Fortes both stated that the individual was shaped by the society in which the individual was a member, and therefore can be regarded as a culture maker, and not just a carrier. Fortes stated that,

> "The multiplicity of social roles does not obliterate the individual. Though he is a microcosm of his society he is always, also, uniquely himself. At times this is the prime determinant of his behaviour, at others a particular social role or membership of a corporate group is decisive." [Fortes, 1945, p.144]

The second feature identified by Bernardi to be a constituent of culture was *ethnos*, or community. This is the individual as a part of a larger whole, group, or society. Bernardi's basic definition of *ethnos* was, "...the collectivity or the community as an association of individuals." [Bernardi, 1977, p.75] He thus

considered culture to be a process rather than an entity; here it is the development of culture through the collective sum of the activity of an individual, and the integration into a whole. *Ethnos* allowed the development of culture beyond the individual and into a generation to generation legacy. *Ethnos* is therefore concerned with the collective nature of culture, when compared to the individualistic and isolated nature of *anthropos*.

The third constituent feature of culture identified by Bernardi was *oikos*, which acknowledges the importance of environment. Bernardi thus stated that culture was dependent on the environment in which it was formed, and was dynamic and constantly changing and adapting to any changes in the environment. Bernardi further differentiated the concept of *oikos* in terms of the material environment and invisible cosmos. Material culture inspired man, and it was this sector of culture that inspired intuition and inventiveness. Meanwhile the invisible cosmos was associated with the spiritual aspect of culture, eg., cosmological beliefs.

The final feature of culture identified by Bernardi, was that of *chronos*, the time feature associated with culture. *Chronos* was associated with the culture-making process, and the time span that was affiliated to it. In identifying *chronos*, Bernardi cited the work of Evans-Pritchard [1940], and noted that "Time is thus a relation between seasons, activities, and social events. It is by isolating this relationship and making it evident to men that it can be described, as it actually is, as a factor of culture." [Bernardi, 1977, p.83]

Bernardi stated that it was the intuition of man, that aids and pushes forward development. A typical example is the first use of fire, which is cited by many anthropologists to show the development of man.

Another scholar who defined the constituents of culture was Hamilton [1987]. She stated that culture was in fact a constructed feature, and was dependent on three basic component factors: technology, social structure, and ideology

[Hamilton, 1987, p.2].

The first feature cited was that of technology (and its products) often referred to as 'material culture'. This feature allows adaptation to physical, and social environments. The second feature, social structure, is comprised of the divisions within a group or social sector, such as gender divisions; it refers to relationships often dictated by outside institutions. The final feature proposed by Hamilton was that of ideology, which includes values, norms, knowledge, themes, philosophies, religious beliefs, ethical principles, ethos, etc. Hamilton differentiated between the three constituents, when she noted that, "...technology is the means used to satisfy bio-material needs; social structure is the means used to satisfy social needs; ideology is the means used to satisfy psychic needs." [Hamilton, 1987, p.3]

Hamilton concurred with White [1975], when she noted that all of the constituents of culture were required and without one, the others could not function [Hamilton, 1987, p.4], and therefore culture would fail to exist.

Stiles [1979] also identified the constituents of culture, and maintained that culture was a series of functions that were characteristic of human behaviour: "The theory of culture tradition is based on a sequence of propositions considered to be characteristic of human behaviour." [Stiles, 1979, p.4] From this perspective Stiles created eight statements, that he felt defined and characterised culture. The eight statements are listed below [Stiles, 1979, p.4]...

"1...Culture is a body of beliefs and standards of behaviour shaping the cognitive structure of an individual.
2...These cultural ideals determine most facets of human individual and group behaviour, including the manufacture of stone tools.
3...Culture is shared by an intercommunicating group of people.
4...A particular intercommunicating group of people will produce a particular complex of behaviour and material culture manifestations determined by shared cultural ideals.
5...Culture is restricted spatially by the distribution and configuration of communication networks.
6...Culture is transmitted by one or more members of a group to younger members.

7...Particular configurations of culture continue through time by this transmission process,
8...Culture changes by three processes- invention, borrowing, and replacement."

Elements of the above statements, show similarities to the perspectives adopted by Tylor [1874], and Vermeersch [1977]. The importance of beliefs and behaviour, making an individual acceptable to a larger group is stressed [statement 1], culture is considered to be the bonding feature within a large group, and allows for intercommunication [statements 2, 3, and 4]. Stiles also accepted the review of Bose [1929, cited by Vermeersch, 1977, p.19], when he stated that culture was transmitted from generation to generation, through time [statement 6].

Culture is a multifaceted entity, constructed of different constituent parts. All scholars within the field identify that individual, social and ideological constituents have to be fulfilled for culture to operate within a society, without one constituent, culture fails to exist.

2.3 Perspectives from the discipline of psychology

There are certain perspectives from the discipline of psychology which are of value in the context of this thesis. Of particular interest is the work of Jung (1875-1961) [1959], and his work on the '*collective unconscious*', examining group behaviour, which has relevance in the field of culture and group behaviour towards pattern adoption. Also of relevance is the study of 'perception' and also the "Gestalt school of psychology', which examined the visual effects and processing of pattern. This thesis is concerned with pattern, adoption and diffusion. Avenues which are of relevance in each of these contexts, and are introduced in the subsequent sections.

2.3.1 Carl Gustav Jung

Carl Gustav Jung (1875-1961)[1959] was a Swiss Psychologist, who was an eminent scholar in the understanding of *collective unconscious*. He influenced the work of scholars from many fields including psychiatry, literature, and religion [Williams, 2001, p.29]. It was Jung that first penned the term *collective unconscious*, this was the belief that large groups of people share a common unconscious, including beliefs, etc., therefore a possible reasoning behind culture formation. It was believed to be an inherited phenomena passed through successive generations, Reber defined the collective unconscious, he stated it was, "Jung's term for that aspect of the unconscious shared by all. The radical unconscious (as it was also called) was assumed by Jung to be inherited, transpersonal and, in his conceptualisation, to consist of the residue of the evolution of man." [Reber, 1995, p.136]

Williams noted that the passage of certain traits were from generation to generation, and therefore genetic, and were the bindings that ran through a population or group giving an instinctive cultural segregation or trait. Williams noted that this was due to what Jung classified as *archetypes*. Archetypes are the unconscious ideas and images that form the components of the collective unconscious. As pointed out by Williams, "The word archetype is from the ancient Greek orkhetupos, which translates as 'beginning or first pattern'. Archetype refers to a recurring pattern that is consistent enough to be considered a universal concept or situation." [Williams, 2001, p.29] Williams further elaborated upon the effect of these archetypes, when she stated,

> "For Jung, the variety of human experience and primordial images originating in a pre-logical thought pattern were somehow genetically coded in humans and transferred to successive generations. Archetypes were instinctive, universal patterns (in that they recur in independent cultures) expressed in behaviour and images. Jung hypothesised that the archetypes arose from the collective unconscious and shaped the

> basic human psyche. The effect of the archetype took place both in the unconscious and between the unconscious and the conscious. When unconscious content was perceived, it confronted consciousness in the form of an image. The symbolism of the archetype was thus the manifestation of the psychic images that differed according to which archetype, or which aspect of the archetype was raised." [Williams, 2001, p.30]

Gregory compared that method of group behaviour and belief penned as the collective unconscious [Jung], to the work of Chomsky, and his *deep structure of language*, which was a common language or accepted train of thought that ran through a cultural group or tribe, Gregory stated, "Carl Jung seems to think of his collective unconscious in terms somewhat similar to Noam Chomsky's Deep Structure of Language: as ancient inherited mind or brain structure." [Gregory, 1981, p.564]

In general the collective unconscious seemed to rely on ancestral experience, to allow for transportation through generations, and culture formation. It is the deep seated beliefs of a particular cultural group that support this collective unconscious.

2.3.2 The Gestalt school

The Gestalt school, was a school of psychology that was founded in Germany in the 1910s. The main exponents of the Gestalt school was Max Wertheimer (1880-1943) [1945], Kurt Koffka (1886-1941) [1935], Wolfgang Kohler (1889-1967) [1929], and by philosophical allegiance, Kurt Lewin [1936, 1951]. The Gestalt school formed in opposition to the Structuralists[2]. The Gestaltists maintained that the physiological phenomena could only be understood if they were viewed as organised, structured wholes, referred to as *Gestalten* [Reber, 1995, p.313].

[2] The Structuralists position that phenomena could be introspectively 'broken down' into primitive perceptual elements was directly challenged by the Gestalt point of view The Gestaltists believed that the Structuralists analyses left out the notion of the whole, for example perception can be distorted if the whole is not viewed.

Koffka [1935] provided a definition to the meaning of *Gestalt*. He believed that Gestalt was a result of organisation, everything is a constituent part of a whole, and has its correct place to aid perception. He stated that,

> "The word 'Gestalt' has the meaning of a concrete individual and characteristic entity, existing as something detached and having a shape or form as one of its attributes (Kohler, 1929, p.129). A Gestalt is therefore a product of organisation, organisation the process that leads to a Gestalt." [Koffka, 1935, p.682]

The main argument of the Gestalt school was that objects have to be viewed as wholes, and if only constituents are examined the perception can differ. Reber provided a summary of the Gestalt school, to highlight the principles, and used the example of a musical melody; all features need to be heard in order to get the whole impression, but the melody can still be recognised even from only the smallest constituent, he stated,

> "The early Gestaltists were masters of the elegant counter example and presented sufficiently convincing arguments and demonstrations to seriously damage the orthodox Structuralists view. For example, a particular melody is easily recognised even when its component parts are dramatically altered: it may be sung, played, changed in key, embedded in multiple variations, etc., without destroying its recognisable Gestalt. Further, each of several notes in any particular melody has a different phenomenological sense if played alone or if introduced into a new melody. In all cases, they argued, the whole dominates the perception and it is experienced as different from simply the sum of its several parts." [Reber, 1995, p.313]

The Gestaltist school of thought was based around the ideal that the 'whole' was more important than the parts composing it, including human societies [Gregory, 1981, p.268]. The general belief was that the brain produced electrical fields exactly the same shape as the image being perceived. It was these fields that Wertheimer referred to as 'isomorphism'. Gregory noted this feature, and stated,

> "The notion is that the brain produces electrical fields of the same shape as observed objects. This supposed identity of shape from objects to brain fields was called 'isomorphism'. The brain fields were supposed to adopt certain preferred forms- to have tendencies towards 'good

> form'... The supposed tendencies for the brain fields to adopt certain forms in preference to others were classified into the Gestalt 'laws of organisation'..." [Gregory, 1981, p.367]

The founders of the Gestalt school were concerned with how the stimulation of separate cones and rods within the eye were associated with the neural channels. The belief that each nerve could transmit only one type of impulse, and therefore were impulse selective, this was the basis of G.D.Muller's "Law of Specific Energies" [Gregory, 1981, p.367]. Koffka referred to the feature that trace systems with the same characteristics were formed within the brain, and that these systems had to contain the same 'wholes' for perception to have occurred. It is thus a form of selection. He stated,

> "A process should, *ceteris paribus*, communicate with a trace system which possessed the same whole character. This must be a trace system which had been produced by a process of the same whole character, because we assumed that the trace retained the dynamic character of the process in the form of tensions or stresses." [Koffka, 1935, p.462]

It was believed by many, including Hebb [1949], and Craik [1943], that the Gestaltist point of view was far too simplistic. They believed that it was not possible for all shapes to be recreated exactly in the brain, for example the brain can't change colour to accommodate for the different colours. Hebb[3] introduced his theory of 'Phase sequences' as an alternative to the Gestaltist point of view. This was the belief that analogue traces were developed within the brain not in the exact representation of the image, but enough to allow for interpretation. He believed that all knowledge came through experience, but it was not necessary for the exact formation of pictures within the brain. This was in opposition to the Gestaltists who believed that exact representation was required, but experience was not necessary as some interpretation could occur naturally. Gregory stated,

[3] For full reference to Hebb's views, the reader is directed to his original work 'Organisation of Behaviour' [1949], and to Craik's work 'The Nature of Explanation' [1943].

> "...Hebb, which introduced his notion of 'Phase Sequences', thought of as analogues developed inductively to match situations, to make behaviour generally appropriate... these 'analogue' brain traces, which are not supposed to be pictures but, rather, more abstract representation of objects and situations which are seen as being built up from individual experiences, presumably by some kind of inductive generalisations carried out by brain mechanisms." [Gregory, 1981, p.371]

The Gestaltists made reference to features of human development such as learning. They regarded learning not as associations between stimuli and responses (as was the belief of the Behaviourists), but as a restructuring or reorganising of the whole situation, they believed that *insight*[4] was the critical feature. Hamlyn made reference to the Gestalt school, and noted that one of the main findings of the school was that experience played very little part in perception. Therefore the Gestalt school believed that nature overrode nurture, and therefore experience played a very little part in perception. Hamlyn stated,

> "...the Gestaltists have constantly maintained that the results of their work show that experience plays very little or no part in determining what we perceive. They have asserted that if naive subjects see something in a certain way, this is an indicator that experience has no effect on the perception." [Hamlyn, 1957, p.46]

Hamlyn believed that education could force different perception, the individual becomes trained to perceive differently through knowledge. He stated, "...we have to be governed in our expectations by what is natural, although it should always be remembered that naturalness is always relative, as must also be sophistication." [Hamlyn, 1957, p.14]

Although the Gestalt school was influential, it has become dispersed over time, although many of its theories have become incorporated into other fields of psychology. Reber commented upon this feature, and noted,

"In general, Gestalt psychology is antithetical to atomistic psychology

[4] "Most generally, an act of apprehending or sensing intuitively the inner nature of something" [Reber, 1995, p.374]

> in all of its varieties and equal hostility was directed toward the Behaviourists and the Structuralists. Although as a separate theory Gestalt psychology hardly exists today, many of its discoveries and insights have been incorporated into the contemporary body of knowledge, particularly in the field of perception." [Reber, 1995, p.313]

Having introduced the Gestalt school of psychology, the next section will be concerned with the field of study known as perception.

2.3.3 Perception

Perception, a field of study of concern to many psychologists, is the act of instinctive recognition. It is the action by which the mind refers its sensations to external objects. Reber defined perception, as: "Collectively, those processes that give coherence and unity to sensory input. This is the most general sense of the term and covers the entire sequence of events from the presentation of a physical stimulus to the phenomenological experiencing of it." [Reber, 1995, p.549]

Perception covers the physical, physiological, neurological, sensory, cognitive, and affective components of recognition. Perception is not uniquely determined by physical stimulation, but is in fact an organised complex of a range of factors. The factors that affect perception are attention, constancy, motivation, organisation, set, learning, distortion and hallucinations, and illusion[5].

De Bono also examined perception, stating that it is perception, that aids in the understanding and the utilisation of patterns. He believed that it was through perception that patterns become established within a group, and frequently used, becoming characteristic of a certain culture. De Bono maintained that the human mind looks for patterns, and so recognition is by pattern formation in the brain. Therefore patterns are intrinsic in human recognition, and so become adopted by

[5] The definitions of attention, constancy, motivation, organisation, set, learning, distortion and hallucination, and illusion, are provided by [Reber, 1995, p.549].

large groups of people. Groups of a similar culture adopt certain patterns. De Bono observed: "The mind functions to create patterns out of its surroundings. Once the patterns are formed it becomes possible to recognise them, to react to them, to use them. As the patterns are used they become ever more firmly established." [De Bono, 1970, p.10] De Bono had a different view to that of the Gestaltists whose views are described in Section 2.3.2. De Bono believed in pattern formation within the brain, therefore recognition through knowledge. The Gestaltists believed that exact replicas of the image were formed in the brain, and previous knowledge was not necessary.

Vernon defined the method of perception, noting that it is not necessary for the viewer to interpret and to understand all of the visual field. Understanding is possible if only a small sector of the field is visible, again contradicting the views of the Gestaltists. Vernon believed that the mind was naturally selective, and only receives enough of the necessary information to automatically fill in the gaps. He noted,

> "...we are as a rule concerned to perceive only as much as will enable us to identify what we see, that is to say, to allocate it to a particular class of objects or shapes, with which we are familiar...In tasks of differentiating, describing, reproducing, or classifying shapes, the observer tends to perceive only as much detail as he thinks necessary to perform the particular task, and ignores the rest." [Vernon, 1962, p.53]

Vernon concurred with Reber and De Bono, that knowledge is fundamental in the understanding of perception. Although an image of an object or a situation may be taken into the brain, without knowledge, the object cannot be interpreted, and therefore perception cannot have taken place, as some knowledge is required. Kohler made reference to the knowledge feature when he stated that,

> "...we must learn to make the all-important distinction between *sensation* and *perception*, between the bare sensory material actually given to us and the host of other items which since early childhood have become associated with it. You cannot see a 'book', I am told, since

> this term involves some knowledge about a class of objects to which this specimen belongs, and about their uses, etc., whereas in pure seeing such knowledge can not enter... 'Objects' cannot exist for us before sensory experience has become imbued with meaning." [Kohler, 1929, p.72]

Perception can be seen not only as the intake into the brain of a situation or image, but also the interpretation and understanding of the information. Therefore some previous knowledge, whether individually gathered, or as part of group culture and group knowledge is required, before the intake can be utilised or stored.

Having introduced the fields of study of anthropology and psychology, the next section is concerned with the discipline of symmetry and its analysis. This field forms the basic tool of analysis to be utilised within the rest of this research.

2.4 Symmetry

Crain and Block widely investigated symmetry, and its analysis, citing the work of many other scholars, including Coxeter [1942, 1961], Buerger [1963], Shubnikov and Koptsik [1974], Belov and Tarkhova [1964], and de Jong [1959], as important and setting the ground in the areas of mathematics and crystallography for the use within symmetry analysis.

This section is intended to introduce symmetry, its background and analysis, and highlights some of its uses in areas such as anthropology, typified by the work of Washburn and Crowe [1988]. The subsequent sub-sections are therefore intended to introduce the subject, which will be defined and explained in more depth in Chapter 3.

2.4.1 Definition of symmetry analysis

Reinhardt and Welters remarked that, "Symmetry analysis finds its origins in the field of geometry... The study of repetition of finite designs into infinity resulted in the classification of repeated patterns." [Reinhardt and Welters, 1999, p.177] Crain and Block explained symmetry analysis, using the four fundamental symmetry operations[6], and then identified three primary design structures of 'finite motifs', 'one-dimensional', and 'two-dimensional' patterns[7]. Throughout their work they made close reference to the work of Washburn and Crowe [1988], and referred to them as a major influential source. Crain and Block explained that symmetry analysis was "...used to determine the sequence of motions by which the motif is manipulated in order to obtain the design image." [Crain and Block, 1991, p.159]. Meanwhile Reinhardt and Welters, referring to the work of Rosen [1975] and Washburn and Crowe [1988], identified possible sources of symmetrical or geometrical patterns suitable for study, emphasing the flexibility of this field of study. They recognised that symmetry analysis can be used to study patterns contained within many different items or fields of design, including pottery, architecture and textiles. They stated that,

> "Symmetry analysis is a tool used to classify arrangements of repeating motifs within a pattern. Employed to analyse symmetry in nature, including crystal lattices, astronomical objects, flowers and human beings, symmetry analysis is also used to characterise the repeating patterns on material objects such as pottery, architecture, and textiles." [Reinhardt and Welters, 1999, p.176]

Reinhardt and Welters recognised the diversity of symmetry analysis, and that it was not a limited field of study. This is highlighted in the work of Washburn and Crowe [1988], who emphasised that symmetry analysis was a tool by which to

[6] The four fundamental symmetry operations will be explained fully in Section 3.2.
[7] The primary design structures of 'finite motifs', one-dimensional patterns, and two-dimensional patterns, will be described in Sections 3.3, 3.4, and 3.5, respectively.

identify similarities and differences.

For the purpose of this research, symmetry analysis is defined as the study and analysis of the repetition of singular motifs to create geometrical patterns.

2.4.2 Symmetry analysis, its interpretation, and perception

Washburn and Crowe have investigated symmetry in patterns, especially in the context of different cultures, and it is their work that is the major source of influence for this research. They expressed the view that certain symmetries, and methods of pattern formation are used exclusively by different cultures. They cited the view that cultural pattern usage develops as culture develops. Therefore it is possible to explore these cultures, using symmetry analysis as a tool and indicator. They expressed the view that, "...different cultural groups use different symmetries, and homogeneity or heterogeneity in symmetries maybe a function of cultural complexity, extent and type of cultural contexts, or other factors." [Washburn and Crowe, 1988, p.12]

Certain symmetry preferences are believed to be culturally exclusive, with certain classes of symmetry being used for the decoration of certain types of fabrics. Washburn and Crowe reinforced their hypothesis by making reference to the work of Brainerd: "...Brainerd suggests that symmetry consistencies may characterise a cultural group. Aberrations from the norm may be evidence of cultural borrowing." [Washburn and Crowe, 1988, p.13]

Within their joint work, Washburn and Crowe draw from a range of disciplines, including anthropology and perception. Making reference to the work of Kim [1981], they noted that,

> "Kim's word play illustrates how different viewers perceive the same scene differently; how viewers perceive only part of what they see; and how perceptions are conditioned by the viewers specific culture, so that

> interpretations of partial or obscured images are related to what the viewer already knows and is familiar with in his world." [Washburn and Crowe, 1988, p.11]

Further to this Washburn and Crowe recognised that images used as decoration, have underlying meanings, often perceived differently, depending upon the culture or beliefs of the viewer. They noted that, "...cultural membership and situation influence the information selection process." [Washburn and Crowe, 1988, p.16]. They stressed further the importance of perception:

> "Perception is a process by which an individual obtains information from the environment. But since in any given environment there is always more information than an individual can assimilate, a person must learn which stimuli are salient. Thus, perception involves selection. Through socialisation, an individual in a particular culture learns to focus on features which will enable him to predict events, reduce uncertainty, and make appropriate responses. The individual stores this information in memory and uses it as a baseline data against which to compare new information." [Washburn and Crowe, 1988, p.16]

Washburn and Crowe stressed the importance of symmetry in a cultural context, and related this to perception and visual recognition. They stated that, "...by understanding the role of symmetry in the visual recognition process we can better recognise its pervasiveness throughout a number of cultural domains." [Washburn and Crowe, 1988, p.17]

Washburn and Crowe highlighted that pattern recognition is a learnt feature and within cultural groups patterns are learnt, stored, and therefore recalled at later dates, and ideas and meanings are perceived. They stated,

> "We do know that pattern recognition begins with the extraction of features from the visual stimuli. It involves features, such as symmetry and orientation, which show relationships between object parts. Features and their relations are combined to form a pattern which is stored in memory and recalled for matching by classification processes in later visual tasks." [Washburn and Crowe, 1988, p.19]

Washburn and Crowe maintained that symmetry, is learnt. Washburn and

Crowe agreed with Corballis and Roldan [1974, 1975] who maintained that symmetry in the vertical direction is easier to recognise, and if not vertical, the mind will manipulate the image into the vertical position, "Individuals mentally rotated the images until the symmetry axis was vertical." [Washburn and Crowe, 1988, p.22] In addition, they recognised that the perception of symmetry is not just about orientation, but also relates to the proximity, and spacing of the motifs within the plane pattern. Washburn and Crowe refer, and justify the findings of Corballis and Roldan [1974, 1975]. The closer the motifs were together, the easier the recognition of the symmetry operation and structure. Washburn and Crowe referred to the work of Corballis and Roldan, and stated, "They found that recognition of symmetrical figures was faster if the units were close together, suggesting that the spatial relationship between parts of a figure is important for perception of the figures as discrete units," [Washburn and Crowe, 1988, p.2]

A further feature of visual recognition, explained by Washburn and Crowe, was that of figured designs, such as commas. These figures are easier and far quicker to recognise and classify than non-figured designs. They commented, "This result reinforces the theory that the perceptual system examines lines and angles for shape perception." [Washburn and Crowe, 1988, p.22]

Washburn and Crowe concluded that symmetry is a learnt feature and therefore is dependent upon the culture of the recipient. In addition, they maintained that, "If a symmetry type preference is learnt, then this would explain why certain symmetries predominate in the art of a given culture." [Washburn and Crowe, 1988, p.23]

2.4.3 The application of symmetry analysis principles

Crain and Block used the methods described by Washburn and Crowe to analyse the

symmetry groups present in samples from three different cultures, these being Moroccan carpets, American coverlets, and Indonesian warp ikats. By using the 'tools of symmetry analysis' (explained further in Chapter 3), the three sets of samples were investigated, and the conclusion indicated that there may be a direct correlation between design structure and the technology by which the fabrics were produced. Crain and Block noted, "...it is reasonable to conclude that there may be some connection between the design structure and the type of technology used in the production of the pieces." [Crain and Block, 1991, p.163]

The final conclusion of Crain and Block was that symmetry analysis enabled different cultures to be compared, and allowed a scientific and mathematical method of pattern analysis. They concluded that, "These preliminary results indicate that symmetry analysis may prove a useful tool for intercultural analyses, and that the preference for particular design structures are based on the technology used to produce the design images." [Crain and Block, 1991, p.165] It is this feature that will be further examined within this research.

Reinhardt and Welters (referring to Bier [1992], Shubnikov and Koptsik [1974]) acknowledged that symmetry analysis could be used to identify similarities and anomalies in pattern between long historical periods, geographically, culturally, and technically [Reinhardt and Welters, 1999, p.176]. They stated that symmetry analysis is particularly relevant when investigating different cultures:

> "The classification of patterns by symmetry provides a systematic technique for the study of function and meaning of design in a cultural context. Although many naturally created and manufactured patterns are not exact in their symmetry, a closely balanced pattern is considered symmetrical and can be examined with symmetry analysis." [Reinhardt and Welters, 1999, p.176]

2.5 Summary

It was recognised that anthropology is an all encompassing area of study, particularly associated with the study of man and culture. A range of perspectives from this discipline are of interest in the context of symmetry analysis, and these have been reviewed in this chapter. In searching for a definition of 'culture', reference was made to the work of important scholars in the field, including Tylor [1874], Hamilton [1987], Radcliffe-Brown [1949, cited by Vermeersch, 1977, p.17; 1952], Vermeersch [1977] and Koffka [1935]. For the purpose of this research the definition of culture is given as 'the norms, customs, language, belief, art, law, etc., that are acquired or learnt by an individual in line with their membership group, to allow them to function acceptably within their group or society'. With the provision of a definition, the constituents of culture were also discussed.

Certain important perspectives from the field of psychology were introduced, in particular perception, and the work of Jung (1875-1961) [1959]. Attention was focused on concepts associated with the *collective unconscious*, the belief that genetic traits run subliminally through a collective group of people, and form an underpinning to culture. Finally the perspectives popularised by the Gestalt school were introduced, including the work of Wertheimer [1945], Koffka [1935], and Kohler [1929], who were concerned with the perception of 'wholes' or *gestalten*. Alternative views provided by Hebb [1949], and Craik [1943] were also reviewed.

The final section of this chapter was concerned with the introduction of the term "symmetry analysis" and its relevance within this area of study. More comprehensive attention is given to this topic in the next chapter.

Chapter 3 The Fundamentals of Symmetry and Counterchange

3.1 Introduction

Symmetry is a principle that is widely used in many different spheres, and has been studied by scholars from many different fields, including mathematicians, chemists, crystallographers, anthropologists, psychologists, as well as designers. Hargittai observed that symmetry was a general unifying concept, of interest to specialists from different fields who saw its relevance in their own areas [Hargittai, 1986, p.xi]. Symmetry has been defined as:

> "Mutual relation of parts in respect of magnitude, and position; relative measurement and arrangement of parts or proportions...Exact correspondence in position of several points or parts of a figure or body with reference to a dividing line, plane or point; arrangement of all the points of a figure or system in pairs or sets so that those of each pair or set are at equal distances on opposite sides of such line, plane or point." [Shorter Oxford Dictionary, 1984, p.2220]

Symmetry is a vital component of patterns and designs, and aids the management of the actual design structure. Washburn and Crowe observed that, "We can clearly see that repeated designs are regulated by the formal rules of symmetry. Further, since symmetries restrict the kinds of pattern arrangements possible, they form a sort of grammar." [Washburn and Crowe, 1988, p.10]

Patterns may be classified dependent on their symmetry characteristics. Washburn and Crowe noted,

> "....symmetry classification is not concerned with the shape of the unit, but with the motions which move the pattern along an axis or around a point....The symmetry motions describe the specific configuration of parts for each design. Symmetry does not describe the parts, but how they are combined and arranged to make a pattern. It is concerned with only one aspect of design - its structure." [Washburn and Crowe, 1988, p.55]

With the above considerations in mind, the objectives of this chapter are:

(i) to describe the four fundamental or basic symmetry operations of translation, rotation, reflection, and glide-reflection;

(ii) to describe and differentiate the main symmetry groups of finite patterns, one-dimensional patterns, and two-dimensional patterns;

(iii) to explain the associated notation systems for the main symmetry groups;

(iv) to introduce the principles of colour-counterchange and to elaborate upon these.

3.2 The basic symmetry operations

Many mathematicians and other scientists such as Coxeter [1942], Jeger, Guggenheimer, Yale [1968], Gans [1969], Ewald [1971], Dodge [1972], Shubnikov and Koptsik [1974], Schattschneider [1978,1986], and Hargittai [1986], recognised that symmetry in patterns can be classified by one or more geometrical actions or symmetry operations (also referred to as "congruence transformations" or "isometries") contained within the pattern or design.

Symmetry operations are vital in the design of any repeating pattern. They produce the structure on which a repeating design can be built. Schattschneider recognised the importance and role of symmetry in design, when she stated that, "...graphic designs found in commercial and decorative art possess symmetry: a part of the design (a motif or a single tile) is repeated regularly to create the whole design." [Schattschneider, 1986, p.673]

There are four basic symmetry operations (or "plane isometries" [Washburn and Crowe, 1988]), and these form the fundamentals of pattern formation. The four basic operations are translation, rotation, reflection, and glide reflection. Each of

these operations will be dealt with individually in the subsequent sections.

Woods defined a symmetry operation as "...any movement of the figure which brings it to an equivalent position..." [Woods, 1935a, p.T203] He extended this, when he noted that,

> "...a figure is said to be symmetrical when it is possible to find two or more positions in which it is exactly super-posible on itself, and the movement necessary to bring the figure from one such equivalent position to another is said to be a symmetry operation of the figure." [Woods, 1935c, p.T341]

Washburn and Crowe widely known researchers in the subject area observed that, "A plane figure is said to be symmetrical if it admits one or more of the four plane isometries." [Washburn and Crowe, 1988, p.45]

Different symmetry groups are created when the four fundamental symmetry operations are used in different combinations. By the addition of translation in either one or two directions, border patterns or all-over patterns are created. The possible combinations will be described in Sections 3.4 and 3.5. Lin [1995] noted that border patterns occurred when motifs were translated in one direction only, and all-over patterns were created if translation took place in two directions. He noted:

> "...the different ways of systematically repeating a basic discrete design element (or motif) in a pattern in one direction (ie. along a border to produce a border pattern) or in two directions (ie. throughout the plane to produce an all-over pattern). Systematic repetition creates the whole design by using one or more of the four distinct types of geometrical actions by which a part of the design is repeated regularly without change in the shape or size of each individual part." [Lin, 1995, p.5]

Within the remainder of this section, the four fundamental symmetry operations of translation, rotation, reflection, and glide reflection, are explained.

3.2.1 Translation

Translation is the repetition either vertically, horizontally, or diagonally, of a figure or motif at regular intervals while retaining exactly the same orientation. The symmetry operation of translation can be seen pictorially in Figure 3.1. Washburn and Crowe observed that, "A translation of the plane is just a displacement or shift by a certain distance along a certain line." [Washburn and Crowe, 1988, p.48].

Figure 3.1 Translation

Schattschneider placed importance upon the displacement associated with translation. A regular displacement must be retained in order for a regular repeating pattern to be generated. She noted, "A translation of points in the plane shifts all points the same distance in the same direction." [Schattschneider, 1986, p.673]

Shubnikov and Koptsik stated that translation is the simplest type of symmetry operation, and observed:

> "The simplest transformation leading to infinite figures with no singular points is the parallel translation of a straight line through a given finite distance along itself. By repetition of this transformation, every point of the straight line is repeated an infinite number of times..." [Shubnikov and Koptsik, 1974, p.79]

They further maintained noted that translation had no limit upon the number of occurrences, and in theory it can occur infinitely. This principle of infinite occurrence can be applied to all of the fundamental symmetry operations.

An important characteristic of translation is that there is no change in orientation of the motif. This was recognised by Lin when he commented,

"Translation, or repetition at regular intervals of a motif or figure in a straight line without change of orientation." [Lin, 1995, p.5]

As recognised by Coxeter, if translation is carried out along one axis only, the result is a one-dimensional translation. Coxeter referred to translation as, "...the product of reflections in two ultra-parallel lines; it induces a one-dimensional translation in the common perpendicular of the two lines, which is called the axis of the translation." [Coxeter, 1942, p.202]

Translation is used in the production of all one-dimensional patterns (border patterns) and two-dimensional patterns (all-over patterns). For the production of border patterns (one-dimensional patterns), translation in one direction is required. For the production of all-over patterns (two-dimensional patterns), translations are required in two independent directions. This will be elaborated further in Sections 3.4 and 3.5.

3.2.2 Rotation

Rotation is the repetition at regular intervals of a motif or figure round an imaginary centre. This imaginary centre can be referred to as a "roto-centre", "rotational centre" or a "centre of rotation". Washburn and Crowe, explained as follows:

> "A rotation has exactly one fixed point, the centre of the rotation. A rotation is completely specified when we know its centre, the angle of rotation, and its sense, clockwise or counterclockwise." [Washburn and Crowe, 1988, p.48]

Likewise Lin defined rotation as the action "...by which a motif or figure is rotated about a fixed point so that it undergoes repetition at regular angular intervals." [Lin, 1995, p.5]

When using rotation for the generation of pattern classes, certain restrictions

do apply. Only rotations of the orders two-, three-, four-, and six-fold rotations, corresponding to 180°, 120°, 90°, and 60°, can be used to generate 'all-over' patterns. Five-fold rotation cannot create all-over patterns, due to the fact that when utilised, gaps or overlaps are created. This is often referred to as the 'crystallographic restriction'. Washburn and Crowe observed:

> "It is a remarkable fact (the crystallographic restriction) that the only possible rotations admissible by two-dimensional repeated patterns in the plane are half-, third-, quarter-, and sixth- turns (180°, 120°, 90°, and 60° rotations respectively)" [Washburn and Crowe, 1988, p.49]

A similar recognition was made by Schattschneider:

> "Since centres of rotation of a pattern are mapped by translations to new centres of rotation, only rotation of order 2, 3, 4, or 6, can occur as isometries of a periodic design. This is often referred to as the crystallographic restriction." [Schattschneider, 1978, p.441]

Rotations are generally identified as a division of 360°. For example in the case of 6-fold rotation the motif is moved by 60°, thus bringing the motif back into coincidence six times through 360°. Lin stated,

> "Geometrically any design in the plane having a regular circle wise repetition is symmetric under rotation, but only by a certain minimum angle and multiples of it. The minimum rotational angle will be equal to 360/n degrees." [Lin, 1995, p.5]

Where n is 1, we get a rotation of 360°, which occurs for asymmetric designs. A rotation of 360° or one-fold rotation, is often referred to as full rotational symmetry. Schattschneider observed: "A rotation of 360° (n=1) sends the point in the plane to its original position. This isometry has the same effect as leaving each point fixed and is called the identity isometry." [Schattschneider, 1986, p.675]

If n is 2, this results in 180°, or two-fold rotation. This is sometimes referred to as 'central symmetry' or 'point symmetry'. In the case of two-fold rotation, two half-turns will return the motif or figure to its original position. Two-fold rotation is represented in Figure 3.2.

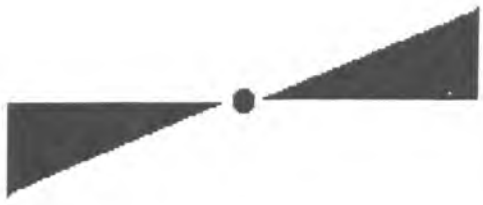
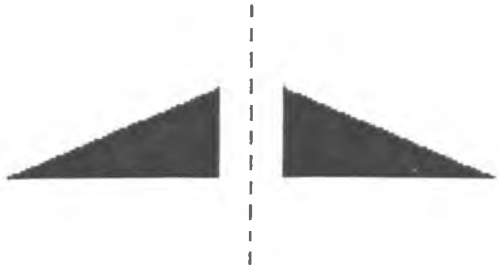


Figure 3.2 2-fold rotation

3.2.3 Reflection

Reflection (Figure 3.3) is the repetition of a figure or motif across an imaginary straight line producing a mirror image, this image is characteristic of so-called "bilateral symmetry". Reflection is also referred to as "line reflection" or "mirror reflection". Washburn and Crowe noted that reflection occurred when "....any figure which can be 'folded in half' so that one half coincides exactly with the other admits a reflection, and the line of the fold is the mirror line for that reflection." [Washburn and Crowe, 1988, p.46]



----- reflection axis or mirror line

Figure 3.3 Reflection

Reflection in both border patterns and all-over patterns can occur in both the horizontal and vertical directions, and in certain cases in both directions at the same time, but always across the reflection axis or mirror line. Schattschneider commented, "A reflection of points in the plane is determined by a fixed line, called a

mirror line or reflection axis; every point not on the line is sent to its mirror image with respect to the line and every point on the line is left fixed." [Schattschneider, 1986, p.673]

In the case of border patterns and all-over patterns, if both vertical and horizontal reflection axes are present, where the two axes intersect, a point of rotation is also generated. Lin referred to this feature with respect to border patterns: "Where both horizontal and vertical reflection axes are present in a border pattern, the point of intersection between each will act as a centre of two-fold rotation." [Lin, 1995, p.17]

Washburn and Crowe made reference to the generation of this point of rotation in the context of two-dimensional (ie.all-over) patterns. They stated, "In two-dimensional patterns, the presence of two intersecting mirror lines implies the presence of a rotation (by an angle which is twice the angle of the intersection of the two lines) about their point of intersection." [Washburn and Crowe, 1988, p.47]

3.2.4 Glide-reflection

The final fundamental symmetry operation is generally termed "glide reflection". Glide reflection occurs when a figure or motif is repeated through a combination of both translation and reflection in association with a glide-reflection axis. An example of glide reflection occurs when observing footprints in wet sand (Figure 3.4). The relevant schematic illustration is presented in Figure 3.5.

Figure 3.4 Footprints in wet sand

Woods referred to glide reflection as "a screw", which he defined as "...a rotation about a screw axis followed by a translation equal to half the unit translation in the direction of the axis." [Woods, 1935c, p.T342] Washburn and Crowe considered that, "A glide reflection can be simply described as a translation ('glide') followed by a reflection in a line parallel to the direction of translation." [Washburn and Crowe, 1988, p.50] Coxeter also defined glide-reflection as "...the product of a translation with reflection in its axis." [Coxeter, 1942, p.202]

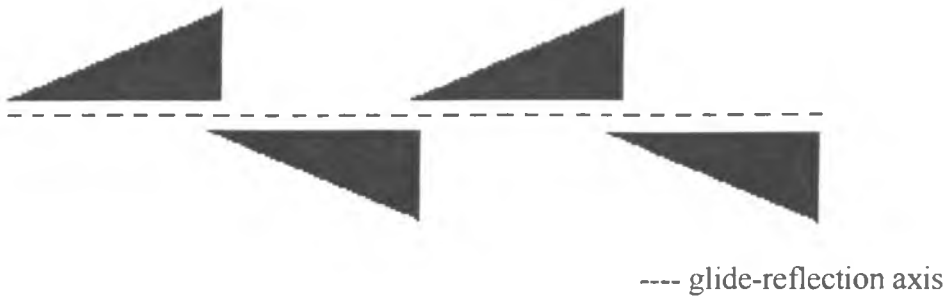


Figure 3.5 Glide-reflection

The operation of translation and reflection can occur independently, one after the other, or simultaneously. Schattschneider noted:

> "A glide-reflection, as the name suggests, is a transformation of points in the plane which combines a translation (glide) and a reflection. It may be obtained by a reflection followed non-stop by a translation which is parallel to the mirror line, or by a translation followed by a reflection in a mirror line parallel to the translation vector." [Schattschneider, 1986, p.677]

Washburn and Crowe observed that glide reflection was the most difficult operation "...to recognise and identify with certainty." [Washburn and Crowe, 1988, p.50] Shubnikov and Koptsik expressed similar views: "Of all the symmetry classes found in linear ornament, the class *a* [glide-reflection] is the most difficult from the point of view of understanding the laws governing the construction of one-sided bands." [Shubnikov and Koptsik, 1974, p.83] (The term "one-sided bands" is equivalent to border patterns, or one-dimensional patterns).

Within this section, the fundamental symmetry operations have been described and presented diagrammatically. These operations have to be understood fully, in order to appreciate the constituent geometrical elements of repeating pattern.

3.3 Finite figures

Finite figures, also known as "bounded figures", "point groups", and "primary motifs", occur when there is only one figure or motif. Primary motifs do not exhibit translation or glide-reflection, they are limited to rotation and/or reflection only, and maybe sub-divided, into either *cn* or *dn* designs dependent upon the symmetry characteristics.

Designs of the *cn* type have rotation about their centre of symmetry only, the order of which is equal to "...the number of equivalent positions obtainable by rotation about the centre of symmetry...." [Woods, 1935a, p.T198] Likewise, Lin stated: "A class *cn* motif is said to have n-fold rotational symmetry about a fixed point: that is to say, an element of the motif is repeated by successive rotations through an angle of (360/n) degrees about a fixed point and integral multiples of that angle." [Lin, 1995, p.38] The 'c' at the front of the notation stands for cyclic. This type of symmetry function will have n-fold rotation only, where n is an integer or whole number. Examples from this group are represented schematically in Figure

3.6. A c2 motif will have no reflection axes, but if rotated by 180° will come into coincidence with itself. It exhibits two-fold rotation and is referred to as a c2 motif.

c1 c2 c4

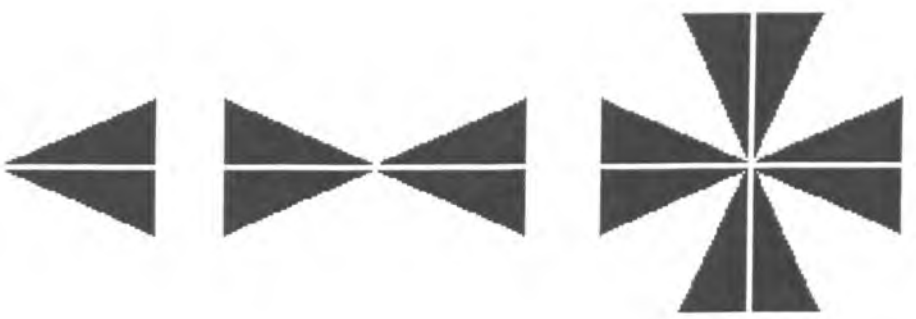
Figure 3.6 Examples of finite designs - cn figures
(motifs with rotational properties only)

The second category of finite designs, are referred to as '*dn*'. This group is characterised by one or more reflection axes. Where there is more than one reflection axis then rotation is created at the point of intersection (for reasons given in the paragraph above). A *dn* motif can have rotational and reflectional properties occurring simultaneously. Therefore it is the presence of reflection axes that differentiates *cn* finite figures from *dn* finite figures.

The 'd' in the notation stands for "dihedral", and figures of this type may have n-fold rotation as well as reflection axes (shown schematically in Figure 3.7). This feature was recognised by Lin, he stated that a dn motif has "...n-fold rotational symmetry combined with n-reflection axes (passing through the centre of the motif) mutually separated by half the minimum angle of rotation." [Lin, 1995, p.52]

For example a d2 motif will have bilateral symmetry present on both the horizontal and vertical axes, intersecting with each other at 90°. The fundamental (minimum) region of the motif is 1/4, and the motif can be brought into coincidence

by rotating through 180°. Two-fold rotation is therefore present.



d1 d2 d4

Figure 3.7 Examples of finite designs - dn figures
(motifs with rotation and/or reflection properties)

An asymmetrical figure will have no reflection axis and a rotation of 360°. The figure must be rotated by a factor of n=1, to enable it to coincide with itself. Such motifs are therefore referred to as "c1" motifs, or asymmetric figures. Lin recognised that asymmetrical figures "...have no symmetrical characteristics, and must therefore be rotated through 360° for all constituent parts to coincide with themselves; such motifs are classified as c1 motifs." [Lin, 1995, p.36]

Finite figures and asymmetrical figures are stationary around an axis point, and have no form of translation. Washburn and Crowe observed: "It is apparent that rotations are the only symmetries (other than reflection) admitted by finite (ie. bounded) figures." [Washburn and Crowe, 1988, p.48]

3.4 One-dimensional patterns

One-dimensional patterns may also be referred to as "border patterns", "band patterns", "periodic border patterns", or "frieze groups". For a one-dimensional pattern, a motif must be repeated at regular intervals in one direction only, as noted

previously in Section 3.2.1. Washburn and Crowe stated "...if a design admits translations in only one direction, the design is called a band, strip, frieze or one-dimensional pattern." [Washburn and Crowe, 1988, p.52]

A border pattern exhibits translation in one direction only, as if trapped between two parallel lines, a feature explained by Schattschneider as follows: "....[border patterns are] enclosed between two parallel lines (the edges of the border), that is, enclosed in a strip of finite width and infinite length, and having centre line L which is equidistant from the edges." [Schattschneider, 1986, p.680]

Within the complete border pattern is a motif or fundamental unit, sometimes referred to as the 'translation unit' [Lin]. If this unit is translated or repeated successively then a border pattern is created. Schattschneider referred to the motif or fundamental unit being encased within a 'generating region', and made the following observation: "...a generating region of a periodic pattern is the smallest region which when acted upon by the relevant set of symmetry operations will produce the whole pattern." [Schattschneider, p.1978] The allocated notation is dependent upon the symmetry operations used to create the border.

Schattschneider distinguished between border and all-over patterns, as follows:

> "Designs which are invariant under all multiples of just one translation are frieze, or border ornaments, and their associated groups are commonly called 'frieze groups'. Patterns which are invariant under linear combinations of two linearly independent translations repeat at regular intervals in two directions, and hence their groups are often termed 'wallpaper groups". [Schattschneider, 1978, p.439]

Shubnikov and Koptsik used the equivalent term "one-sided bands" and explained these "...as figures without singular points but with a singular polar plane and a singular translation axis." [Shubnikov and Koptsik, 1974, p.86]

Through the use of the four fundamental symmetry operations, there are seven different classes of border patterns producible. These seven different border

classes are represented schematically in Figure 3.8.

The notation for border patterns is based on *pxyz* (a form of notation used by the International Union of Crystallographers). The '*p*' is the preface for all seven of the border patterns. The letter'*x*' is the symbol which specifies any geometrical characteristic which is present in the direction which is perpendicular to the longitudinal axis of the border. The '*y*' in the *pxyz*, specifies a geometrical characteristic through the central axis which is parallel to the sides of the border. The '*z*' in the notation in the case of border patterns will denote the presence of a two-fold rotation centre; a 2 in this position therefore shows two-fold rotation presence.

Only two-fold rotation is possible in a border pattern in order to maintain the correct side positions and orientation of the border. This feature was noted by Lin: "Two-fold rotation is the only order of rotation which is applicable in the context of border patterns, as only this rotational order ensures that the sides of the border remain correctly orientated after transformation." [Lin, 1995, p.70]

The simple breakdown of the one-dimensional pattern notation can be seen below...

p = prefix for all one-dimensional border patterns.
x = 'm' if vertical reflection, or '1' if not present.
y = 'm' if longitudinal reflection, 'a' if glide-reflection or '1' if neither is present.
z = '2' if two-fold rotation is present or '1' if not present.

The most fundamental one-dimensional pattern is class *p111*. This pattern has translation only, and is usually constructed of an asymmetrical or *c1* motif.

An example of each of the seven border (one-dimensional groups) is illustrated in Figure 3.9; these designs were taken from various Persian carpet borders.

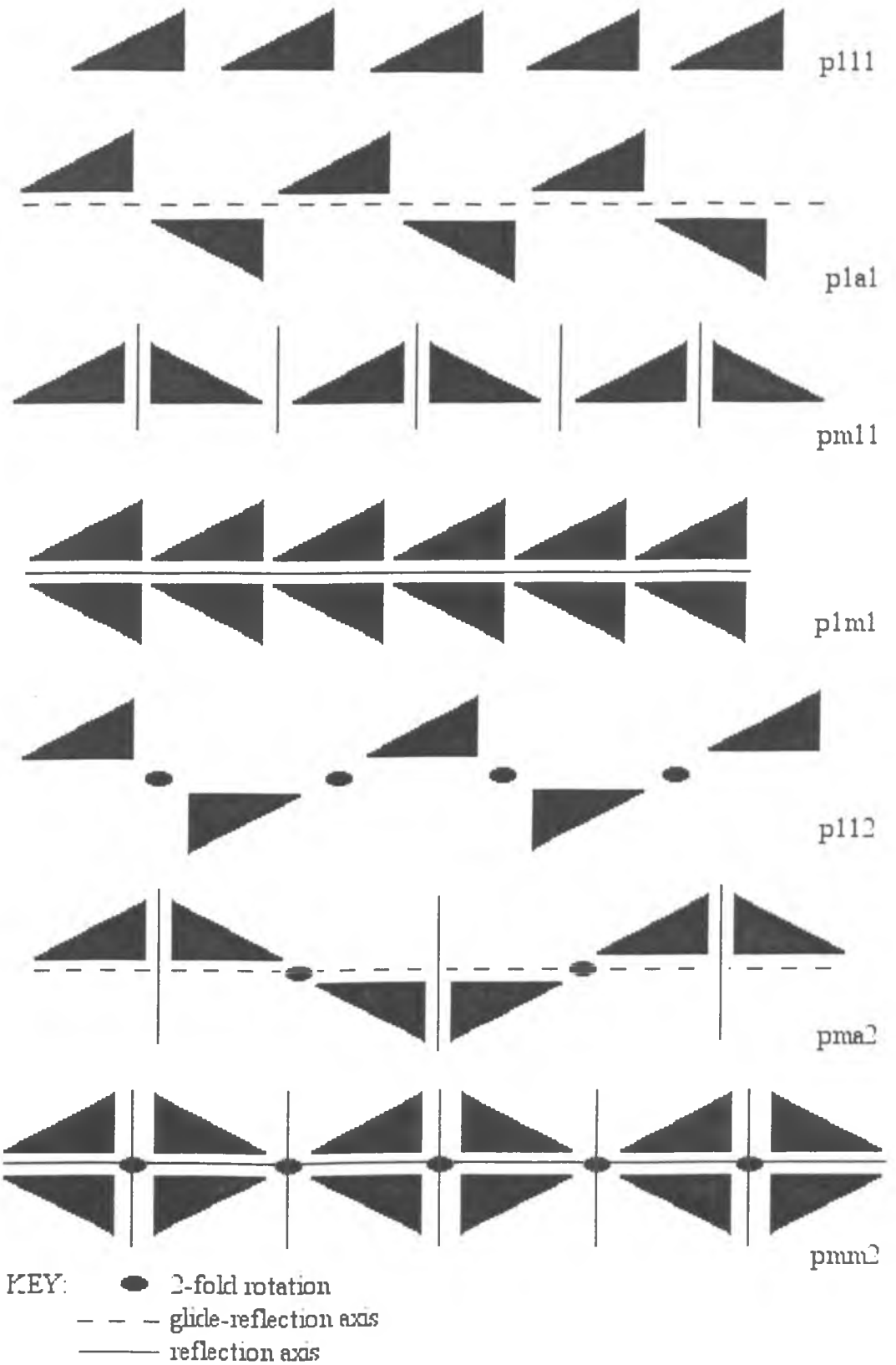
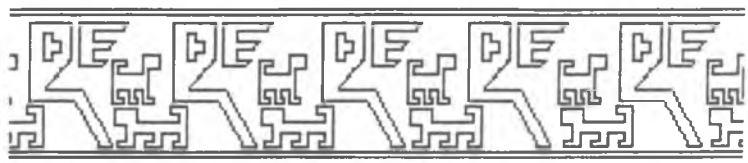
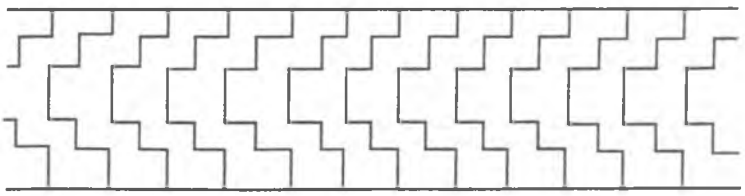


Figure 3.8 Schematic illustration of the seven primary classes of border patterns



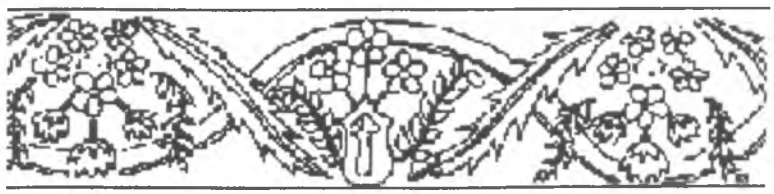
p111

[Gans-Ruedin, 1971,p.163]



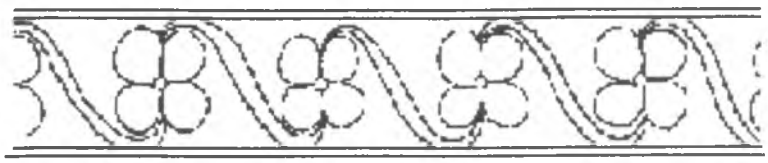
p1m1

[Gans-Ruedin, 1971,p.210]



pm11

[Gans-Ruedin, 1971,p.201]



p112

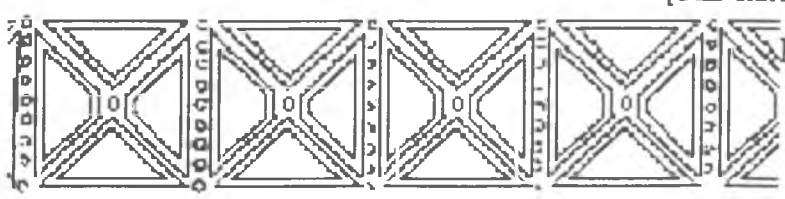
[Gans-Ruedin, 1971,p.220]

p1a1

[Gans-Ruedin, 1971,p.128]

pma2

[Gans-Ruedin, 1971,p.232]



pmm2

[Gans-Ruedin, 1971,p.209]

Figure 3.9 Examples of border patterns from traditional carpets

3.5 Two-dimensional patterns

The second classification group is two-dimensional patterns, which are also known as "all-over designs", "wallpaper designs", or "periodic patterns". A two-dimensional group uses the same four basic symmetry operations as the one-dimensional patterns, but they exhibit translation in two independent directions. Washburn and Crowe observed that, "If a plane figure admits translations in two or more directions it is a two-dimensional pattern." [Washburn and Crowe, 1988, p.52]

Two-dimensional patterns are produced by using different combinations of the four fundamental symmetry operations, in combination with a further symmetry component: "the five Bravais lattices[8]". These are also known as the five types of net [Woods, 1935b]. The five distinct lattice types are ordinary, rectangular, rhombic or centred-rectangular, square and hexagonal. Woods defined the construction of a lattice as follows:

> "Start with a chain of points with interval a in some straight line, and...make each of these points a point of another chain, of interval b, making an angle ω, say, with the first chain, we thus obtain an array of points which is such that any translation equal to a multiple of a in the direction of the first chain, or to a multiple of b in the direction of others, moves the figure into an equivalent position. Such an array is called a net of points." [Woods, 1935b, p.T294]

By using a combination of these lattices, and the fundamental symmetry operations, it is possible to produce seventeen groups of all-over (two-dimensional) patterns.

Grunbaum, et al [Grunbaum and Shepherd, 1986], agreed with these findings, but stated that the distinguishing feature between one-dimensional and two-dimensional patterns is the number of directions of translation required for the pattern generation. All-over patterns require translation in two independent

[8] The Bravais lattices are available in figure form in [Schattschneider, D , American Mathematical Monthly, Volume 85, 1978, pp 437-450].

directions, while one-dimensional require translation along the parallel in one-direction only. They stated, "It is well known that there are seventeen classes of symmetry groups of planar ornaments which repeat in at least two non-parallel directions; these are known as the (classes of) wallpaper (or crystallographic plane) groups." [Grunbaum and Shephard, 1986, p.641]

Associated with these seventeen all-over patterns is a four-figured notation, which identifies the chosen unit cell, the highest order of rotation within the pattern, and the presence of any symmetry axis in the two directions of either reflection or glide reflection. All two-dimensional patterns have a notation and can be classified into one of the seventeen groups. The notation is described below.

The full international four-symbol notation was described by Washburn and Crowe, and is as follows....

> "The first figure in the notation is either a '*p*' or a '*c*', and these letters denote either a primitive or centred cell, dependent upon the Bravais lattice type used. The second figure is an integer which denotes the highest order of rotation. The third figure in the four figure notation denotes any symmetry axis that is perpendicular to the x-axis, if an '*m*' (mirror) is present, this indicates a reflection axis, a '*g*' present indicates a glide reflection presence. The fourth figure again is either '*m*' or '*g*', but this time for the presence of either a mirror reflection line or a glide reflection line at an angle œ to the x-axis. If in the case of the third and the fourth digit in the notation a '*1*' appears, this indicates that there was no presence of either mirror symmetry or glide reflection". [Washburn and Crowe, 1988, p.60]

Schematic illustrations of all seventeen classes are shown in Figure 3.10. The notation that is used for the identification of symmetry patterns is based on crystallography notation, as stated by Rose and Stafford, "The notation used to identify the wallpaper groups is an adaptation of the symbolism used by crystallographers." [Rose and Stafford, 1981, p.62]

Figure 3.10 Schematic illustration of the seventeen primary classes of all-over patterns

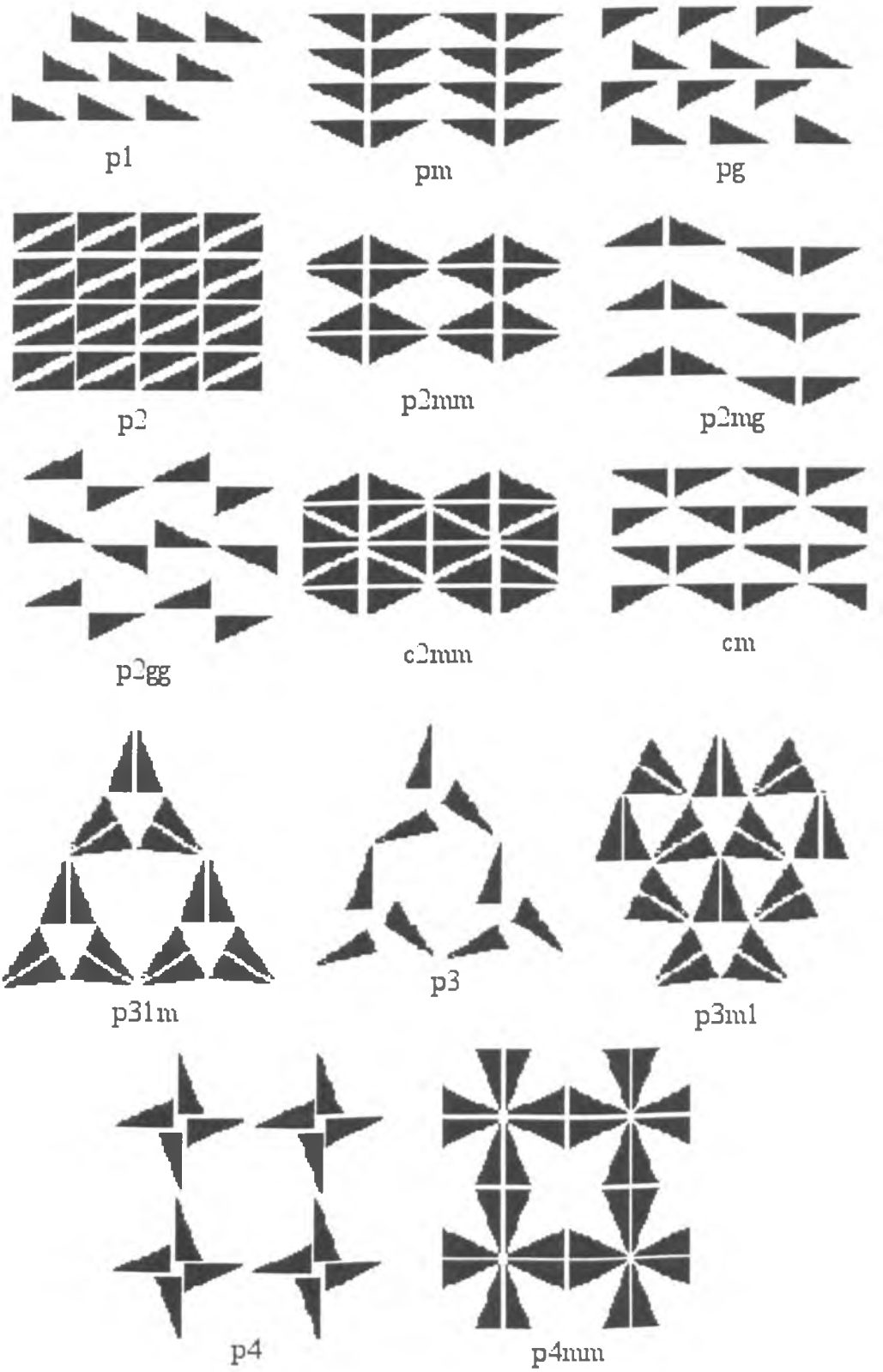
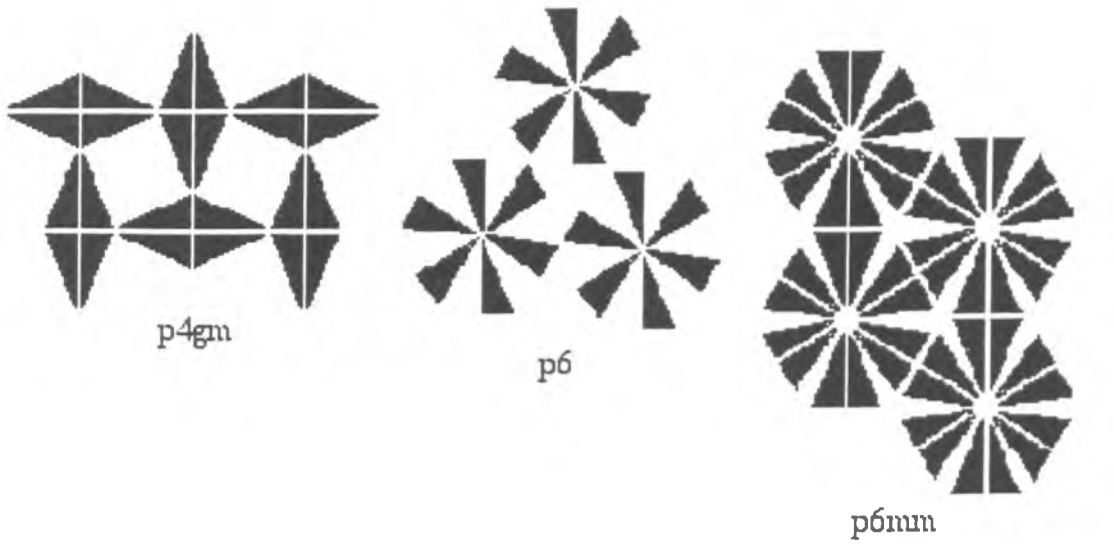


Figure 3.10 Schematic illustration of the seventeen primary classes of all-over patterns (continued)



derived from: [Hann and Lin, 1999]

3.6 The fundamentals of counterchange symmetry

As well as the one-colour classifications of finite motifs, one-dimensional and two-dimensional patterns, as seen in Sections 3.3, 3.4, and 3.5, it is possible to generate further classes by the introduction of colour to the primary patterns. The term "primary pattern" refers to the original seven one-colour one-dimensional (border) patterns, and the seventeen one-colour two-dimensional (all-over) patterns, which were categorised earlier in this chapter, and are presented schematically in Figures 3.8, and 3.10.

The introduction of colour into the primary symmetry classes of all-over patterns and border patterns produces counterchange patterns. Counterchange patterns are formed by following the characteristic symmetry operations of each pattern type, and then systematically changing colours in a continuous way.

Woods [1935,1936] investigated counterchange and noted that the primary symmetry classes can be used as the basis for the generation of counterchange

patterns. He stated, "Any ordinary pattern may therefore be regarded as a basic form from which counterchange patterns may be derived." [Woods, 1935a, p.T207]

In the subsequent sections, the fundamental principles of counterchange will be explained, and the one-dimensional and two-dimensional counterchange patterns described.

Key researchers in the area of counterchange designs or patterns include: Schwarzenberger [1984], Woods [1935], Senechal [1975], Loeb [1971], Lockwood and Macmillan [1978], Grunbaum and Shephard [1986], Schattschneider [1978, 1986], Washburn and Crowe [1988], and Weiting [1982].

Woods explained counterchange symmetry as follows:

> "...if the figure is drawn in black and white, black falls on black and white on white. It may happen, however that a figure is such that it can be moved to a new position in which black and white are interchanged. For example, if we consider a square divided into black and white halves by a diagonal, it has in a strict sense, no centre and only one axis of symmetry. On the other hand, there is a sort of pseudo-central symmetry; for a rotation through 180° about the centre of the square interchanges the positions of the black and white exactly; and clearly there is a similar kind of axial symmetry about the line dividing black from white. We shall call symmetry of this sort 'counterchange symmetry'..." [Woods, 1935a, p.T204]

In the operation of counterchange, there are two types of motion that are consistent with colour. These are, those that reverse or interchange colour, and those that preserve colour. The interchange of colour occurs when one colour changes to become another as a consequence of a symmetry operation (for example black becomes white, and white becomes black). This feature was noted by Washburn and Crowe [1988], and is fundamental to the understanding of counterchange symmetry.

Woods considered the concept of counterchange symmetry in plane patterns, and noted the difference between a geometrical symmetry operation and a counterchange symmetry operation. He concluded that with a geometrical symmetry operation, any operation will superimpose an object onto another of the same sort.

With a counterchange operation on the other hand, a reversal of some sort occurs. For example, a white dot would become a black dot, if true counterchange had occurred. Woods stated,

> "When a pattern has a purely geometrical symmetry element these arrows are arranged so that the symmetry operation superimposes every arrows on one of the same sort. The geometrical part of a counterchange operation, however, interchanges the positions of the positive and negative arrows, so that the operation of reversal means that each positive arrow must be negative and vice-versa." [Woods, 1936, p.306]

The most basic form of counterchange is that of two-colour counterchange. Two-colour counterchange groups fall into two distinct groups. The first group occurs when the entire plane is covered in two colours; these are referred to as "two-colour counterchange patterns" for border and all-over patterns, and "two-colour designs" in the case of finite designs. All of these groups were first referred to as "counterchange groups" or "patterns" by Christie [1929]. It should be noted, however, that Christie did not recognise the scope of theoretical possibilities.

In this first group of counterchange patterns, the colours change systematically and change all over the pattern. Washburn and Crowe observed:

> "Rigid motions which interchange the colours everywhere, like those for a checkerboard, are said to be consistent with colour; rigid motions which move each colour onto the same colour are also consistent with colour." [Washburn and Crowe, 1988, p.64]

In the case of this first group, the two colours will interchange systematically across the whole plane. Therefore in the case of white and black, white will become black, and black will become white. All colours present interchange systematically throughout the whole plane, as in the case of a checkerboard. Washburn and Crowe noted,

> "As for the checkerboard, a true two-colour pattern is one in which the part of the pattern which is coloured one of the colours is exactly like the part of the pattern which is coloured the other colour: that is,

> some rigid motion of the plane interchanges the two colours." [Washburn and Crowe, 1988, p.65]

In the second case of counterchange, another colour is present in the background, and this colours part of the plane, or part of a strip, or part of some finite region. This background colour never actively takes part in the interchange, it remains static. The two other colours, are the only colours that interchange systematically. It can be seen that sometimes in the case of three-colour designs, one colour will remain stationary, and will be referred to as a background colour, the other two colours will systematically change. In this case (from the viewpoint of geometrical symmetry) it is referred to as a "two-colour pattern". Washburn and Crowe noted, "...what might be thought of as part of a pattern, is to be considered background because no rigid motion moves this background onto the pattern proper." [Washburn and Crowe, 1988, p.65]

Sometimes two-colours can be present, but if the two colours do not systematically change, a background colour is present, then this pattern type is referred to as a "one-colour pattern". Washburn and Crowe stated that only when the background colour can be counterchanged with the other colour, does this become a two-colour pattern from the viewpoint of geometrical symmetry. They observed:

> "If we find that what we called 'background' can be moved by a symmetry of the whole figure to coincide with what we called 'pattern', then what we have is not in fact a one-colour pattern, but a two-colour pattern of the first category." [Washburn and Crowe, 1988, p.65]

Woods identified a method of carrying out counterchange, using the fundamental primary structures for plane patterns. It can be seen that by using the original seven one-dimensional (border) and seventeen two-dimensional (all-over) patterns, and changing some of the symmetry operations by reversal, the counterchange groups, also known as "counterchange derivatives" [Woods], can be generated. Woods noted:

> "We start by taking any one of the fundamental types (the basic pattern)...and we search for counterchange derivatives by adding reversals to certain of the symmetry operations. In effect this means that we change half the arrows in the diagram of the basic type from positive to negative, and each different way in which this can be done gives a positive counterchange derivative." [Woods, 1936, p.T307]

In the case of two-colour counterchange, the basic notation that is widely used involves the addition of a prime (') to indicate a colour change. MacGillavry commented: "In the notation of black-and-white symmetry a prime indicates a change of colour. *p'* therefore indicates a primitive cell, containing one motif in parallel orientation, disregarding its colour." [MacGillavry, 1976, p.32]

3.7 Finite counterchange patterns

In the case of '*cn*' motifs there is only one way of colouring the motifs using two-colours. When undertaking colour counterchange on *cn* motifs, only even numbered motifs such as *c2*, *c4*, *c6*..etc, can be coloured using two colours. In the case of *cn* motifs whose symmetrical feature is that of rotation, the only way to colour them is to alternate the two colours around the motif. Washburn and Crowe observed that there was,

> "..only one way of colouring a *cn* design with two colours, consistent with all its isometries, and this is to alternate the colours around the design. Even this is only possible when *n* is an even number. Such a two-colour colouring of *cn* (where n is even) denoted by *cn'*." [Washburn and Crowe, 1988, p.68]

Examples of two-colour counterchange patterns comprised of *cn* motifs can be seen in Figure 3.11.

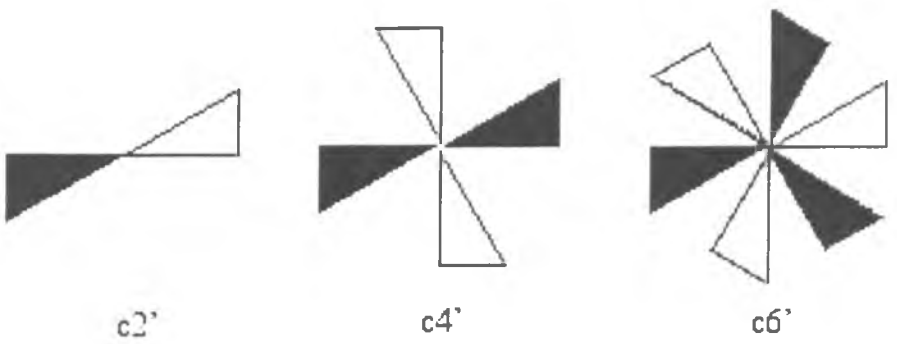


Figure 3.11 Examples of two-colour counterchange patterns for *cn* motifs

In the case of *dn* finite motifs there are two ways of colouring the motifs perfectly to achieve two-colour counterchange designs. These motifs are characterised by the presence of n-fold rotation and n-reflection axis. Two possibilities are offered by systematic colour countering.

With the action of counterchange there are three important phrases that feature frequently in the relevant literature; these are "preserve colours", "reverse colours", and "consistent with colour". Washburn and Crowe defined each of these features when investigating counterchange possibilities. Each term is further examined below.

When the term "preserve colour" is used, this means that the colour on both sides of the axis, or on either side of the symmetry operation is retained. That is, it has been preserved during the whole symmetry operation. Washburn and Crowe stated, "Preserves colour means that the same colouring is maintained, ie, all white units superimpose on white units and all black units superimpose on black units. No colour changes occur." [Washburn and Crowe, 1988, p.81]

The term "reverses colour" is used when the colour changes across a symmetry operation, (such as across a mirror axis) and the motif is white on one side of the axis, and black on the other: the colour is thus reversed through the action of the symmetry operation. Washburn and Crowe noted, "Reverses colour means that

colour changes have occurred everywhere, ie, all white units superimpose on black units and all black units superimpose on white units." [Washburn and Crowe, 1988, p.81]

The final term 'consistent with colour' is used when certain symmetry operations generate a preservation of colour, while others generate a reversal of colour, all in the same constituent unit cell. Washburn and Crowe again make reference to this feature:

> "The phrase consistent with colour asks the user to determine whether only colour reversals or only colour preservations are present from one point of rotation or line of reflection in the pattern. To do this the user rotates or reflects the entire pattern about his point or across this line. It is important to recognise that, in a given design, different points of rotation or reflection may or may not produce symmetries consistent with colour, or consistent in the same way." [Washburn and Crowe, 1988, p.81]

If *n* is odd, only one type of colouring is possible; reflection reverses colours, and rotation preserves colours.

If *n* is even, half the reflections reverse colours and half of them preserve the colours, and rotation by one nth of 360° reverse colours.

The first case is where the colours are interchanged again around the design; this is suitable for the colouring of both odd and even *dn* figures. Examples of this kind of colouring can be seen in Figure 3.12. The method of notation for this kind of motif is *d'n*.

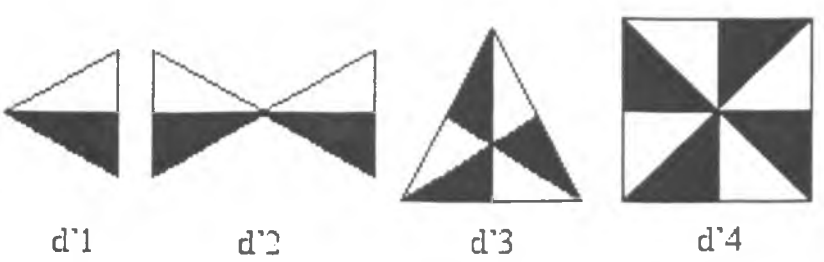


Figure 3.12 Examples of two-colour counterchange patterns for *d'n* motifs

The second method of colouring *dn* motifs can only be used for colouring

even n valued *dn* figures, in exactly the same way as *cn* figures are coloured. The notation that is given to this class is of the type *dn'*. Examples of this kind of figure can again be seen in Figure 3.13.

Figure 3.13 Examples of two-colour counterchange patterns for *dn'* motifs

For *d'n* motifs all reflections change the colours, while rotation preserves the colours. In the case of *dn'* motifs it is the rotation that interchanges the colour. Washburn and Crowe offer the following explanation:

> "If n is even there are two different colourings of *dn* with two colours. The first is like the odd case: all reflections reverse the colours; all rotations preserve the colours. It is *d'n*, exactly as for odd n. In the second colouring of *dn*, where n is even, half of the reflections reverse the colours and half preserve colours; rotations by one nth of a full turn reverse colours. We denote this design by *dn'*." [Washburn and Crowe, 1988, p.68]

For higher ordered colouring of finite motifs, Lin noted, "To systematically colour a *dn* motif with three or more colours, the number of colours involved (denoted by k) must be a factor of the number of fundamental units within the motif." [Lin, 1995, p196]

Therefore for three-colour counterchange patterns, only *d3*, *d6*, *d9*...etc motifs can be coloured perfectly. Following this rule for the colouring of four-coloured counterchange motifs, only motifs of *d4*, *d8* , *d12*, etc. can be coloured perfectly. Therefore in general it can be seen that *k* (number of colours) must be a factor of *dn* or *cn* for a perfectly coloured motif.

In the same way that finite figures can undergo colour-counterchange, one-

dimensional and two-dimensional patterns can also undergo counterchange generation. In the subsequent sections, these processes will be examined.

3.8 Two-colour one-dimensional counterchange patterns

With the introduction of two or more colours in the primary one-dimensional and two-dimensional patterns, the number of potential symmetry operations functioning upon the design also increases. The four fundamental symmetry operations of reflection (3.2.3), translation (3.2.1), rotation (3.2.2), and glide reflection (3.2.4) are still operating, but three further fundamental symmetry operations are operational. These are: two-fold rotation in the plane, screw rotation and mirror rotation. Each is described below. All relevant notation is derived from the "International Tables for X-Ray Crystallography" [The International Union of Crystallography, 1952].

3.8.1 Two-fold rotation in the plane

The first new symmetry operation of relevance to colour counterchange is two-fold rotation in the plane. This is generated by a reflection across an axis with a colour change (illustrated schematically in Figure 3.14).

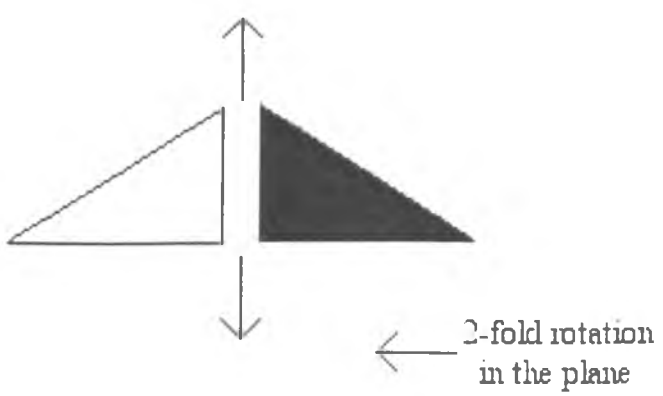


Figure 3.14 Two-fold rotation in the Plane

3.8.2 Screw rotation

The next fundamental symmetry operation is that of screw rotation. This operation is a blend of rotation and translation. Screw rotation is of course similar to glide reflection, but colour change across the axis occurs in addition (shown schematically in Figure 3.15).

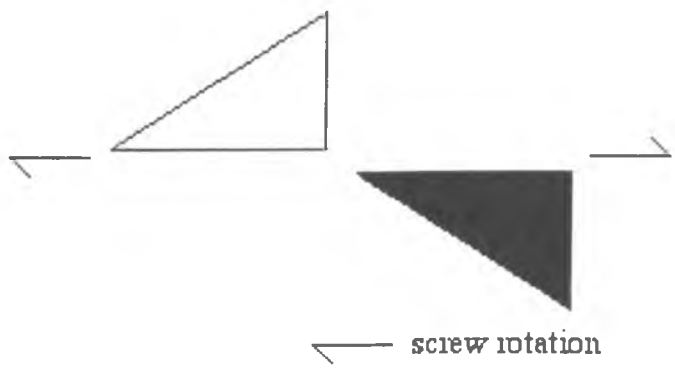


Figure 3.15 Screw rotation

3.8.3 Mirror rotation

Mirror rotation involves rotation with a colour change around the order of the rotation. The number of colours involved in the counterchange must be a factor of the order of rotation. For example for a four-fold rotation, two colours would create a perfectly coloured motif, due to two being a factor of four.

The symmetry operation of mirror rotation was recognised by Shubnikov and Belov. They noted,

> "In some cases of mirror-rotation the operation of inversion is created. Inversion occurs when all points can be reflected in a central point, where the rotation and reflection planes intersect, to coincide with identical points that are diametrically opposite. Two-fold mirror-rotation is one such case." [Shubnikov and Belov, 1964, p.12]

Mirror rotation is shown schematically in Figure 3.16. With each revolution a

colour change occurs, and therefore mirror rotation is characterised by a colour change with a rotation.

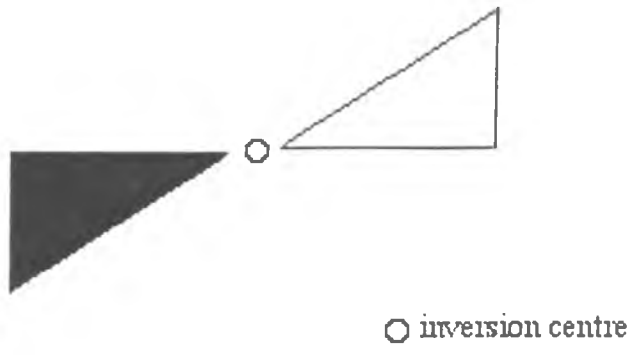


Figure 3.16 Mirror rotation

By the introduction of two colours into the seven primary one-dimensional (border) patterns, a total of seventeen two-colour one-dimensional patterns are producible[9] . The fundamental cells of the seventeen two-colour one-dimensional (border) patterns, produced when two-colours are systematically introduced into the seven primary one-dimensional (border) patterns, are shown in Figure 3.17.

To aid in the identification and classification a table has been produced listing the symmetry operation acting upon each of the seventeen classes of two-colour one-dimensional patterns. This is presented in Table 3.1.

[9] Schematic illustrations of the seventeen two-colour one-dimensional (border) patterns are available in "The application of the principles of symmetry to the synthesis of multi-coloured counterchange patterns", X.Lin, Ph.D thesis, Department of Textile Industries, University of Leeds, 1995.

Figure 3.17 Fundamental cells of the seventeen two-colour counterchange border patterns

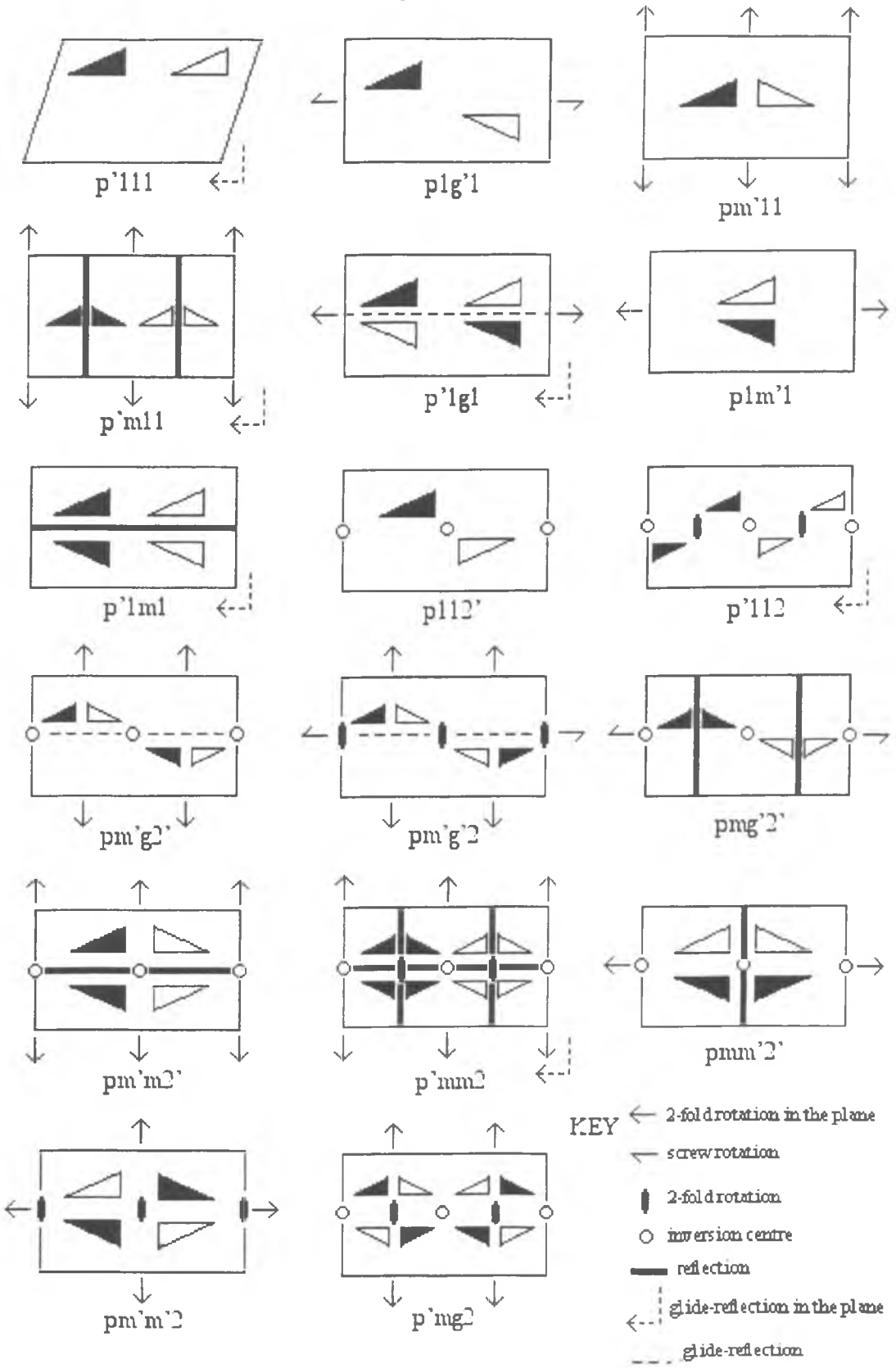


Table 3.1 Characteristics of the seventeen two-colour one-dimensional patterns

notation	action under which colour changed	action under which colour preserved
p'111	horizontal translation	
	glide-reflection in the plane	
p1g'1	glide-reflection (screw axis)	
pm'11	vertical reflection (2-fold rotation in the plane)	
p'm11	horizontal translation	vertical reflection
	2-fold rotation in the plane	
p'1g1	translation	glide-reflection
	glide-reflection in the plane	
	2-fold rotation in the plane	
p1m'1	horizontal reflection (2-fold rotation in the plane)	
p'1m1	translation	horizontal reflection
	glide-reflection in the plane	
p112'	2-fold rotation (inversion centre)	
p'112	translation	2-fold rotation
	glide-reflection in the plane	
	2-fold rotation (inversion centre)	
pm'g2'	2-fold rotation (inversion centre)	glide-reflection
	vertical reflection (2-fold rotation in the plane)	
pm'g'2	glide-reflection (screw axis)	2-fold rotation
	vertical reflection (2-fold rotation in the plane)	
pmg'2'	glide-reflection (screw axis)	vertical reflection
	2-fold rotation (inversion centre)	
pm'm2'	2-fold rotation (inversion centre)	horizontal reflection
	vertical reflection (2-fold rotation in the plane)	
p'mm2	translation	horizontal reflection
	2-fold rotation (inversion centre)	vertical reflection
	vertical reflection (2-fold rotation in the plane)	2-fold rotation
	glide-reflection in the plane	
pmm'2'	2-fold rotation (inversion centre)	vertical reflection
	horizontal reflection (2-fold rotation in the plane)	
pm'm'2	2-fold rotation in the plane	2-fold rotation
	vertical/horizontal reflection	
p'mg2	2-fold rotation (inversion centre)	vertical reflection
	vertical reflection (2-fold rotation in the plane)	2-fold rotation
	glide-reflection in the plane	
	translation	

3.9 Two-colour two-dimensional counterchange patterns

The introduction of colour counterchange to the seventeen primary all-over patterns

results in forty-six two-colour counterchange patterns[10] . Unit cells for each are presented in Figure 3.18. Table 3.2 can be used as an aid in the identification and classification of the patterns.

However in the case of counterchange patterns, there is no universally accepted notation for the forty-six two-colour all-over patterns, but the notation of Belov and Tarkhova [1964] is widely used, along with the adapted notation of Grunbaum and Shephard [1987], Loeb [1971], and Lockwood and Macmillan [1978]. Washburn and Crowe commented:

> "...one-colour notation is based on a primitive (or centred) cell of one of the
> five lattices which underlie all two-dimensional patterns. The two-colour notation is also based on this underlying lattice, but in a more complicated way." [Washburn and Crowe, 1988, p.70]

As with the notation for finite and one-dimensional patterns, a prime is attached to a symbol, indicating a change of colour. For example a glide reflection is referred to as g, but if with the glide-reflection there is a change of colour, the notation would be g'. Lockwood and Macmillan commented:

> "...if there is no change of colour with simple translation, the prefix is p or c (unprimed) and the alternation of colour is indicated in the remaining parts of the symbol." [Lockwood and Macmillan, 1978, p.65]

The main exception is in the case of translation. In addition the p also changes to p' but with the addition of a subscript of either b or c, to become p_c' or p_b'. p_c' is used when the translation makes a colour change along the edge of a primitive cell, or p_b' when the counterchange occurs along the edge of a centred cell. Washburn and Crowe commented:

> "As a general rule (not without several exceptions) a prime (') attached to a symbol indicates a colour change when the corresponding operation is performed. If a translation makes the colour change, the p

[10] Schematic illustrations of the forty-six two-colour two-dimensional (all-over) patterns are available in "The application of the principles of symmetry to the synthesis of multicoloured counterchange patterns", X.Lin, Ph D thesis, Department of Textile Industries, University of Leeds, 1995

of the symbol is changed to p_b', when the translation is along the edge of the primitive cell or to p_c' when the translation is along a diagonal of the primitive cell. (However when p is changed to p_b' or p_c' in this way, no other symbol has a prime attached). When all the mirror reflections in one direction reverse the colours then the corresponding m becomes m'; when all the glide-reflections in one direction reverse the colours then the corresponding g becomes g'." [Washburn and Crowe, 1988, p.70]

Figure 3.18 Fundamental cells of the forty-six two-colour all-over patterns

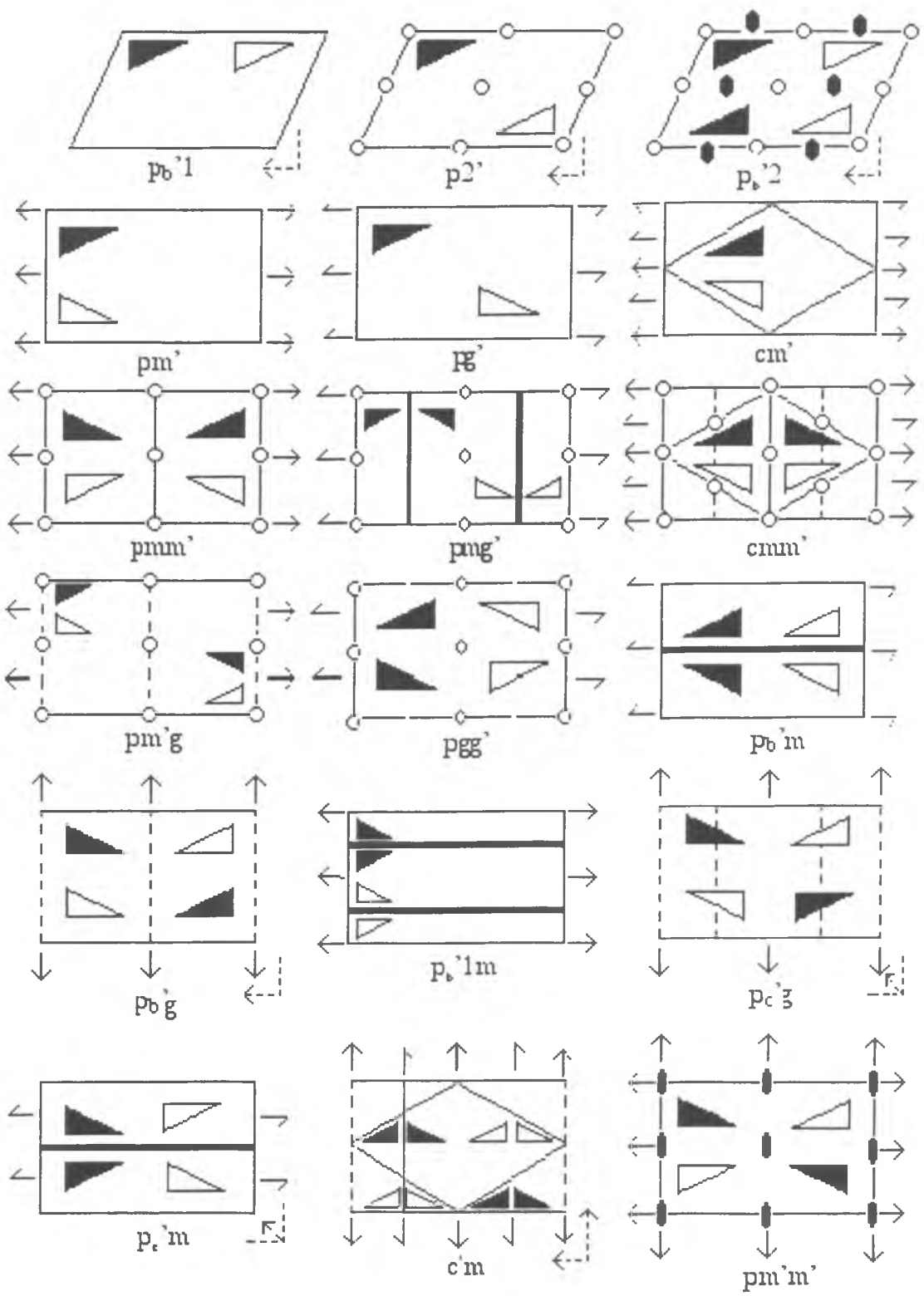


Figure 3.18 Fundamental cells of the forty-six two-colour all-over patterns (continued)

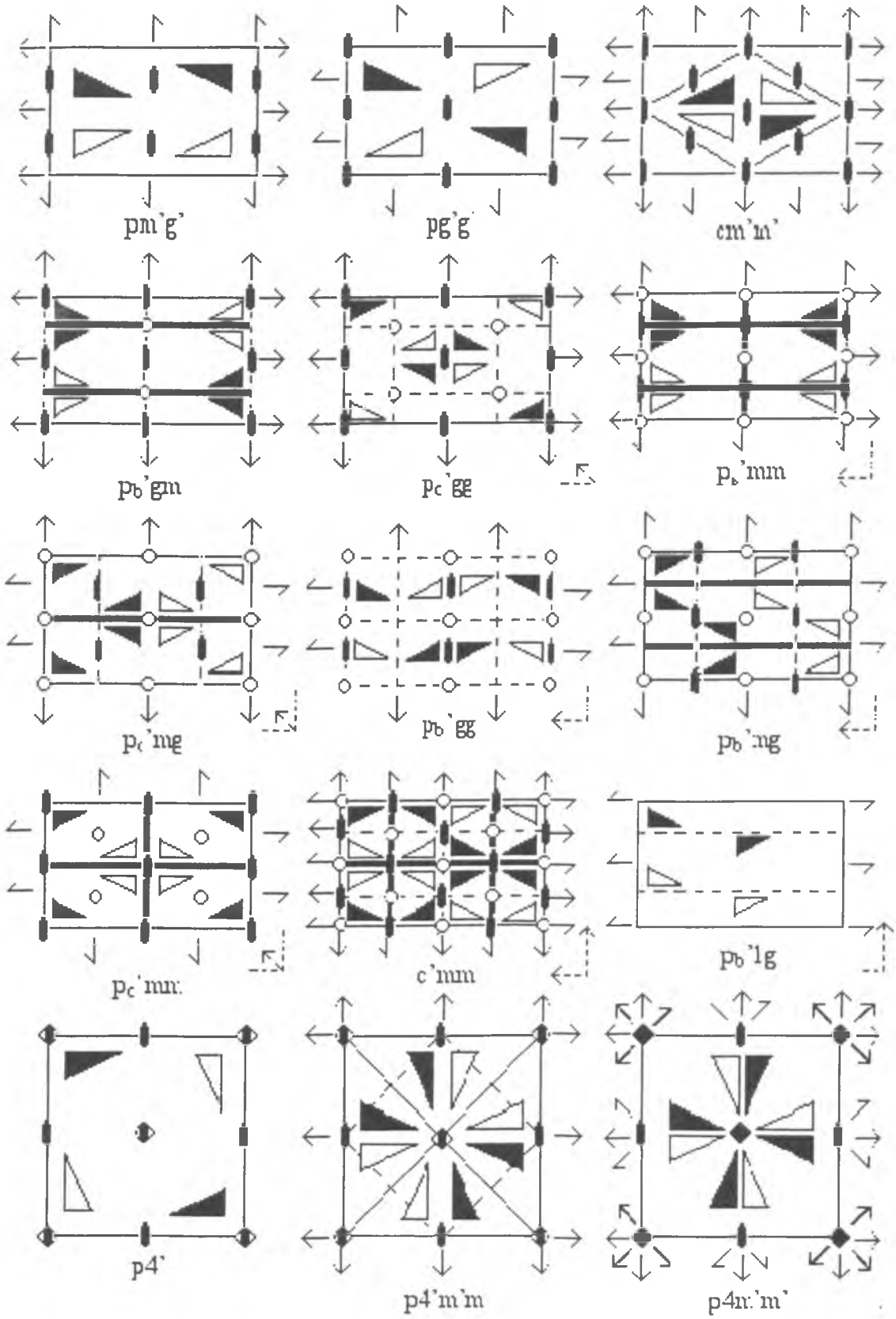


Figure 3.18 Fundamental cells of the forty-six two-colour all-over patterns (continued)

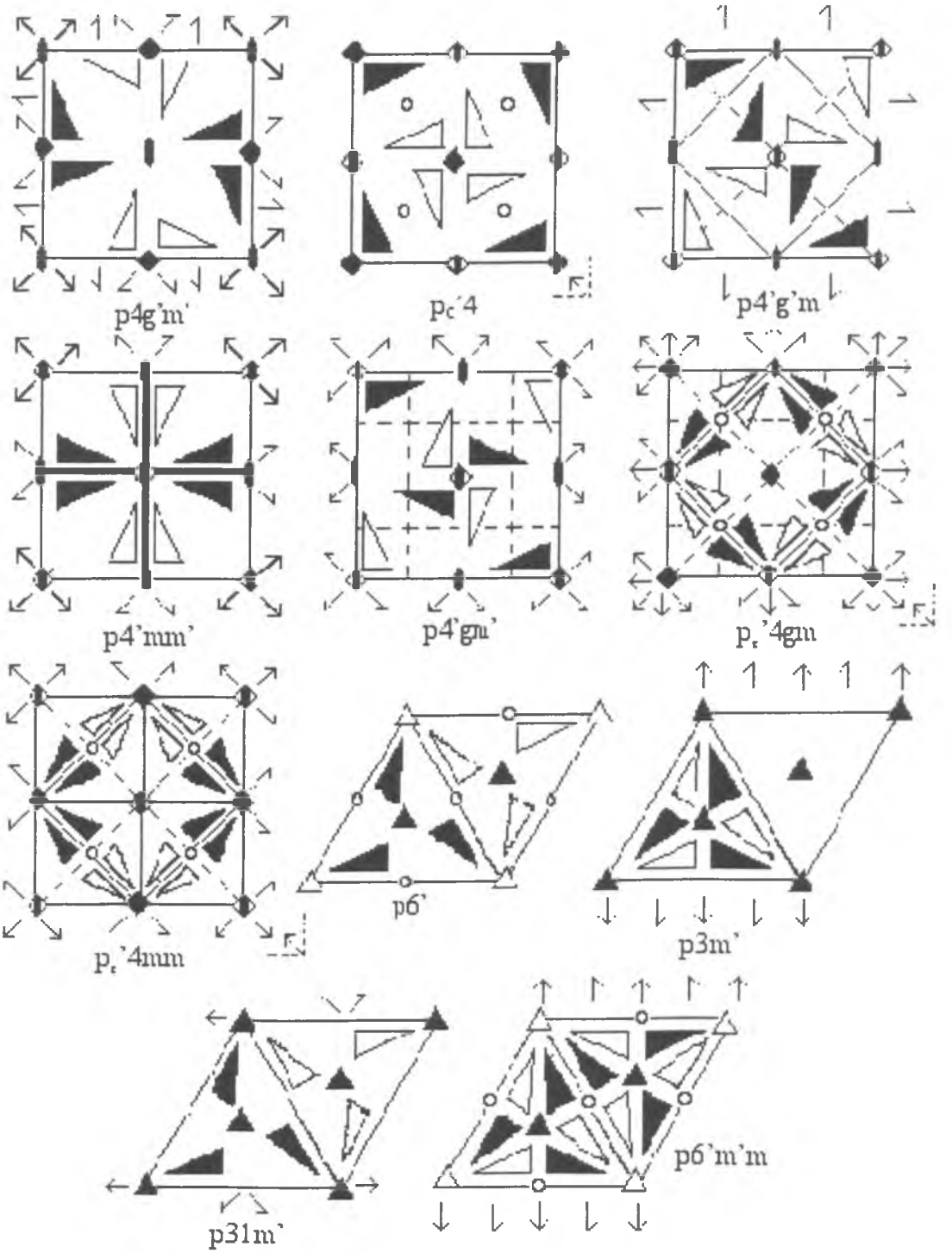
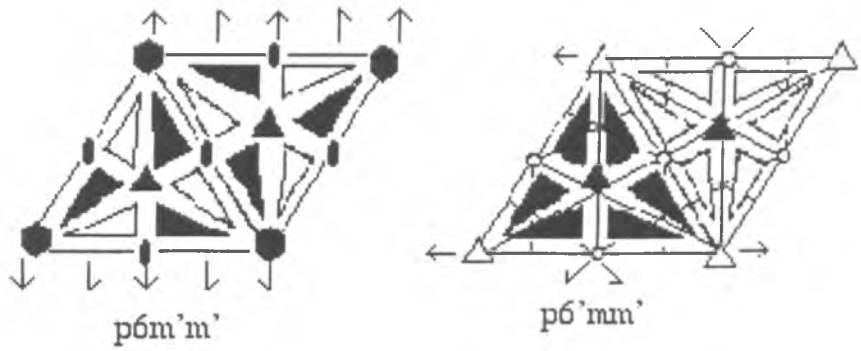


Figure 3.18 Fundamental cells of the forty-six two-colour all-over patterns (continued)



Often when counterchange is included in the all-over patterns, the introduction of colour, actually reduces the symmetries of the pattern that are present, and this is evident in the notation of the groups. Washburn and Crowe noted:

> "It sometimes happens that a pattern is coloured in such a way as to reduce the symmetries of the original pattern; that is' some of the symmetries of the original pattern are not consistent with the colouring." [Washburn and Crowe, 1988, p.76]

Having introduced two-colour counterchange patterns for finite motifs, one-dimensional and two-dimensional patterns, the section below focuses on the introduction of higher order colour counterchange.

3.10 Higher order colour counterchange patterns

Counterchange is not limited to two colours. In theory you can use an infinite number of colours to generate a pattern, providing it produces a perfectly coloured design, the symmetry operations acting on the design are followed, and the pattern coloured systematically.

Grunbaum and Shephard, further investigated higher denominated colour-counterchange, looking at one-. two-, three-, and four-colour counterchange. They stated,

"...in analogy to the seventeen classes of wallpaper groups, there are forty-six classes of colour-symmetry groups for two-coloured patterns. During the last few years it has been shown that there are twenty-three classes of colour groups for three colours, and that the corresponding numbers for four-, five- and six- colours are ninety-six, fourteen, and ninety." [Grunbaum, Shephard, et al., 1986, p.647]

Table 3.2 Table of the forty-six two-colour two-dimensional patterns

notation	action underwhich colour changed	action underwhich colour preserved
p'b1	translation	
	glide-reflection in the plane	
p2'	2-fold rotation (inversion centre)	
p'b2	translation	2-fold rotation
	2-fold rotation (inversion centre)	
	glide-reflection in the plane	
pm'	reflection (2-fold rotation in the plane)	
pg'	glide-reflection (screw axis)	
cm'	reflection (2-fold rotation in the plane)	
	glide-reflection (screw axis)	
pmm'	2-fold rotation (inversion centre)	vertical reflection
	horizontal reflection (2-fold rotation in the plane)	
pmg'	2-fold rotation (inversion centre)	vertical reflection
	glide-reflection (screw axis)	
pgg'	horizontal glide-reflection (screw axis)	vertical glide-reflection
	2-fold rotation (inversion centre)	
p'bm	translation	horizontal reflection
	glide-reflection (screw axis)	
p'bg	vertical reflection (2-fold rotation in the plane)	glide-reflection
	glide-reflection in the plane	
p'b1m	translation	horizontal reflection
	reflection (2-fold rotation in the plane)	
p'cg	glide-reflection in the plane	
	reflection (2-fold rotation in the plane)	
	glide-reflection (screw axis)	
p'cm	glide-reflection in the plane	horizontal reflection
	glide-reflection (screw axis)	
c'm	glide-reflection in the plane	
	reflection (2-fold rotation in the plane)	
	translation	
	glide-reflection (screw axis)	
pm'm'	vertical/horizontal reflection (2-fold rotation in the plane)	2-fold rotation
pm'g'	horizontal reflection (2-fold rotation in the plane)	2-fold rotation
	glide-reflection (screw axis)	
pg'g'	vertical/horizontal glide-reflection (screw axis)	2-fold rotation
cm'm'	vertical/horizontal reflection (2-fold rotation in the plane)	2-fold rotation
	vertical/horizontal glide-reflection (screw axis)	
p'bgm	2-fold rotation (inversion centre)	2-fold rotation
	vertical/horizontal reflection (2-fold rotation in the plane)	horizontal reflection

Table 3.2 Table of the forty-six two-colour two-dimensional patterns (continued)

notation	action underwhich colour changed	action underwhich colour preserved
p'cgg	glide-reflection in the plane	2-fold rotation
	2-fold rotation (inversion centre)	glide-reflection
	vertical/horizontal reflection (2-fold rotation in the plane)	
p'bmm	2-fold rotation (inversion centre)	2-fold rotation
	glide-reflection in the plane	vertical/horizontal glide-reflection
	vertical glide-reflection (screw axis)	
	horizontal reflection (2-fold rotation in the plane)	
p'cmg	2-fold rotation (inversion centre)	2-fold rotation
	horizontal glide-reflection (screw axis)	vertical glide-reflection
	vertical reflection (2-fold rotation in the plane)	
	glide-reflection in the plane	
p'bgg	2-fold rotation (inversion centre)	2-fold rotation
	glide-reflection in the plane	vertical/horizontal glide-reflection
	horizontal glide-reflection (screw axis)	
	vertical reflection (2-fold rotation in the plane)	
p'bmg	glide-reflection in the plane	vertical/horizontal reflection
	2-fold rotation (inversion centre)	2-fold rotation
	vertical/horizontal glide-reflection (screw axis)	
c'mm	glide-reflection in the plane	2-fold rotation
	2-fold rotation (inversion centre)	vertical/horizontal glide-reflection
	vertical/horizontal reflection (2-fold rotation in the plane)	vertical/horizontal reflection
	vertical/horizontal glide-reflection (screw axis)	
	translation	
cmm'	2-fold rotation (inversion centre)	vertical reflection
	horizontal reflection (2-fold rotation in the plane)	vertical glide-reflection
	horizontal glide-reflection (screw axis)	
pm'g	horizontal reflection (2-fold rotation in the plane)	vertical glide-reflection
	2-fold rotation (inversion centre)	
p4'	4-fold rotation (inversion centre)	2-fold rotation
p4'm'm	4-fold rotation (inversion centre)	2-fold rotation
	vertical/horizontal reflection (2-fold rotation in the plane)	diagonal glide-reflection
p4m'm'	diagonal glide-reflection (screw axis)	4-fold rotation
	vertical/horizontal reflection (2-fold rotation in the plane)	2-fold rotation
p4g'm'	vertical/horizontal glide-reflection (screw axis)	4-fold rotation
	diagonal glide-reflection (screw axis)	2-fold rotation
	diagonal reflection (2-fold reflection in the plane)	
p'c4	2-fold rotation (inversion centre)	4-fold rotation
	4-fold rotation (inversion centre)	2-fold rotation
	glide-reflection in the plane	

Table 3.2 Table of the forty-six two-colour two-dimensional patterns (continued)

notation	action underwhich colour changed	action underwhich colour preserved
p4'g'm	4-fold rotation (inversion centre)	diagonal glide-reflection
	vertical/horizontal glide-reflection (screw axis)	diagonal reflection
		2-fold rotation
p4'mm'	diagonal reflection (2-fold rotation in the plane)	2-fold rotation
	diagonal glide-reflection (screw axis)	vertical/horizontal reflection
p'c4gm	glide-reflection in the plane	diagonal reflection
	4-fold rotation (inversion centre)	vertical/horizontal glide-reflection
	2-fold rotation (inversion centre)	4-fold rotation
	vert/hori/diagonal reflection (2-fold rotation in the plane)	diagonal glide-reflection
	diagonal glide-reflection (screw axis)	
p'c4mm	glide-reflection in the plane	4-fold rotation
	4-fold rotation (inversion centre)	vertical/horizontal/diagonal reflection
	2-fold rotation (inversion centre)	
	diagonal reflection (2-fold rotation in the plane)	
	horizontal/vertical glide-reflection (screw axis)	
	diagonal glide-reflection (screw axis)	
p4'gm'	4-fold rotation (inversion centre)	2-fold rotation
	diagonal reflection (2-fold rotation in the plane)	vertical/horizontal glide-reflection
	horizontal glide-reflection (screw axis)	
p'b1g	glide-reflection in the plane	glide-reflection
	translation	
	horizontal glide-reflection (screw axis)	
p6'	3-fold rotation (inversion centre)	3-fold rotation
	2-fold rotation (inversion centre)	
p3m'	vertical/diagonal reflection (2-fold rotation in the plane)	3-fold rotation
	vertical/diagonal glide-reflection (screw axis)	
p31m'	diagonal reflection (2-fold rotation in the plane)	3-fold rotation
	diagonal glide-reflection (screw axis)	
p6'm'm	2-fold rotation (inversion centre)	3-fold rotation
	3-fold rotation (inversion centre)	horizontal/diagonal glide-reflection
	vertical/diagonal reflection (2-fold rotation in the plane)	
	diagonal glide-reflection (screw axis)	
p6'mm'	3-fold rotation (inversion centre)	3-fold rotation
	2-fold rotation (inversion centre)	vertical/diagonal reflection
	diagonal reflection (2-fold rotation in the plane)	vertical/diagonal glide-reflection
	diagonal glide-reflection (screw axis)	
p6m'm'	vertical/diagonal reflection (2-fold rotation in the plane)	6-fold rotation
	vertical/diagonal glide-reflection (screw axis)	3-fold rotation
		2-fold rotation

Systematically changing a greater number of colours yields the following all-over pattern possibilities: twenty-three classes using three colours, and ninety-six classes using four colours. Relevant tables were provided by Engel [1986]. When increasing the number of colours we still have to keep in mind the fact that the colours must be systematically changed in a continuous way with respect to the symmetry operations. Lin observed:

> "...colours must be systematically changed in a continuous way with respect to the relevant symmetry operations, and each symmetry operation must induce a permutation of the colours in the coloured pattern or tiling." [Lin, 1995, p.267]

When producing counterchange patterns using more than two colours, a definite colour changing sequence needs to be set, for example black changes to white, which then changes to red, before returning to black. There must always be order in the method of colour selection, this was recognised by Lockwood and Macmillan, when they noted,

> "If more that two colours are used they must be in a definite sequence, the steps of the sequence being associated with a symmetry movement of the pattern." [Lockwood and Macmillan, 1978, p.67]

3.11 Summary

The perspectives and concepts presented in this chapter are the essential setting for this research thesis.

In the first section of this chapter, the basic symmetry operations of translation, rotation, reflection, and glide-reflection were introduced. Different categories of designs were identified: finite figures, one-dimensional patterns, and two-dimensional patterns. The role played by Bravais lattices was acknowledged, and schematic illustrations of the unit cells were produced for all pattern classes. The concept of colour counterchange was introduced. Two colour finite figures, and

their notation were described, and relevant schematic illustrations provided. The introduction of two colours into the primary one-dimensional patterns was considered. Further symmetry operations associated with colour-counterchange were identified, these being two-fold rotation in the plane, mirror rotation, and screw rotation. Seventeen counterchange one-dimensional patterns were considered. A table to aid the recognition of these was presented. Unit cells were produced for the forty-six possible classes of two colour (counterchange) two-dimensional patterns. Again a table was produced to aid the identification of each class.

The concepts introduced above are applied to the classification of a range of patterns in the next chapter.

Chapter 4 Symmetry Classification of Surface Patterns on Representative Samples of Turkish and Persian Carpets

4.1 Introduction

It is widely accepted that a given culture preferentially adopts and utilises only certain geometrical groups within its traditional arts and crafts. Washburn and Crowe referred to this feature, when they stated:

> "...symmetry is a mathematical property which generates repeated patterns, as well as a feature used in the perception and categorisation of form. Studies to date have clearly and consistently shown that a given culture preferentially uses only certain of these structural transformations and how the consistencies and changes in such structural aspects of style directly relate to cultural consistencies and changes." [Washburn and Crowe, 1988, p.269]

With the above consideration in mind, the objectives of this chapter are:

(i) to apply the principles of symmetry to the classification of patterns from a representative selection of Persian and Turkish carpets;

(ii) to carry out a comparative analysis of the resultant data;

(iii) to address the validity of the hypothesis that pattern usage and in particular, its geometrical structure, is culturally sensitive.

4.2 Data collection and justification

For the purpose of this study, it was essential to identify the population, from which the sample would be taken. Dixon and Massey defined the population as: "Any set of individuals having some common observable characteristic..." [Dixon and Massey, 1985, p.39] For this research the populations are identified as Persian and Anatolian(Turkish) pile carpets. To enable a valid survey to be carried out, samples had to be selected. Dixon and Massey defined a sample as: "Any subset of a

population..." [Dixon and Massey, 1985, p.39] For the purpose of this study samples of 500 carpets of Persian origin, and 500 Turkish carpets were selected. It was believed that a selection of 500 Persian and 500 Turkish carpets would be deemed large enough to be representative from the sources available.

Data were sourced from a range of illustrative texts which have been referenced frequently by authoritative scholars, and were readily available. These were Bennett [1972, 1978, 1985], Campana [1969], Cecil-Edwards [1983], Eiland and Eiland III [1998], Gans-Ruedin [1971], Gantzhorn [1998], Harris [1977], Kendrick [1922], Middleton [1996], Milhofer [1976], Reed [1972], and Zipper and Fritzsche [1989]. Each of these sources provided illustrations of a broad cross-section of carpets. The sample of carpets to be analysed was determined by a random method. Dixon and Massey offered an explanation of random sampling, when they stated: "In a random sample every individual in the population has an equal and independent chance of being chosen for the sample." [Dixon and Massey, 1985, p.42]

For the actual collection of data, no carpet was selected twice; therefore a method of sampling without replacement was chosen. Dixon and Massey explained: "...if the next sample member is selected from a population that does not include previously selected members, the sampling is called sampling without replacement." [Dixon and Massey, 1985, p.42] This process of sampling enabled the analysis to have 1000 independent individuals, and therefore no cross-over or unnecessary bias. Bias occurs when a individual within a population is selected more frequently, or is more prone to selection. Referring to the occurrence of bias within random sampling, Dixon and Massey commented:

> "If a sample was desired but some individuals in the population are more likely to be chosen than others, the sample is said to be biased. It has been found that subjective methods of selecting individuals for a sample often lead to biased samples, apparently owing primarily to

> preferences of the person making the selections. To prevent bias, and to avoid the charge of bias even if the sample is not biased, some non subjective method of choosing a sample, such as random sampling should be employed." [Dixon and Massey, 1985, p.42]

Once the sample and population had been identified, symmetry classification of constituent patterns was undertaken. To facilitate pattern classification, reference was made to Tables 3.1 and 3.2. The results of the classification are presented below.

4.3 Results

The data resultant from the classification of patterns sourced from the 500 Persian and 500 Turkish carpets are presented in this section. In order to get a valid view of the symmetries, it was assumed in each relevant case that the pattern in the central field continued on to infinity in two directions, and was not limited by the borders that surround the central ground. The schematic structure of a typical oriental carpet is presented in Figure 4.1.

Where a carpet had a medallion present in the central field, a general overview of the symmetry was assumed, (ie. the pattern surrounding the medallion was assumed to continue). The medallion is often seen in Persian carpets and forms a focal point to the carpet, often the decoration within the medallion itself, is echoed in the central ground. Therefore an overall symmetry was assumed in such cases.

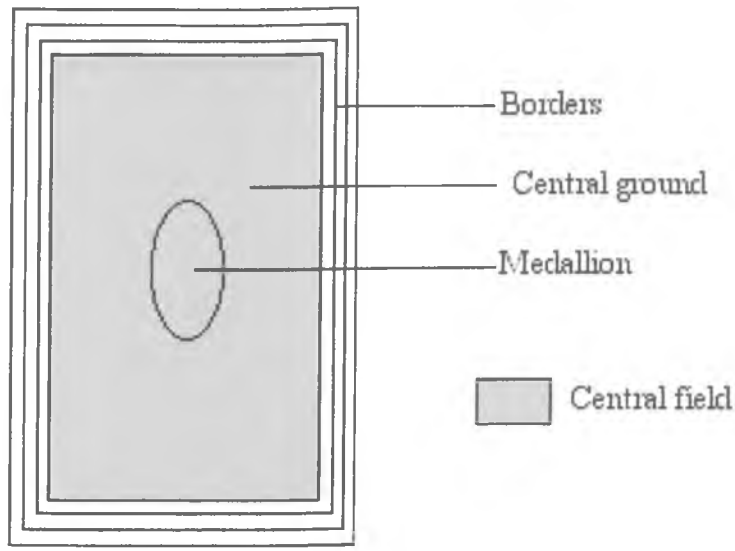


Figure 4 1 Structure of an oriental carpet

In the subsequent sections of this Chapter, a comparison is presented between the Persian and Turkish carpet samples, with respect to the number of borders, the geometrical classification of the borders, the central field classification, and finally the occurrences of colour-counterchange within the two samples.

4.3.1 Number of borders

Within this section the number of patterned borders in each carpet design is considered. During data collection, if the border was a single coloured, unpatterned guard stripe, it was omitted from the study, for the primary concern was with the geometrical pattern structure of the borders.

The number of borders is an important feature, for it is believed that Persian carpets are characterised by multiple borders surrounding the main field. Both Bennett [Bennett, 1978, p.12] and Cecil-Edwards used this belief as the basis on which to distinguish a genuine Persian carpet from carpets produced elsewhere. Cecil-Edwards noted,

> "We are so accustomed, for instance, to see borders in Persian carpets that we overlook the tenacity and immutability of the border convention...But no man has yet seen a Persian carpet without a border. For the Persians regard a border as a necessary framework to set off the ground pattern. Their designers would maintain that without it the attention is distracted from a steady contemplation of the main design." [Cecil-Edwards, 1975, p.36]

Bennett regards Persian and Turkish carpets as being the closest related in design structure. Early dated carpets from Persia and Turkey were very similar, but Bennett stated that as these cultures evolved, differences become apparent. Bennett stated,

> "In Timurid times, design in Persia closely resembled that in Turkey: predominantly geometrical patterns arranged in a universal repeat. However, towards the end of the 15th century, design gradually became more curvilinear and floral motifs began to appear..." [Bennett, 1978, p.11]

From the study of 500 Persian carpets and 500 Turkish carpets, the number of borders in each sample respectively were 2293, and 2270. From these data it can be seen that multiple borders play a significant role in the design structure of both styles of carpets. The average number of borders in Persian carpets was 4.586, compared to 4.54 in the Turkish sample (Appendix 4.1). Although both of these figures are similar, the standard deviation of the sample did vary. In the Persian sample the standard deviation of the sample was 1.46, and in the Turkish sample, 2.49 (Appendix 4.1). There is a greater variance in the distribution of the borders in the Turkish sample than in the Persian sample; this is illustrated in Figure 4.2.

Table 4.1 Number of borders within Persian carpet sample

Number of Borders	frequency	percentage %
1	16	3.2
2	10	2
3	176	35.2
4	70	14
5	103	20.6
6	31	6.2
7	52	10.4
8	20	4
9	7	1.4
10	5	1
11	9	1.8
12	1	0.2
	∑500	

Table 4.2 Number of borders within Turkish carpet sample

Number of Borders	frequency	percentage %
0	1	0.2
1	21	4.2
2	46	9.2
3	168	33.6
4	50	10
5	67	13.4
6	43	8.6
7	58	11.6
8	23	4.6
9	7	1.4
10	4	0.8
11	1	0.2
12	3	0.6
13	2	0.4
14	3	0.6
15	-	-
16	-	-
17	2	0.4
18	1	0.2
	∑500	

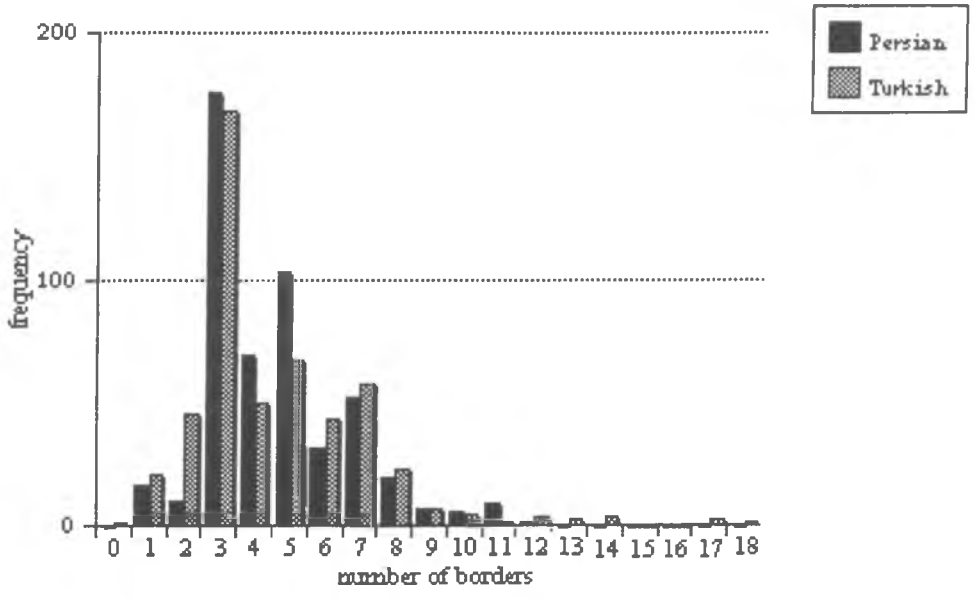


Figure 4.2 Graph showing frequency of borders in Persian and Turkish carpets

It is clearly seen from Figure 4.2, and Tables 4.1 and 4.2, that in the case of both Persian and Turkish carpets, there is a prevalence to the number of borders found within the design structure. In both cases the most frequent number of borders was 3; 35.2% of the Persian sample, and 33.6% of the Turkish sample fell within this category. No Persian carpets, and only 0.2% of the Turkish carpets had no borders, and only 3.2% of the Persian carpets and 4.2% of the Turkish carpets had a single border. This supports the view that the majority of both Persian and Turkish carpets have multiple borders surrounding their central fields. In the vast majority of cases borders form an integral part of the design structure.

Although there are variations between the two populations, in both cases the higher percentages are assigned to the odd number of borders, for example, 3, 5 and 7 borders, thus suggesting a preference for unevenly balanced designs.

The actual spread of borders does vary between the two groups, the Persian distribution fits into a spread of 1-12 borders, whereas the Turkish borders fit into a spread of 0-18 borders, indicating that the Turkish designs often had a higher number

of borders as a frame to the central fields[11] .

From examining Figure 4.2, both populations follow a similar distribution, possibly suggesting that the border usage is universal, and not culturally sensitive. To further test this theory, a randomness test* was carried out (Appendix 4.2 and 4.3). The Persian sample had a z value of -3.02, and the Turkish sample had a z value of -4.3, which when tested at a level of significance of 0.05, suggested that the data were not random for either sample. From examining these data it appears that the number of borders is not culturally selective, and that the design structure follows a set, conventional methodology of design.

4.3.2 Classification of borders

From the total sample of 1000 carpets, the total number of borders for the Persian sample was 2,293, and 2,270 for the Turkish sample. Each border pattern was classified into one of the seven primary classes of border patterns. Tables 4.3 and 4.4 shows the results, including the frequency, and the percentages generated from the data collected. Figure 4.3 shows these data pictorially.

*For a brief description of this z test, refer to Appendix 4.2.

[11] From the data, the Turkish carpets had a prevalence for higher numbers of multiple borders that the Persian carpets. This appears to contradict the views of Bennett [1972, 1978, 1985] and Cecil-Edwards [1983], as noted on p.75, stating that Persian carpets are characterised by multiple borders However Bennett further noted that Persian and Turkish carpets are close relations in design structure [Bennett, 1978, p.11]. Therefore the findings from the survey further reinforce the views of both Bennett and Cecil-Edwards, that borders are an integral feature of Persian, and also Turkish carpets.

Table 4.3 Classification of borders in Persian carpet sample

classification	frequency	percentage %
pmm2	267	11.6
pma2	432	18.8
pm11	701	30.6
p1m1	99	4.3
p1a1	223	9.7
p112	99	4.3
p111	408	17.9
unclear	61	2.7
inscription	3	0.1
plain	0	0
	∑2293	

Table 4.4 Classification of borders in Turkish carpet sample

classification	frequency	percentage %
pmm2	362	15.9
pma2	199	8.8
pm11	522	23
p1m1	230	10.1
p1a1	193	8.5
p112	403	17.8
p111	329	14.5
unclear	25	1.1
inscription	1	0.04
plain	6	0.3
	∑2270	

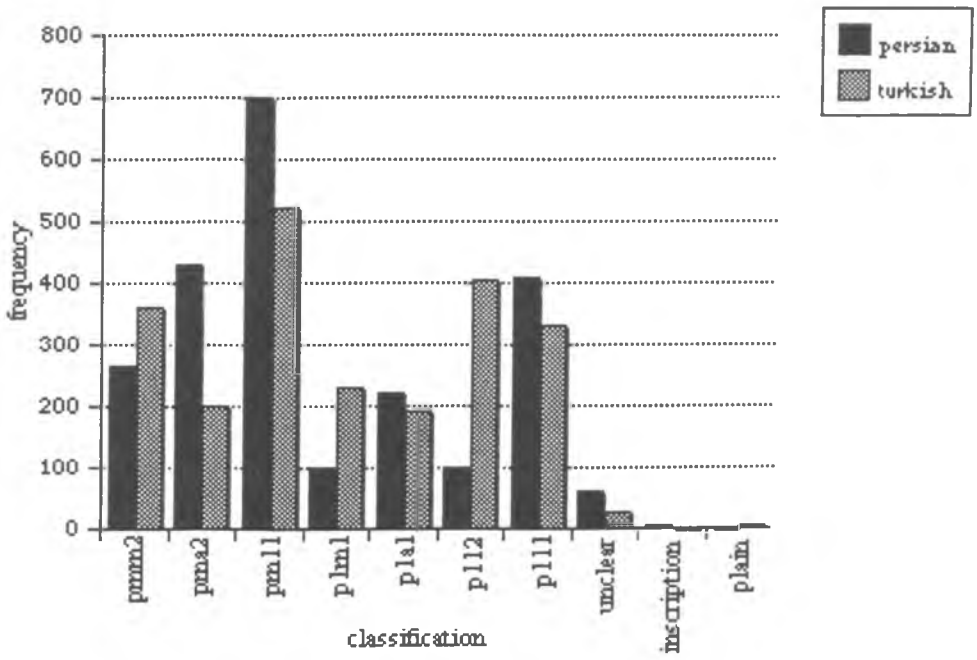


Figure 4.3 Graph showing the classification of Persian and Turkish carpet borders

The data indicate a preference for certain border pattern classes. In both populations all seven classes were present. The most prevalent border class used was pm11, which accounted for 30.5% of the Persian sample, and 23% of the Turkish borders classified. This classification occurs when there is a line of reflection, but no rotation or glide reflection.

It is widely accepted by many scholars, including those associated with the Gestalt school [Vernon, 1971], that vertical reflection is the easiest of all orientations to perceive. Washburn [1999] and Wagemans [1996] made reference to the ease of perception of vertical symmetry. It is assumed and accepted by psychologists that the perception of vertical symmetry is simple, and the easiest to identify and characterise due to its similarity with human orientation. The human body is orientated vertically, and therefore the brain compensates to keep the human body vertical. Even objects not orientated vertically are characterised against the vertical axis. Due to the constant management of the vertical orientation of the body, the

brain is educated to identify this axis, and therefore due to experience, vertical symmetry is the least complex symmetry to interpret and utilise. Wagemans stated: "...near-vertical and near-horizontal axes are better, probably because they are closest to the cardinal reference frame..." [Wagemans, 1996, p.44]

Wagemans [1990] as well as Palmer and Hemeway [1978], recognised that a crude overview occurs initially when viewing a shape, and the easiest symmetries are assigned, such as vertical and horizontal reflection. Later, with further examination, rotation and glide-reflection are assigned. It apparently takes longer and a greater developed perception system to detect rotational and multiple symmetries. He noted, the operation of a,

> "...dual-process model consisting of a selection-evaluation cycle. First a potential axis of symmetry would be selected by a rapid but crude analysis of symmetry in all orientations simultaneously. By establishing a perceptual frame for reference in the appropriate orientation, a detailed evaluation would then be performed by explicit comparison of the two pattern halves." [Wagemans, 1996, p.37]

In the Persian carpet borders the most popular classes were pm11, pma2 (18.8%), p111 (17.9%) and pmm2 (11.6%). The most popular Turkish border classes were pm11 (23%), p112 (17.8%), pmm2 (15.9%), and p111 (14.5%). Between the two sample populations there are certain important differences. For example the pma2 class, exhibiting translation, mirror reflection, glide-reflection, and two-fold rotation, was far more frequently used in Persian carpet design than in Turkish carpet design. The opposite was the case with class p112, which shows two-fold rotational properties; this class was far more popular in the Turkish carpet sample than in the Persian carpet sample.

Generally there does appear to be cultural selectiveness within the two populations towards the one-dimensional (border) patterns utilised. Certain classes were more frequently used in one population than the other. For example, class

p112 was used widely in Turkish carpet design, and infrequently in Persian carpets within the samples. A similar feature was noted with the utilisation of class p1m1, with preferential usage in Turkish carpet design. However the opposite was the case with the favoured usage of the class pma2 by Persian carpet designers. Preferential use of certain pattern classes can therefore be seen in each cultural context.

4.3.3 Classification of central field

Subsequent to classifying border patterns with respect to their symmetry characteristics, patterns in the central field of samples of Turkish and Persian carpets were classified. In each case the sample size was 500.

From the sample of 500 Persian carpets, a total of 502 patterns were classified; each carpet offered at least one pattern, and two carpets offered two patterns in their central fields. The relevant data are presented in Tables 4.5 and 4.6, and Figure 4.4.

Table 4.5 Classification of the central field - Persian carpets

classification	frequency	percentage %
cm	31	6.2
pm	80	15.9
pg	18	3.6
p1	45	9
pmm	136	27.1
cmm	12	2.4
pmg	20	4
pgg	1	0.2
p2	4	0.8
p4m	102	20.3
p4g	41	8.2
p4	11	2.2
p3m1	-	-
p31m	-	-
p3	-	-
p6m	-	-
p6	-	-
unclear	1	0.6
	∑502	

Table 4.6 Classification of the central field - Turkish carpets

classification	frequency	percentage %
cm	5	1
pm	198	39.6
pg	1	0.2
p1	29	5.8
pmm	124	24.8
cmm	2	0.4
pmg	2	0.4
pgg	-	-
p2	2	0.4
p4m	83	16.6
p4g	52	10.4
p4	2	0.4
p3m1	-	-
p31m	-	-
p3	-	-
p6m	-	-
p6	-	-
unclear	-	-
	∑500	

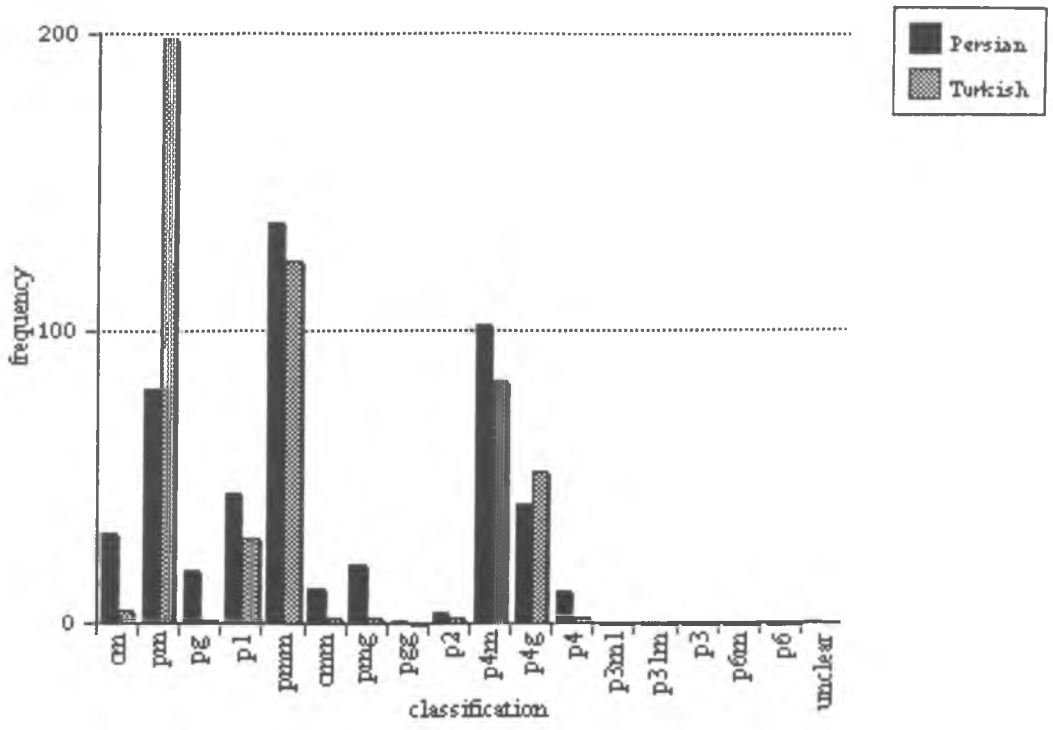


Figure 4.4 A graph showing the central field classification of Persian and Turkish carpets within the sample[12]

Referring to Figure 4.4, it is apparent that certain symmetry classes were prevalent in the central field patterns of the samples. Three symmetry classes appear to be utilised more frequently in the designs of the carpets, these being classes pm, pmm, and p4m.

Class pmm was the most frequently utilised in both samples, exhibiting a value of 27.1% with the Persian sample, and 24.8% with the Turkish sample. This is not surprising, as this class has both horizontal and vertical reflection axes present, and only two-fold rotation. It is particularly important that this class of pattern exhibits exactly the same appearance from opposite sides, often generating a feeling of visual harmony. Many of the carpets classified under this heading also had medallions present, which produce two-fold rotation, and automatically mirror-

[12] In addition to the seventeen classes of all-over designs for the central field, there was the utilisation also of an eighteenth class, for designs that were unclear. For example in the survey from the two samples only one Persian carpet fitted into this class. This was due to the fact that the carpet was represented poorly pictorially, and to assign a classification when the design was unclear would have been misrepresentative, and therefore the design was classified simply as unclear

reflection lines, and so generically fit into this classification. The dominance of class pmm (p2mm) conforms to a frequently cited view of scholars that Persian carpets are made of reflecting quadrants, and therefore naturally fit into this class.

From the survey it was evident that two other classes were featured widely in both the Persian and Turkish samples: classes p4m and pm. The first of these accounted for 20.3% of the Persian carpets, and 16.6% of the Turkish carpets. In the context of these Persian carpets, the carpet design was based around a medallion feature, that was again echoed in the pattern of the central field. The medallion carpets appeared more frequently to be of Persian origin. Many of the Turkish carpets that were assigned this class had geometric based tiling patterns, generating four-fold rotation and mirror axis, characteristic of this class.

A total of 15.9% of the Persian and 39.6% of the Turkish carpet designs were classified as class pm, which denoted the presence of a vertical reflection axis only. Many patterns naturally fit into this category, such as the Persian 'Tree of Life' carpets, and especially in the case of Turkish carpets, the prayer rugs, with the characteristic mihrab feature in the central field, which automatically generates an axis of mirror symmetry.

Within the Persian sample, twelve of the seventeen possible all-over pattern classes were represented. The five classes that were not represented were p31m, p3m1, p3, p6, and p6m. Of the seventeen possible classes, eleven were represented in the Turkish population sample; those classes not represented were pgg, p3m1, p31m, p3, p6m, and p6. The absence of the 3-fold and 6-fold rotational classes from both surveys can be explained by the nature of the carpets having a rectangular structure The 1-fold, 2-fold, and 4-fold, rotational groups naturally fit to the shape of the unit area. The carpets are also woven with the warp and weft at right angles, and therefore automatically fit into rotational groups that are divisible by this angle. Therefore the 1-, 2-, and 4-fold rotational patterns fit this right angled structure,

whilst the 3- and 6-fold rotational classes are not divisible by this factor. It can be seen therefore that the inherent characteristics of the construction technique inhibit the use of classes with 3-fold or 6-fold rotation. It is evident therefore that in oriental carpet designs from Persia and Turkey, all carpet designs can be classified under twelve of the seventeen classes only.

Generally it can be seen that the Turkish carpets are more geometrical and abstract in nature, and therefore fit certain classes, such as pm, pmm, p4m, and p4g naturally, due to the presence of reflection axes. Of the other classes available, although seven were utilised the percentages were relatively low, in comparison to these four main classes. In the case of the Persian carpets, the distribution appears a little more even across all twelve utilised groups. Generally the Persian carpets are far more naturalistic, utilising stylised natural forms, such as plants, when compared to the Turkish counterparts; this was recognised previously by Bennett [1978, p.11].

To confirm that the resultant distributions of symmetry classes were non-random, a chi-squared (x^2) test was performed on both sets of data[13]. This statistical test compared the observed frequency to the expected frequency (under conditions of randomness). For the results of the x^2-test the reader is directed to Appendix 4.4 and 4.5.

Chi-squared values of 918.78 with sixteen degrees of freedom, tested at a significance level of 0.05 for the Persian carpet sample; and 1553.33 with sixteen degrees of freedom, tested at a significance level of 0.0.5 for the Turkish carpet sample were attained. Both of the resultant values confirm beyond reasonable doubt that the distribution was non-random. From this test it is evident that a definite preference is expressed by both populations towards a small number of symmetry classes. This result further lends support to hypothesis (iii). It is clear in both the

[13] Further references to the chi-squared (x^2) test are available, and the reader is directed to the work of Hann [1991, p.105], Hann [1992, pp.579-590], Hayslett [1980, pp.168-180], and Freund [19881, pp.318-328].

cases of Persian and Turkish carpets, that pattern usage and in particular its geometrical structure, is culturally sensitive.

4.3.4 Presence of counterchange within the sample

This section examines the presence of colour counterchange in the carpet designs from each sample population. Both border patterns and central field patterns were considered. Relevant frequencies and percentages obtained are presented in Tables 4.7 and 4.8.

Table 4.7 Presence of counterchange in Persian carpet sample

presence of counterchange	frequency	percentage %
yes	193	38.6
no	307	61.4
	∑500	

Table 4.8 Presence of counterchange in Turkish carpet sample

presence of counterchange	frequency	percentage %
yes	166	33.2
no	334	66.8
	∑500	

From the data presented above, it can be seen that colour-counterchange was present within both samples. It was found that 38.6% of the Persian sample and 33.2% of the Turkish sample, exhibited some form of colour counterchange. From Tables 4.7 and 4.8, it is easily recognised that the occurrences of counterchange were significantly less than the non-occurrences. It appears that in the majority of the designs the original seven one-dimensional (border), and seventeen two-dimensional patterns are preferentially utilised within the design structures of the carpets.

Following on from the above results, an examination is made of the actual

occurrence of colour-counterchange, whether it be one-dimensional two-colour counterchange, or two-dimensional two-colour counterchange. Of the carpets actually found to exhibit counterchange at all, there were 347 examples of colour-counterchange within the Persian carpets, and 236 examples within the Turkish carpets. The resultant data are presented in Tables 4.9, and 4.10.

Table 4.9 Occurrences of counterchange in Persian carpet sample

type of counterchange	frequency	percentage %
border	336	96.8
all-over	11	3.2
	∑347	

Table 4.10 Occurrences of counterchange in Turkish carpet sample

type of counterchange	frequency	percentage %
border	226	96.4
all-over	10	3.6
	∑236	

Within both the Persian and Turkish carpet samples the majority of colour-counterchange occurrences were found in border designs. With similar values of 96.8% for the Persian sample, and 96.4% for the Turkish sample. Only 3.2% of the Persian and 3.6% of the Turkish occurrences of counterchange occurred within the central field. Therefore it can be seen that there is a heavy bias towards counterchange being used in the one-dimensional (border) patterns.

Within the next sections, the distribution and classification of colour-counterchange throughout the borders and all-over patterns is examined.

4.3.5 Classification of border counterchange

As shown previously (Chapter 3), a total of seventeen two-colour counterchange

border patterns can be produced. This section aims to investigate the incidence of colour counterchange in the samples of Persian and Turkish carpets. All of the border patterns within this section were first classified into primary classes and subsequently in terms of colour symmetry (or counterchange of colour). The findings can be seen in Tables 4.11 and 4.12, and Figure 4.5.

Table 4.11 Classification of border counterchange - Persian

classification	frequency	percentage %
pm'm2'	-	-
pmm'2'	-	-
p'mm2	36	10.7
p'ma2	-	-
pm'm'2	4	1.2
pma'2'	98	29.2
pm'a2'	9	2.7
pm'a'2	1	0.3
p'112	20	6
p112'	11	3.3
pm'11	1	0.3
p'm11	32	9.5
p'1m1	11	3.3
p'1a1	-	-
p1m'1	2	0.6
p1a'1	57	17
p'111	54	16.1
	∑336	

Table 4.12 Classification of border counterchange - Turkish

classification	frequency	percentage %
pm'm2'	1	0.4
pmm'2'	-	-
p'mm2	95	35.7
p'ma2	4	1.5
pm'm'2	23	8.6
pma'2'	21	7.9
pm'a2'	10	3.8
pm'a'2	3	1.1
p'112	52	19.5
p112'	2	0.8
pm'11	2	0.8
p'm11	17	6.4
p'1m1	14	5.3
p'1a1	5	1.9
p1m'1	-	-
p1a'1	1	0.4
p'111	16	6
	∑226	

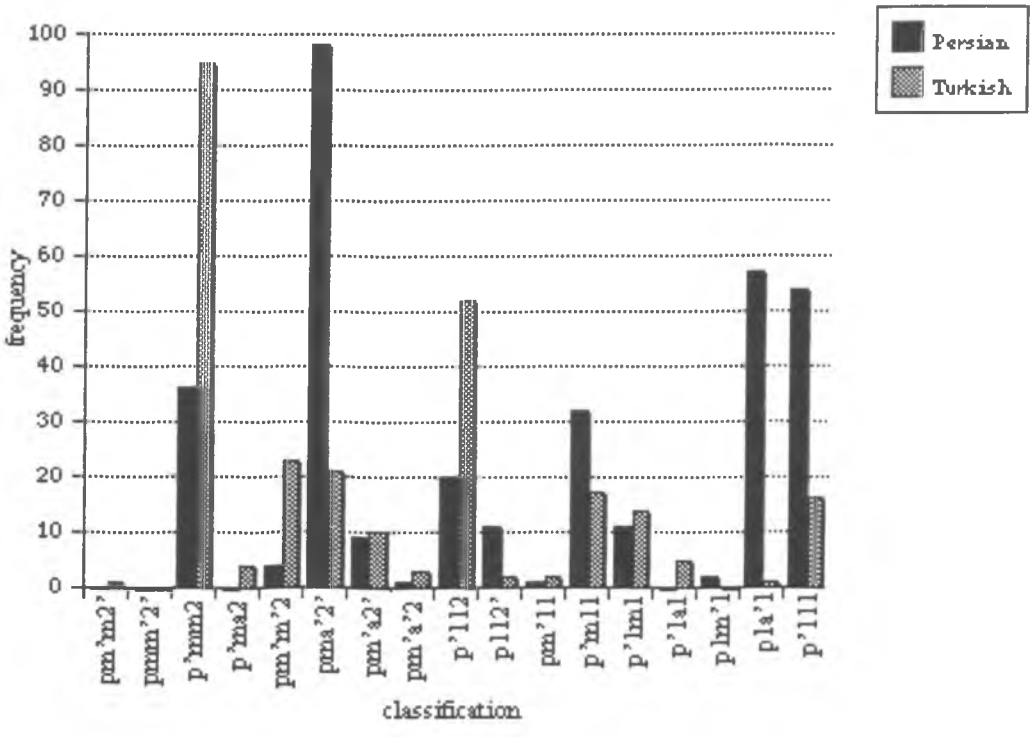


Figure 4.5 Graph showing the classification of colour counterchange within the borders

From referring to Tables 4.11 and 4.12, it can be seen that in the Persian sample thirteen of the seventeen possible border counterchange classes are present, and fifteen of the seventeen possible in the Turkish sample.

By far the most popular class within the Persian sample was the pma'2` with 29.2%, compared to only 7.9% of the Turkish sample. The most frequent class in the Turkish sample was p'mm2 with a value of 35.7% of the sample, whilst this class only accounted for 10.7% in the Persian sample.

Generally from examining Figure 4.5, it does appear that the counterchange classification within the two sample populations, does appear to be culturally sensitive. There appears to be prevalent classifications used within the Persian and Turkish carpets.

Only in four classes were the values for the two samples similar. These were: pm'a2; with values of 2.7% (Persian sample) and 3.8% (Turkish sample), pm`a'2; with values of 0.3% (Persian sample) and 1.1% (Turkish sample), pm'11; only 0.3% (Persian sample) and 0,8% (Turkish sample), and finally the p'1m1 class; with 3.3% (Persian sample) compared to 5.3% (Turkish sample).

In conclusion it can be seen that there is definite preferences within the two different cultures for certain one-dimensional (border) colour-counterchange classes.

4.3.6 Classification of central field counterchange (all-over)

The final section of this analytical study investigates the distribution of colour-counterchange in the central field patterns. As shown previously, only eleven occurrences of colour-counterchange were evident in the sample of Persian carpets, and ten occurrences in the case of the Turkish carpets, within the central fields. Therefore overall, this accounts for a very small percentage of the total survey.

As shown previously, the systematic change of two colours in the seventeen

primary all-over (two-dimensional) classes, generates forty-six two-colour counterchange pattern classes.

On classifying the central field designs in the two sample populations it was found that only seven of the forty-six two-colour counterchange classes were represented in the Persian sample, and only eight of the forty-six classifications in the Turkish sample. Relevant classes are therefore recorded in Tables 4.13, and 4.14, and Figure 4.6[14] .

Table 4.13 Classification of central field counterchange (all-over) - Persian

classification	frequency	percentage %
pm'a2'	1	9.1
p'bmm	3	27.3
p1a'1	1	9.1
p4'g'm	1	9.1
c'mm	1	9.1
c'm	3	27.3
pm'	1	9.1
	∑11	

Table 4.14 Classification of central field counterchange (all-over) - Turkish

classification	frequency	percentage %
p4'	1	10
pm'm'	2	20
p'c4gm	1	10
p'b1m	1	10
p4'gm'	1	10
p'bmm	1	10
p'c4mm	1	10
p'cmm	2	20
	∑10	

[14] For further reference to the forty-six two-colour two-dimensional counterchange classes, the reader is directed to Section 3.9, and the work of Washburn and Crowe [1988].

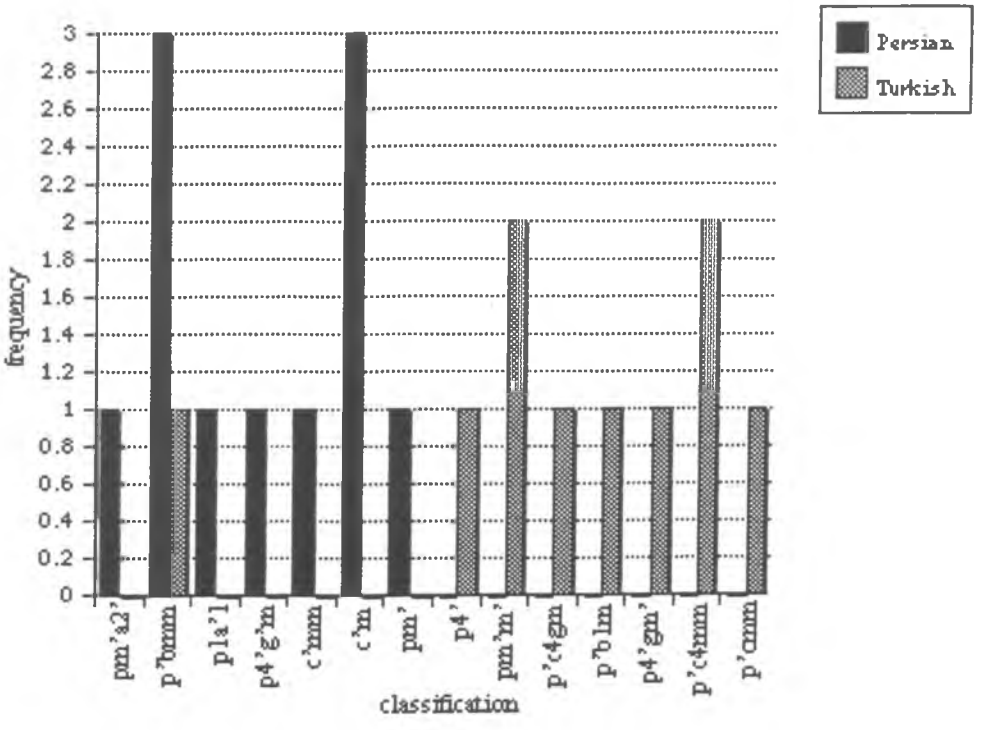


Figure 4.6 Graph showing the central field counterchange (all-over)

From Table 4.13, and Figure 4.6, it can be seen that only seven of the forty-six two-colour two-dimensional counterchange classes are present within the sample of 500 Persian carpets, and by referring to Figure 4.6, and Table 4.14, it can be seen that eight counterchange classes are present within the Turkish carpet sample. Only one class is utilised in both the Persian and Turkish carpet designs, that is the $p'_{b}mm$ class. All of the other classes are independently present by one or other of the two sample populations.

In the case of both samples two classes were used preferentially; for the Persian carpets it was $p'_{b}mm$ (27.3%), and c'm (27.3%), and in the case of the Turkish carpets it was pm'm' (20%), and $p'_{c}mm$ (20%).

For both the Persian and Turkish carpets, the other classes applied only had one occurrence. For the Persian carpets pm'a2', p1a'1, p4'g'm, c'mm and pm', each accounted for 9.1% of the occurrences. In the case of the Turkish designs p4',

p'_c4gm, p'_b1m, p4'gm', p'_bmm and p'_c4mm, each achieved 10% of the results.

It can be seen therefore that the two-colour two-dimensional (all-over) counterchange classes were rarely used in the production of Persian and Turkish carpet designs.

Due to the very small level of occurrences, it would be unrealistic to make an assumption on the cultural selectiveness of central field colour-counterchange. To increase the validity of such conclusions, a larger study would need to be undertaken.

4.4 Summary

A number of conclusions may be drawn from this study. Of the 1000 carpet sample, the most popular number of borders (the mode) within both the Persian and Turkish samples was 3; this was evident in 35.2% of the Persian carpets, and 33.6% of the Turkish carpets. Generally the tendency in both samples appeared to be towards an odd number of borders; for example 3, 5, and 7 borders were far more prevalent in the design structure, than even numbers of borders, such as 2, 4, or 6 borders.

It was evident in both Persian and Turkish carpets, that borders form an integral feature of the design structure, a view which concurs with the work of both Bennett [1978] and Cecil-Edwards [1975]. By carrying out a hypothesis test (Appendix 4.2 and 4.3), examining the cultural selectiveness of border frequency within the design structure, it was deduced that the number of borders was not a cultural indicator.

Of the possible seven primary one-dimensional (border) classes possible, all seven were represented in both the Persian and Turkish samples. The most popular border classes represented in the Persian sample were pm11 (30.5%), and pma2 (18.8%). The most frequently utilised in the 500 Turkish carpets were pm11 (23.0%), p112 (17.8%), and pmm2 (15.9%).

The popularity of the pm11 class, can be explained by considering the rules of perception, and work of associated scholars, such as those associated with the Gestalt school. Vertical symmetry is the simplest of all symmetries to identify, due to its similarity to the vertical orientation of the human body. Even if a motif is not orientated to the vertical, the mind rotates it back to the vertical, to aid interpretation. The pm11 class shows only vertical symmetry, and this was the most frequently utilised class in both sample populations.

From the viewpoint of pattern geometry, certain differences were evident in the Persian and Turkish carpet samples. The Turkish carpets appeared to utilise the rotational orientated classes more frequently such as pmm2, and p112, when compared to the Persian carpets that appeared to prefer the reflectional and glide-reflectional orientated classes such as pm11, p1a1 and pma2.

Of the seventeen two-dimensional (all-over) classes possible, twelve were represented in the sample of Persian carpets, and eleven in the sample of Turkish carpets. The classes originating from the 3- and 6-fold rotation groups were absent from both the Persian and Turkish samples.

The most popular two-dimensional classification in the case of the Persian carpets was class pmm (p2mm), which accounted for 27.1% of the Persian sample, and 24.8% of the Turkish sample. This class produces a design that has the same appearance when viewed from opposite directions. Many of the Persian carpets also have a medallion feature, and thus are divided into four reflecting quadrants, and due to the nature of the structure, and being designed within the confines of a rectangle, fit accurately into this class.

The most popular two-dimensional classification used in the Turkish carpets was class pm, which accounted for 39.6% of the sample. Class pm generates a reflectional axis, usually orientated vertically. Many of the Turkish carpets were prayer rugs, and so feature a mihrab or archway structure in the central field, and so

generate no rotational properties, simply a singular vertical reflectional axis, and so this class was prevalent in the sample studied.

The presence of colour counterchange, in 38.6% of the Persian sample, and 33.2% of the Turkish sample was noted. Within the sample the most prevalent form of colour counterchange, was that of border counterchange (one-dimensional colour-counterchange). In the Persian sample there were 336 occurrences equivalent to 96.8% of all counterchange occurrences, and 226 occurrences equivalent to 96.4% of counterchange occurrences in the Turkish sample of carpets.

The Persian and Turkish samples respectively yielded 13 and 15 of the possible 17 two-colour one-dimensional (border) pattern classes. The most popular colour-counterchange class in the Persian sample was class pma'2' with 29.2%, but this accounted for only 7.9% of the Turkish sample. The most popular Turkish counterchange class was p'mm2 with 35.7% of the sample. This class accounted for 10.7% of the Persian carpets. Generally it did appear that there was cultural selectiveness in the utilisation of one-dimensional colour counterchange classes. Certain classes were preferentially utilised by one of the two samples.

Of the total sample only 11 of the Persian carpets, and 10 of the Turkish carpets exhibited any two-dimensional (all-over) two-colour counterchange, equivalent to only 3.2% of all of the Persian counterchange occurrences, and 3.6% of the Turkish occurrences. Of the possible forty-six two-colour two-dimensional (all-over) counterchange classes, only seven classes were represented in the Persian sample, and eight classes in the Turkish sample.

The only class that was utilised by both samples was p'_bmm. Other central field counterchange classes were used independently by the two sample populations. This feature does suggest the presence of culture selectiveness in two-dimensional counterchange classes. However the actual percentage of the total sample for two-dimensional colour counterchange was so small, that it really was not influential. It

appears that central field counterchange was rarely used in the designs of Persian and Turkish carpets. To enable more valid conclusions to be drawn on the usage of two-dimensional colour-counterchange classes, a larger sample would need to be undertaken, to remove any doubt in the utilisation of these classes in the design of oriental carpets.

In conclusion it does appear that there are some significant differences in the design structure of the two samples of carpets, but there are also similarities. Bennett [1978] stated that Persian and Turkish carpets were the closest in relation, and this survey does appear to support this belief. To further elaborate on these findings a possible further study would need to be undertaken, possibly examining the symmetrical characteristics of another carpet group, with greater accepted differences, such as the carpets of the Caucasus.

Chapter 5 The Pazyryk Carpet

5.1 Introduction

The Pazyryk carpet was discovered during an archeological dig in the Altai mountains in Siberia (Figure 5.1). The Pazyryk kurgans or tombs were excavated on a number of occasions, in 1929 by M.P.Griaznov and S.I.Rudenko, and again by S.I.Rudenko from 1947 to 1949. This latter series of digs, which are the concern of this chapter, were the most fruitful of the two, and led to the discovery of the Pazyryk carpet.

The kurgans, which are believed to be datable to the fourth or fifth centuries B.C.E.[15] , contained the burial chambers of (it is assumed) family or tribal chieftains. Prokhorov stated,

> "Pazyryk kurgans, a group of large kurgans in the Pazyryk valley, on the right bank of the Bol'shoi Ulagan River, in the Ulagan Raion, Gorno-Altai Autonomous Oblast...The Pazyryk kurgans contain the graves of family or tribal chieftains and were constructed for the most part in the fifth and fourth centuries B.C., some researchers believe they were constructed later, in the third century B.C.. The kurgans were excavated by M.P.Griaznov and S.I.Rudenko in 1929, and by S.I.Rudenko from 1947 to 1949..." [Prokhorov, 1974, p.365]

With the above considerations in mind the objectives of this chapter are:

(i) to describe the context of the Pazyryk carpets discovery;

(ii) to focus on both the structural and symbolic aspects of its design;

(iii) to debate the carpets origin, and its intended end-use.

[15] The abbreviations B.C.E. (before the common era) and C.E (common era) will be used throughout this thesis, thus replacing B.C. and A.D. which have largely fallen into disuse in modern historical texts. Where appropriate, the older convention is retained in quotations from other texts.

5.2 The context of the carpet's discovery

Within the subsequent sections, the importance of the discovery of the Pazyryk carpet will be outlined, along with information relating to its miraculous survival. Archeological details will be presented to facilitate the understanding of its discovery.

5.2.1 The known chronology of carpet manufacture

The written history of the pile carpet was challenged dramatically following the discovery of the Pazyryk carpet in the late 1940s. Found to date to the fifth century B.C.E., it changed all existing views. The complexity of the Pazyryk carpet's design is testament to the antiquity of a highly developed pile carpet weaving industry, predating its production in the fifth century B.C.E.. Bauman commented:

> "The most dramatic archeological discovery in the field of carpet history was made in 1947 by Soviet archeologist Sergei I. Rudenko. While excavating the frozen burial mound of a Scythian prince in the Pazyryk valley amid the Altai mountains of Southern Siberia, Rudenko found a nearly complete carpet which, after more than two millennia encased in ice, is one of the oldest known pile-woven fabrics. The so-called Pazyryk Rug is datable to the fifth century B.C.." [Bauman, 1987, p.14]

Rudenko reinforced his views on the highly sophisticated nature of the carpet by examining the knot density:

> "...There are 3,600 knots per square decimetre. The whole carpet therefore contains in excess of 1,250,000 knots. An experienced central Asian or Asia Minor female carpet weaver can tie between 2,000 and 3,000 knots per day in a carpet as fine as this one. It would therefore have taken more than 18 months to produce such a piece of work..." [Rudenko, 1968, pp.41-55]

The history of carpet weaving underwent many developments during the last century. In the early twentieth century it was believed that the starting point of pile

carpet weaving was the sixteenth century, and that such carpets were of Persian origin. This belief was undermined in 1927 when Sir Aurel Stein discovered some pile fragments near Lou Lan in Chinese Turkestan. These fragments were dated to the second or third centuries C.E., nearly a millennium after the Pazyryk carpet was produced. In comparison with the Stein fragments, the Pazyryk carpet is much more substantial and also perfectly preserved. Bauman observed:

> "Prior to the discovery of the Pazyryk Rug, the earliest known carpet fragments were considered to have been made in the second or third century A.D.. These fragments were discovered by Sir Aurel Stein of the British Museum in 1927 near Lou Lan, Chinese Turkestan... Thus, the discovery of the Pazyryk Rug pushed back by several hundred years the known history of carpet weaving. Moreover, it is evident from the technical skill which went into the Pazyryk Rug that its manufacture had benefited from perhaps several centuries of carpet weaving tradition." [Bauman, 1987, p.14]

Recognising the advanced technical skill displayed by the Pazyryk carpet and, in addition, the complexity of the decoration (which incorporates human and animal figures as well as a range of geometrical elements) suggest that its production was part of a long-standing tradition with skills developed over several (or more) generations. This indication of a highly developed weaving skill was noted by Hubel,

> "Before the discovery of the finds at Pazyryk and Basadar the oldest examples of knotted carpets were a few modest fragments from eastern Turkestan... They all date from the fifth to sixth century and have a density of about 500 knots to the square dm.; it is assumed from them that the beginnings of knotting technique lay in the few centuries before the beginning of our era. The lucky chance of the preservation of the Pazyryk and Basadar finds has made it possible to put back this date by one or even two millennia; and the highly advanced technique presupposes a long period of development." [Hubel, 1970, p.19]

It can also be argued that for a skill base as developed as that evident in the Pazyryk carpet, circumstances of political, economic and social stability must have been prevalent. The carpet must have been produced within a settled community. Both Rudenko and Schurmann made reference to the population of the Altai region

being nomadic. Herodotus made reference to the Scythians, who were the resident population of the Altai, being non-agricultural but nomadic. He stated, "...the Scythians are not an agricultural people, but nomadic." [Herodotus, 1996, p.217] This brings into question whether a carpet of such advanced manufacture, design, and fineness could be produced by a non-settled population. This point will be discussed in more detail in Section 5.6, and 5.7.

Within this section the importance of the Pazyryk carpet in the known chronology of carpet manufacture has been established. Within the next section the context of its discovery is the focus.

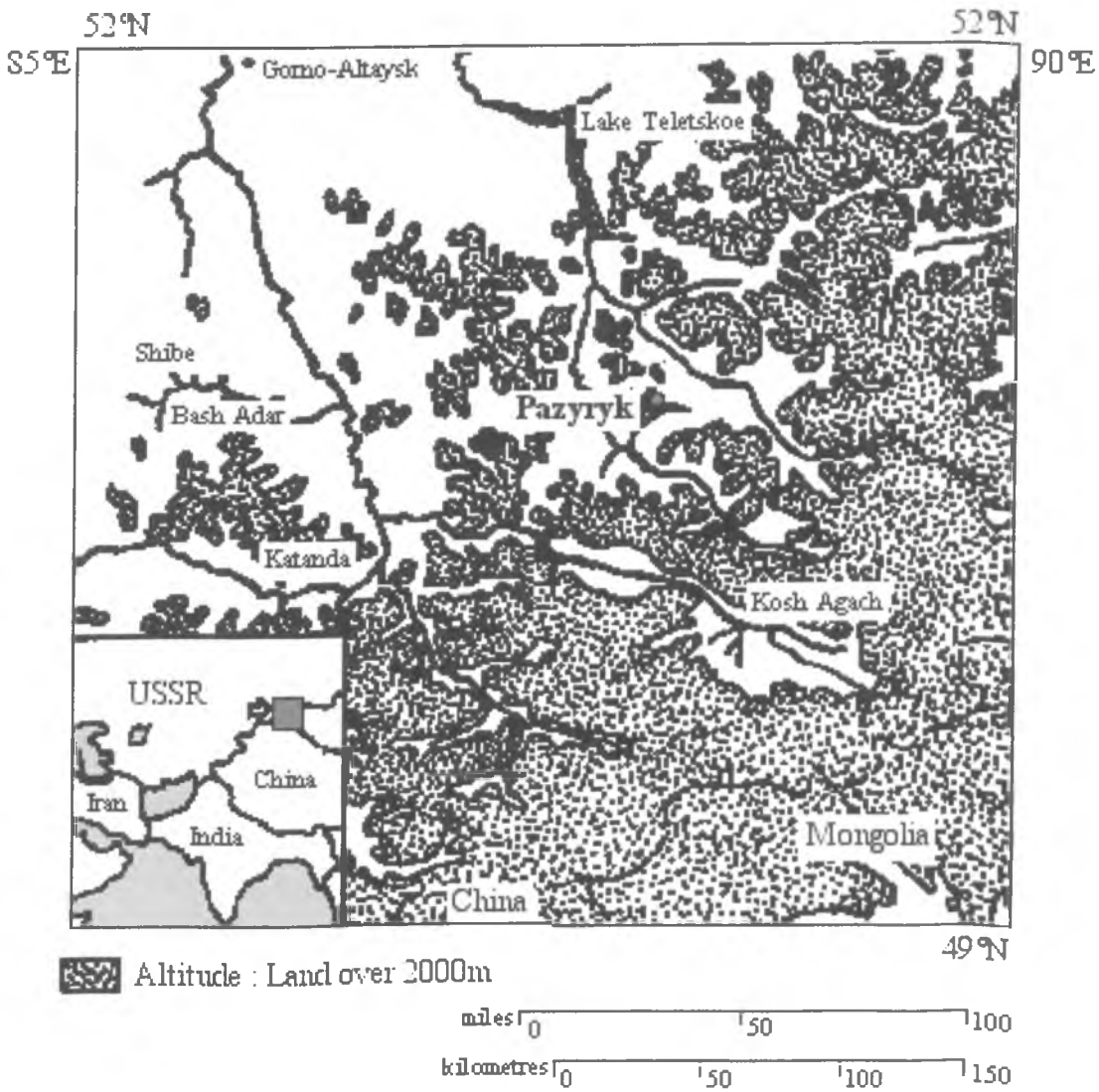
5.2.2 The kurgans of the Pazyryk valley, and their construction

A kurgan is basically a tomb or grave site. Hubel stated that, "Kurgans are mounds which may be 20 metres high and 250 metres in circumference raised over the graves of Scythian chieftains." [Hubel, 1970, p.14]. Prokhorov offered the following elaboration:

> "The Pazyryk kurgans contain the graves of family or tribal chieftains... The excavations uncovered rectangular pits up to 4m. deep, with areas of about 50sq.m., containing burial chambers (log framework) up to 2m. high. Each chamber had a floor, double walls, and a double ceiling and was covered with birch bark, shrubbery, and a layer of logs that extended to the edges of the pit. A mound of earth was raised upon the logs and then covered by stones." [Prokhorov, 1974, p.365]

Prokhorov detailed the construction of the barrows or kurgans in general, although in numerous kurgans there were substantial differences. For example in kurgan five (which is of relevance in the context of the Pazyryk carpet) birch bark was not used as a covering, which was the case in all of the other kurgans in the series. Differences such as these are noted in the description of kurgan five given later in this chapter.

Figure 5.1 Location of the Pazyryk valley



The Altai region had interested archeologists and anthropologists alike over a long period of time. Predating the work of Rudenko, the kurgans in the Pazyryk valley had already been investigated by Radloff in 1865, Gryaznov [Griaznov] (with Rudenko) in 1925 to 1929, and Shibe in 1927. It was the Rudenko led work in 1947 to 1949 which uncovered the contents of the remaining four main barrows in the area.

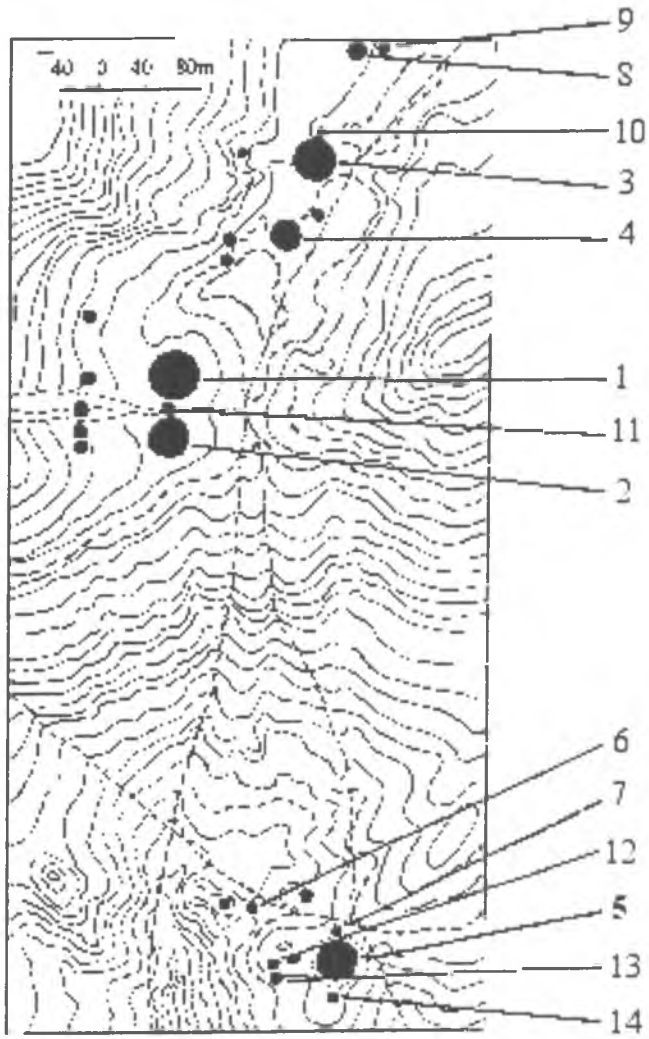
Thompson[16] , who translated Rudenko's work referred to the work of Radloff,

> "Frozen barrows had first been very summarily excavated in the Altai in 1865 by W.Radloff, and two more were dug by Gryaznov during the Hermitage expedition of 1925-9 to the Altai, Shibe (1927) and Pazyryk, number one (1929). No further work was carried out until 1947-9, when the other four large barrows at Pazyryk were excavated by Rudenko." [Rudenko, 1953, p.xviii]

Kurgan (or barrow) five is the concern of this chapter, for it was here that the Pazyryk carpet was discovered during the Rudenko-led expedition of 1947 to 1949. This kurgan lay to the south of the first excavation site in a small cluster of barrows. The distribution of the kurgans can be seen by referring to Figure 5.2. Barrow one was the first barrow uncovered in 1929. This formed a small cluster with kurgans two and eleven. Kurgans three, four, eight, nine, and ten, also lay in a small cluster roughly 280m. to the north-east of kurgan one. Kurgan five lay with kurgans six, seven, twelve, thirteen, and fourteen, roughly 500m. in a south-south-easterly direction from the primary site.

[16] Thompson translated the work of Rudenko [1953]. Thompson wrote a forward to the work, and it is from this section that this reference was taken.

Figure 5.2 Plan of the Pazyryk group of barrows

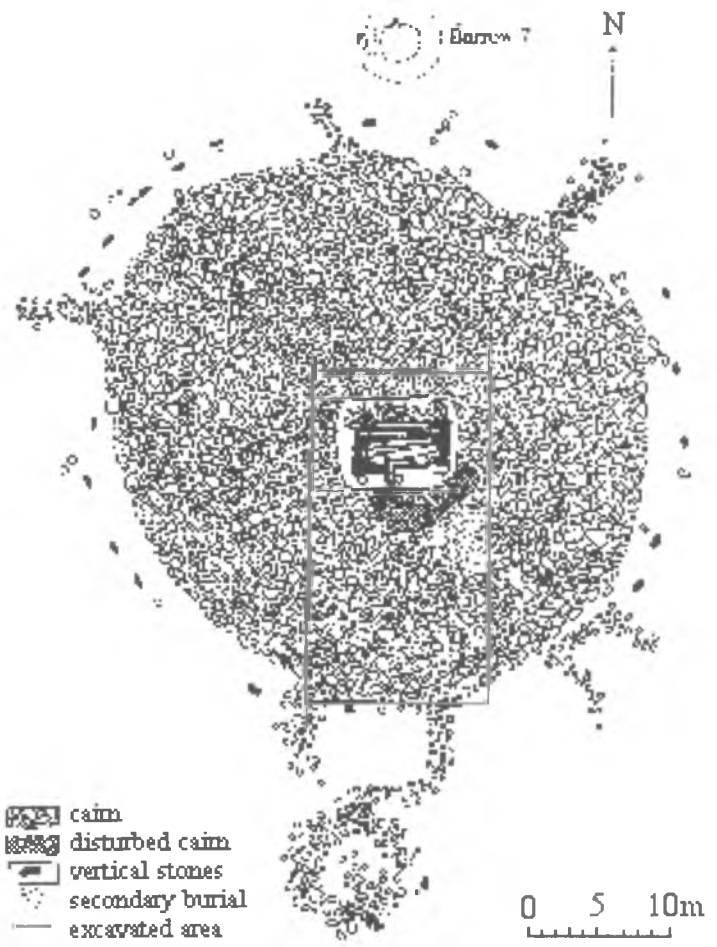


recreated from [Rudenko, 1953, p.4]

The different kurgans were uncovered in numerical order, kurgan one in 1929, number two in 1947-1948, the third and fourth in 1948, and finally kurgan five in 1949. [Rudenko, 1953, p.13] These were the five main burial sites. The others were

far smaller, and very little of archeological importance was yielded from these.

Figure 5.3 Plan of Pazyryk barrow 5



recreated from [Rudenko, 1953, p.51]

The construction of the five main kurgans (numbered one to five) follow roughly the same layout, and were comprised of a burial chamber at the bottom of a deep shaft. The burial chamber included a smaller box in a larger box built from logs.

The dead and various valuables were interred in the smaller box which formed the main burial chamber. In a separate side chamber, located in the north of the shaft was a horse burial chamber. After the interment the burial site was covered by further logs and earth, before a mound of rocks and stones were laid on the surface. In the case of the main kurgans, the mound of rocks measured 36 to 46 metres in diameter, (Figure 5.3). Rudenko described the structure of the kurgans:

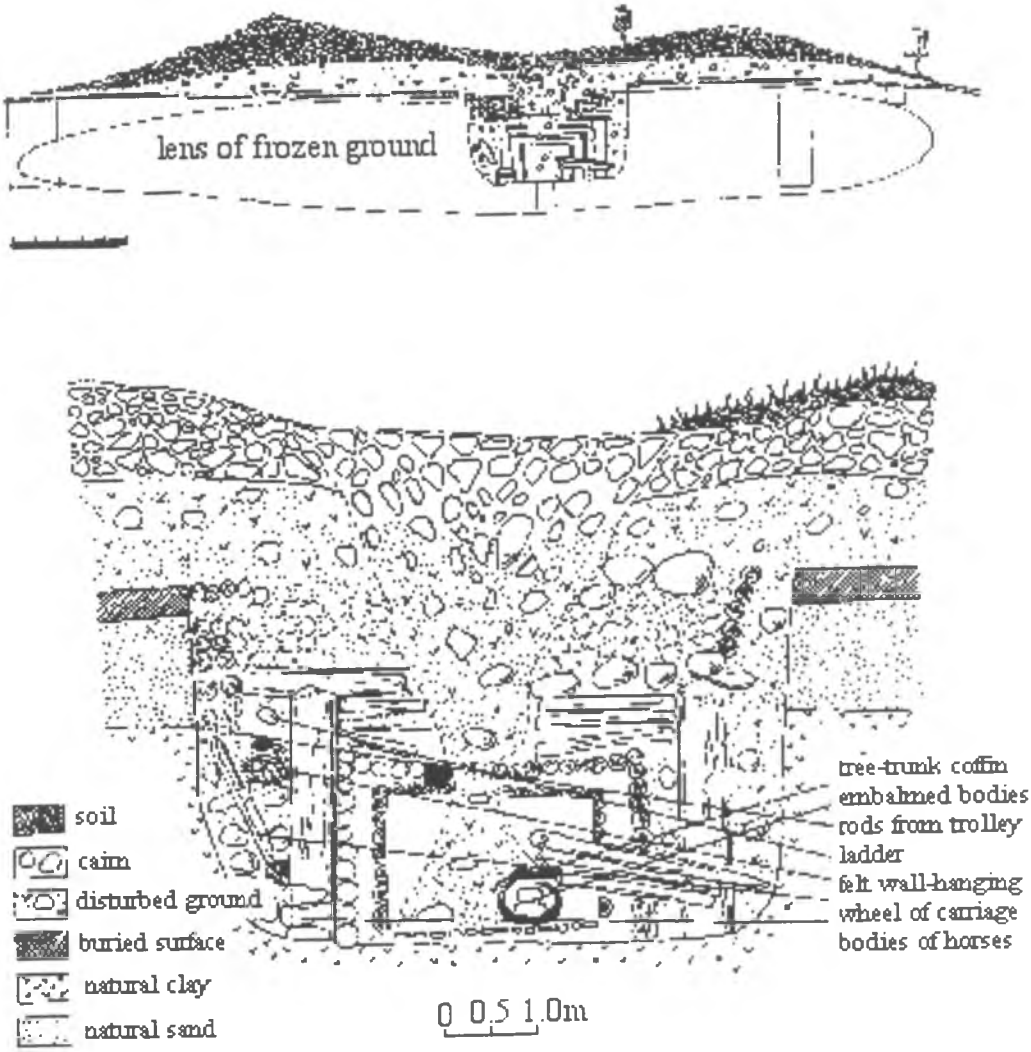
> "In all the large Pazyryk barrows at the bottom of the burial shaft (with an area of about 50sq.m...), at a depth of about 4m. there was a log chamber with a floor area of about 17sq.m., with a height of 1.8-2m.. The upper half of the tomb shaft was filled with layers of logs and substantial rocks. The tomb shaft was covered by a cupola-shaped earth mound varying from 0.9 to 2m. high at the centre, over which lay a cairn of stones 1.3-1.7m. high and 36-46m. in diameter..." [Rudenko, 1953, p.7]

Schurmann explained that, "The kurgans are usually divided into a main chamber where the dead are lying, and side chambers for the killed horses and carriages." [Schurmann, 1982, p.17]

Figures 5.4, 5.5 and 5.6 have been created from Rudenko's 1953 publication, and show the distribution of the artifacts within kurgan five. When describing the importance of the construction, in the preservation of the tomb, Rudenko noted that,

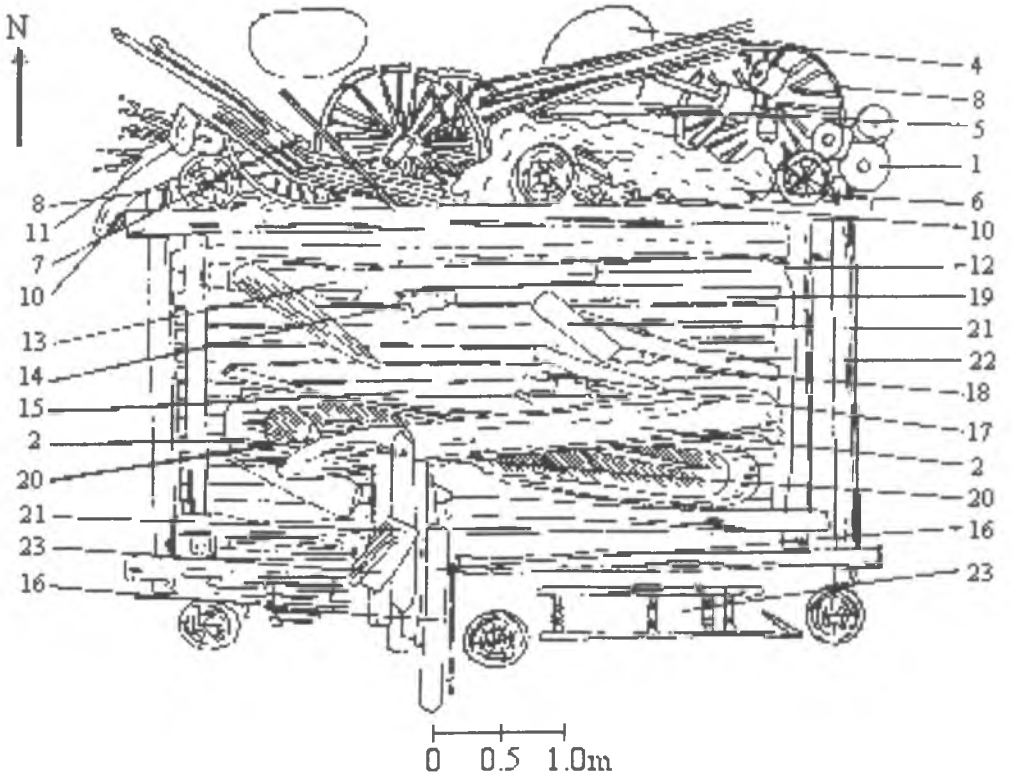
> "The burial chamber of barrow 5 was constructed on just the same plan as those of the first two but it was longer. The inner box, which was 1.4m. high, measured 2.3m. by 5.2m.; the outer box 3.4m. by 6.4m. and 1.9m. high. The floor consisted of thirteen planks of exactly the same thickness as in the first two barrows. the inner box had walls of eight members and a ceiling of thirteen logs, the outer box of ten and eighteen logs respectively. A distinctive feature of this chamber was that the inner box was constructed of tree logs dressed flat on the inside face. As in barrow 2 the space between the boxes in barrow 5 had not been filled up, leaving out of account a few objects put in there. On the other hand the space between the outer box and shaft wall had been filled up with pounded stone on the west and east sides entirely, and partially on the south side, which did not occur in the first two barrows." [Rudenko, 1953, p.19]

Figure 5.4 Section of barrow 5 and its burial shaft



recreated from [Rudenko, 1953, p.20]

Figure 5.5 Disposition of objects within barrow 5



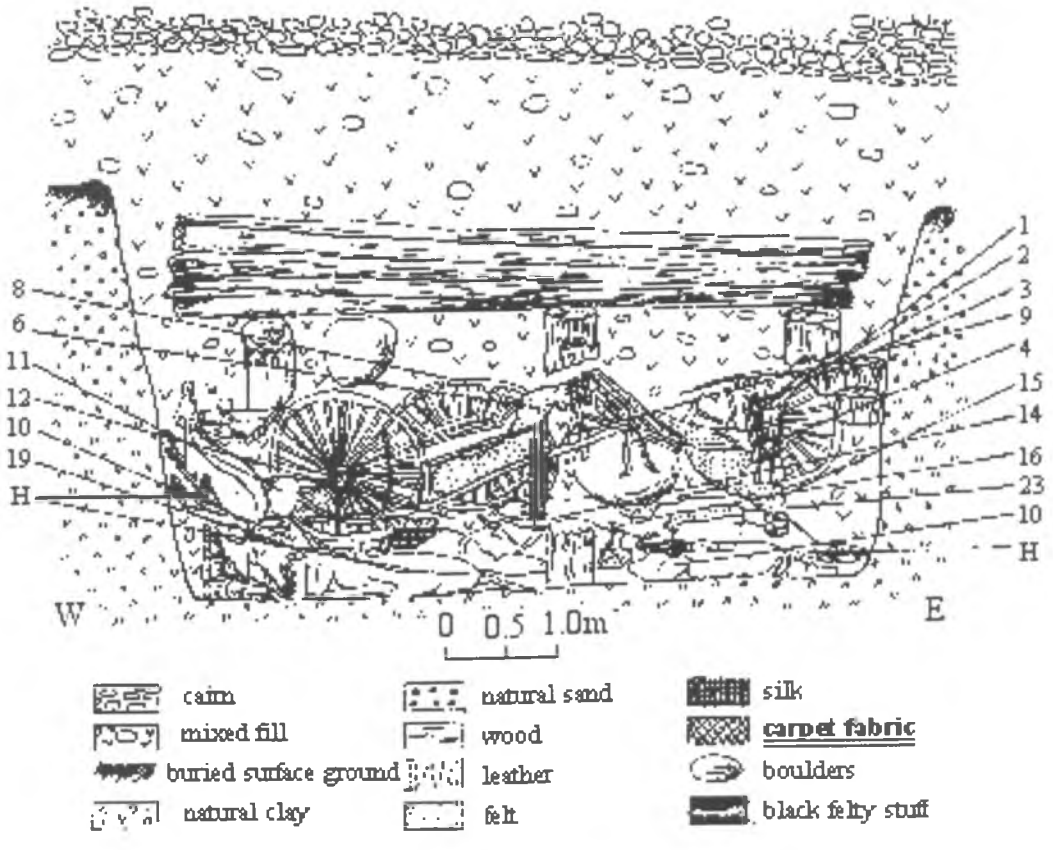
1, wheels of trolley
2, tree trunk coffin and lid
3, interred corpses
4, rods from trolleys
5, steps
6, large felt carpet
7-9, parts of carriage
10, horse bodies

11 pile carpet
12, shard of bottle
13, goats fleece
14, fleece
15, table legs
16, rods of hexapod
17, horn drum
18, felt cushion

19, horn vessel
20, female head-dress
21, boards with lashings
22, logs of chamber ceiling
23, pieces of carriage

recreated from [Rudenko, 1953, p.38]

Figure 5.6 Vertical disposition within horse chamber of barrow 5



1, trolley wheels
2, body of carriage
3, swans from carriage
4, black felt canopy
5, pieces of felt
6, felt carpet
7, sticks with spatualte ends
8, carriage wheels
9, pole of carriage
10, horse tails
11, **pile carpet**
12-23, saddle and bridle
H, horse bodies

recreated from [Rudenko, 1953, p.43]

Within this section the material construction of the burial site has been described. In the next section, the actual preservation of the tomb, and the facilitating environmental conditions will be detailed.

5.2.3 Preservation aided by environmental conditions

The Pazyryk kurgans had undergone a sequence of freezing, known and referred to as "barrow congelation", [Rudenko, 1953]. This environment preserved the contents from shortly after they were constructed around 500 B.C.E., until they were opened by Rudenko. Due to the degenerative nature of fibrous items, very few examples of early carpets existed and therefore the discovery of the Pazyryk carpet transformed documented textile history. The ice that had formed within the kurgan had held the carpet deep frozen, and formed a protective layer preventing the carpet from rotting away. The construction of the barrows with a double wall and broken rock, had aided refrigeration, and prevented heat from penetrating into the inner chamber.

Rudenko explained the frozen preservation of the contents in terms of two forms of barrow congelation. Firstly the formation of a layer of permafrost within the barrows due to the nature of their construction, and the surrounding climatic conditions experienced within the Altai valley. The location of the Altai valley can be seen by referring to Figure 5.1. The second form, which occurred shortly after the formation of the barrows, resulted from an in-fill of water into the tomb, which then froze due to the ambient low temperature. This second form of barrow congelation was believed to have occurred when the kurgans were plundered by grave robbers. Referring to barrow two, Rudenko made reference to the formation of the two types of ice present within the kurgans. Due to the fact that two different types of ice were present shows that the ice formed at two different times. Rudenko commented:

"Study of the ice filling the chamber in barrow 2 has given

> extraordinarily interesting results, and resolved the question. The ice in this tomb has been produced in two phases: in a phase at the original barrow congelation and in a phase after the plundering." [Rudenko, 1953, p.10]

Rudenko noted that two types of ice were distinguishable by both colour and nature, phase one ice was porous and translucent, believed to have formed through barrow congelation. The phase two ice had elongated bubbles, and was yellow in colour, and formed due to water running into the shaft after plundering. Therefore within the barrows there were two levels of freezing [Rudenko, 1953, p.10]. Of the barrows uncovered, barrows two, three, four, and five, all showed the presence of the two layers of ice. Each layer aided the preservation which included items recovered showing damage caused presumably by grave robbers. Damage included axe marks in coffins, possibly created when the plunders had to use force to open or move objects [Rudenko, 1953, p.11]. After plundering, the frozen tombs apparently remained in a state of equilibrium, without temperature fluctuations which would have encouraged decomposition.

The barrows of the Pazyryk valley all date to within a hundred years of each other and, according to Rudenko, were plundered at around the same time. Rudenko stated that,

> "The large barrows of the Pazyryk group... were not all of one date. The time between the construction of the first and last could have been a hundred years, but the plundering was all done at once. The identical method of gaining access to all the burial chambers, even down to small details, points to this." [Rudenko, 1953, p.11]

Hubel acknowledged the effect of the grave robbers upon the preservation of the tombs, but does not account for the congelation of the barrows. Hubel maintained that the action of the water preserved the contents, especially the textile pieces. He commented:

> "The good state of preservation of the textile, in spite of almost two

> and a half thousand years of age, is primarily due to grave robbers. Their activities, which may have taken place during the week-long festivities of the funeral, enabled water to seep into the interior of the tomb where it froze. The preservative layer of ice was so protected by the insulation of the stone slabs covering the kurgan that it never melted again, even in summer." [Hubel, 1970, p.14]

There appears to be strong evidence to confirm that the tombs were plundered, and that the creation of ice, following water seeping in, was instrumental in protecting the pieces. Hubel unlike Rudenko does not account for the two types of ice present. Hubel does not acknowledge the congelation of the barrows, and has simplified the preservation of the pieces. Congelation and post-freezing due to the robberies appears the more likely option due to the two different types of ice formation. Also the time elapsed from primary freezing and then the formation of the second layer of ice, must have taken significantly longer than the week suggested by Hubel, and therefore the account given by Rudenko seems the more likely.

5.2.4 Evidence of previous grave robbery

When uncovered it was discovered that all of the tombs had been disturbed, and all of the main barrows had been raided, with the majority of the contents removed. The only items that were left, were what had been dropped or considered unsuitable for removal. This was the belief of Rudenko:

> "The chambers of all the barrows (except number 2) had been almost entirely emptied. Clothing, decorated wall-hangings of the felt, household gear -even earthenware bottles- were removed... Where anything survived it was accidental, carelessly dropped or, as in barrow 2, was stuck in the ice of the first phase, if there had been no ice evidently nothing would have remained even there." [Rudenko, 1953, p.12]

Along with the main burial chamber, there was a separate horse burial

chamber. Each kurgan had horse bodies contained within it, horses appeared to feature greatly in the funeral rites of the tribes of the area, Herodotus made reference to the importance of the horse, when he stated that, "All sorts of cattle are offered in sacrifice, but most commonly horses." [Herodotus, 1996, p.234] This feature will be elaborated further in Section 5.7. In all except barrow number one, unlike the main burial chamber, the horse burial chamber had been entirely left untouched by the grave robbers. Within barrow one access had been made into the horse chamber, but then evidence showed little was touched. Rudenko believed that these chambers were untouched due to the fact that the bodies of the horses were far too difficult and heavy to manoeuvre by a small group, and because the items left were mainly items associated with the horses, such as saddlery, and therefore believed to be of little value to the robbers. It is also possible that this chamber may have been left untouched due to beliefs associated with the horses; this possibility is discussed later. The Pazyryk carpet was uncovered within the horse burial chamber and therefore left undiscovered. The diagram of the burials in barrow five, can be seen by referring to Figures 5.4, 5.5 and 5.6. Rudenko commented:

> "...the job of clearing the horse burial out was beyond the resources of a small gang, and for a big gang there was not room to work... In the second place it would be known to the thieves that they could count on finding nothing more valuable there than saddlery and a certain number of thin gold plates." [Rudenko, 1953, p.12]

5.2.5 Context of the carpets discovery and its importance

As noted previously, the Pazyryk carpet was discovered in 1949 by Sergei Ivanovich Rudenko in barrow number five of the archeological dig of the kurgans of the Pazyryk Valley in the High Altai; the location of Pazyryk can be seen by referring to Figure 5.1; the location of barrow five can be seen by referring to Figure 5.2.

The carpet itself was uncovered in the horse burial chamber. A plan of the

chamber, recreated from Rudenko's work can be seen in Figure 5.6. Rudenko catalogued this discovery as, "Pile carpet from Hither Asia." [Rudenko, 1953, p.326]. It should be noted that this was not the only example of a pile woven carpet discovered in the Pazyryk valley. Other pile fabrics were uncovered, and these included, "Strips of a woollen pile textile with whole loops" [Rudenko, 1953, p.317], which were uncovered in barrow two. What made the Pazyryk carpet special, was that it was an almost complete example of a highly developed patterned carpet, with cut pile. The fragments from barrow two had uncut loops, other small samples with cut loops forming the pile were only strips of fabric, not a complete piece. Other examples of textile pieces were discovered in numerous barrows, but were of a felt type, as in barrow two. Rudenko catalogued, "Pieces of patterned borders of felt carpets" [Rudenko, 1953, p.316]. The Pazyryk carpet of barrow number five was the only complete pile carpet discovered during the dig, and predated all previously catalogued examples.

Schurmann acknowledged the importance of the Pazyryk find, and also referred to the high level of craftsmanship that was exhibited by it. He believed that the skill of pile carpet weaving must already have been a highly developed one, and not just a chance discovery during the production of this one piece. Schurmann noted,

> "When it became known more than 20 years ago, that a rug was found in an ice grave in the Altai, where it had been buried for almost 2500 years, an edifice collapsed in the carpet world. It meant that the long cherished opinion, that the 16th century brought us the best of artistic carpet weaving, had to be discarded. Almost 2000 years earlier rugs were knotted that in fineness of weave and imagination of design were a culmination in themselves." [Schurmann, 1982, p.5]

Schurmann noted the importance of the Pazyryk findings, but assumed this was the only example of pre-sixteenth century C.E. pile carpet, making no reference to the findings of Stein, that had already been dated to the second and third centuries

C.E.

Schurmann made reference to the fact that the artistic level within the production of the carpet was high, and not an object created by chance. His view was that the carpet was a highly considered piece, with meaning behind all motifs. The symbolic aspects of the carpets design are discussed in Section 5.3. Schurmann acknowledged the fact that the craft of carpet weaving must have been developing for a significant period of time, to enable a carpet of such advanced design to be created. Schurmann stated,

> "It cannot be sufficiently emphasised that the Pazyryk rug was not an example of primitive carpet weaving. It was conceived neither by nomads nor by peasants. Rather it is a highly sophisticated work of art full of meaning and symbolism and, at that, perhaps not even the culmination point of a point. Surely many hundreds of years of development had passed before a rug of so outstanding a quality and conception of design could have been knotted." [Schurmann, 1982, p.6]

Schurmann relied heavily on the previous work of Rudenko, but never made any reference to the Stein fragments, detailed by Bauman [Bauman, 1987, p.14]. Very little literature is available detailing the Stein fragments.

Schurmann drew several valid conclusions, acknowledging that the Pazyryk carpet was "...conceived neither by nomads nor by peasants..." [Schurmann, 1982, p.6]. He believed that the carpet was probably produced by some settled community, possibly not of the Altai region; this point will be discussed in more detail, in Section 5.6. Schurmann acknowledged that the carpet was not a 'chance' piece, but produced from possibly hundreds of years of development of the skills. Schurmann stated, "Surely many hundreds of years of development had passed before a rug of so outstanding a quality and conception of design could have been knotted." [Schurmann, 1982, p.6] Although acknowledging that the craft of knotted pile manufacture must have been well developed, without examples predating the Pazyryk carpet the stages of pile carpet development cannot presently be

determined.

Within the next section, the actual design structure of the Pazyryk carpet will be analysed. Suggestions for motif representation and possible symbolism contained within it will be detailed, along with previously made conclusions from scholars within the field.

5.3 The design structure of the Pazyryk carpet

The carpet is illustrated in Figure 5.7, and further single illustrations of the constituent features of the carpet, are presented in Chapter 7. It is highly decorated and structurally advanced, and follows the Persian carpet rules[17] , with a central field surrounded by a number of borders of differing dimensions. The carpet is large, measuring 1.83 metres x 1.98 metres, and therefore is almost square in dimensions. The carpet has selvedge or warp ends present as a fringe at the top and bottom edges. Rudenko noticed the presence of this fringe, which was created when the carpet was removed from the loom. He noted also that the pile of the carpet must have been post-production cut to a length of 2.4mm, but subsequently it became flattened to only 2mm. He stated:

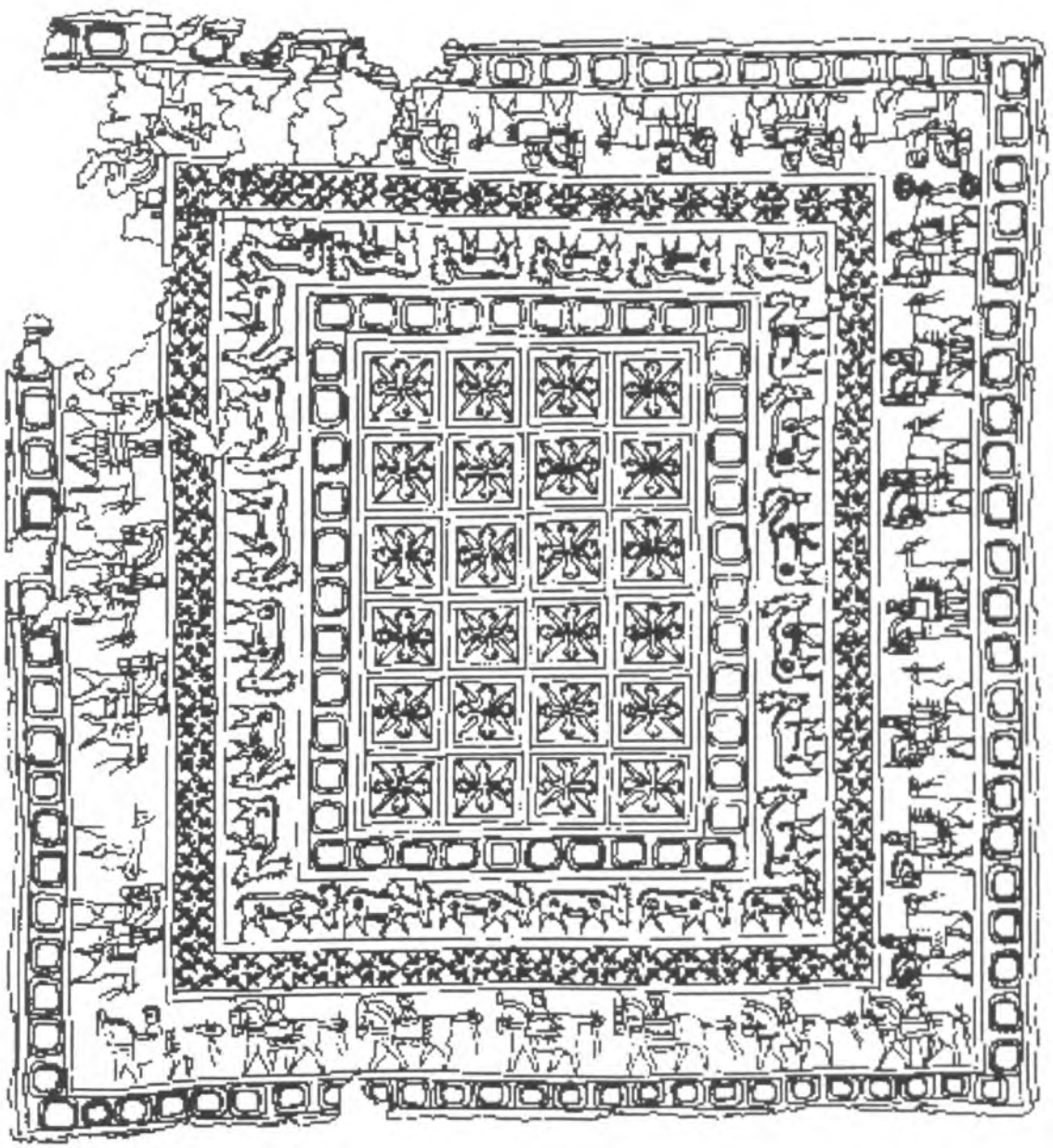
> "When the carpet was first removed from its loom, the threads of the warp were cut in such a way that tassels of 1-1.5cm. were produced. The ends of the tassels were not tied. When the carpet was cut, the final thickness was only 2.4mm. and when the pile was flattened the thickness was only 2mm." [Rudenko, 1968, pp.41-55]

Rudenko made reference to tassels, unfortunately this denotes the further manipulation of the yarns, which does not appear to have been the case when examining photographs of the Pazyryk carpet. The resultant warp ends from the carpet are generated from the weaving process, and therefore the term 'fringe' better

[17] It is believed by many scholars, including Bennett and Cecil-Edwards that Persian carpets are characterised by multiple borders surrounding their central fields. This was noted previously, and the reader is directed to Section 4.3.1.

describes them, as no subsequent manipulation of the warp ends appears to have taken place.

Figure 5.7 Design structure of the Pazyryk carpet



5.3.1 Borders of the Pazyryk carpet

There are eleven borders, although only five of these can be classed as being significant borders, the other six, appear to just be separating borders, consisting of alternating coloured blocks, changing from black to white, to red, to white, and back to the beginning of the sequence. In the first main border, there are medallion lozenges present, with again a border surrounding each of the medallions, the border is again constructed of alternating dots of black and white, and forms a frame to the main central field of the medallion; this border may possibly represent a pearl border typical of later Egyptian Coptic textiles. This suggestion is discussed in more detail later in this chapter.

Around the edges or main border there are 82 medallions present, although the number on the complete carpet would have been greater, but damage to the carpet has degraded the lower corner. All of these medallions follow the same pattern, with a border surrounding a central area, with decoration, around the left, bottom and right edges of the carpet. The medallions all appear to be of the same dimensions, but then in the top edge they appear to be smaller, and there is a greater concentration of lozenges in the top edge. In the top edge there are 25 medallions, in the right edge, 18 medallions, although some have been lost or damaged due to degradation, in the bottom edge, 19 medallions, and in the left edge, 21 medallions. It appears that the distribution of medallions from the right to the left would be about the same, as the medallions appear to be parallel to their counterparts on the opposite side.

5.3.1.1 Symbolism contained within the medallion border

Rudenko referred to the content of these medallions, and believed within each is a stylised representation of a griffin. He observed:

> "The central field of the carpet is framed by a row of repeated squares, each containing a griffin image. Their heads are turned back and a tongue shows in the open beaks. The wings and tails are also backward facing so that the images completely fill the squares." [Rudenko, 1968, pp.41-55]

There appears to be a consensus that the animal motif is indeed a griffin. Schurmann described the griffin as being eagle-like, a motif that appears at many other points in the Pazyryk kurgans. Schurmann stated,

> "The small, first, inner border consists of small squares in which eagle-like griffins appear on a yellow ground. The head of the griffin looks backwards and in the opened beak the tongue is visible, their body is red and the feathers of their wings are dark blue and white." [Schurmann, 1982, p.9]

Rudenko described the griffins as having either a lion's or tiger's body. This pointed to the image being typical of an Achaemenidian representation due to the stance, and the way the tongue protrudes from the open mouth. Rudenko commented:

> "The eagle-griffins are just as indictive. It is difficult to decide whether they have a lion's or tiger's body. The turned-back, large-eared griffin's head, with tongue stuck out of a half-opened mouth, the raised wing and curled-up tail, are all just characteristic. In this case there is a typical half-horseshoe on the griffin's crupper." [Rudenko, 1953, p.303]

Rudenko made further reference to the griffin and its origin, he stated that it was a Persian motif, which then dissociated into various forms, such as the lion-griffin of Achaemenian times, or a Babylonian winged lion with eagle's claws and body, and the eagle-griffin of Assyrian origin. The general consensus of opinion is that the griffins on the Pazyryk carpet are eagle-griffins and as observed by Rudenko, "Eagle-griffins with a lion's body are also an Assyrian motif." [Rudenko, 1953, p.257] He expanded:

> "The griffin is without any doubt a motif derived from Hither Asia, the horned lion-griffin being known only to Persian art. We may recall the capitals from Persepolis, the tile friezes in Susa and the cylinders

> showing a lion-griffin of Achaemenian times. The griffin is known to have been borrowed by the Persians from Assyria and Babylon, although the creature we see in the majority of cases at Pazyryk is especially Persian. Babylon knew a winged lion with long, pointed ears, eagles claw and tail; in Assyria an eagles head with a comb was substituted for a lions head. The Persians made use of both variants and gave the griffin new features, adding horns and sometimes replacing its short bird's tail with a scorpion's tail." [Rudenko, 1953, p.257]

This comment by Rudenko on variants brings into question, the validity of the image being a griffin. It is possible that the motif may be representative of a Semurv (Simurgh), Hippocampus, or that of a carnivore attacking a herbivore. These possibilities are discussed further below.

The Semurv was deemed important in the Avesta, a religious book associated closely with the Zoroastrians. The Zoroastrians were at a peak around the 5th century B.C.E., in Persia, thus corresponding in time to the production of the Pazyryk carpet. As with other major religions, Zoroastrianism is based on a dual system of good and evil. The motifs of a carnivore falling upon a herbivore featured widely within the kurgans, may be related back to the battle between good and evil, and linked to the Avesta. Hayward and Sparkes gave a further explanation of Zoroastrianism as follows:

> "Pertaining to Zoroaster or the religious system set forth by him and his followers in the Zend-Avesta, based on the dual principle of Ormuzd, the god of light and good, and Ahrman, the god of darkness and evil, the ancient Persian religion of the Magi and still held by the Parsees, sometimes called fire-worshippers." [Hayward, 1964, p.1297]

The image relating to a Semurv is noted by Rudenko, and he believed that this animal had a very strong protective function, and therefore featured widely in the kurgans. Rudenko noted:

> "Certain forms peculiar to the Scyths of the Black Sea and High Altai occupy a special position. These are the creatures that combine in themselves traits of several species of animal: the body of a feline

> carnivore, with deer or elk's antlers with griffin's heads on the tips of the tines; deer with eagles's beak, feline tail with a griffin's head terminal, or on antlers, or sometimes on the withers, and so on. A speciality of the Altai is the winged tiger, or leopard, again with a griffin's beak. They can probably be regarded as having a protective function;..." [Rudenko, 1953, p.289]

Often the motif of a carnivore, such as a lion, or tiger, is shown attacking a herbivore such as a deer, goat or ram, etc. This is believed to pertain to the battle between good and evil, typically highlighted in the principles governing Zoroastrianism. It is possible therefore that this is the image represented in the centre of the medallion. However generally it is stated by most scholars on this subject, that it is an eagle griffin represented. This dualistic battle was recognised by Rudenko,

> "It is possible that some of the dualistic ideas reached the Altai when the motif was adopted, but that by the time under discussion they had been considerably modified. Besides the attacks of griffins, eagle- and lion-griffins on deer, elk, mountain rams and goats, as well as fish seizing mountain rams, we also see struggles between an eagle-griffin and a lion-griffin, between two griffins and between a lion-griffin and a tiger." [Rudenko, 1953, p.289]

Around each of the medallions is a border containing black and white repeating dots; this is not unlike the pearl border featured widely around Persian textiles and art. A typical characteristic of early Persian design was to surround animal images with a frame of pearls, and this characteristic appears to have been exploited in the Pazyryk carpet. This feature is widely accepted to be a dominant theme in Sassanian textiles (224-624C.E.), but it is possible that this decorative element originated earlier in the Achaemenid dynasty, (557-330B.C.E.) of which the Pazyryk carpet is datable.

5.3.1.2 Presence of other motifs

In the bottom left-hand corner of this first main border, there are two circles present. Many scholars have regarded these circles as being used to fill in the space, possibly left as a fault in the design at weaving. Others believed that there is significant symbolism present. Schurmann regarded these two segregated circles as being representative of two wheels. They appear again later in the carpet contained within another border. Therefore they are believed to be a feature rather than a corrective method to a mis-spacing. The symbolism regarded by Schurmann will be discussed in Section 5.7.

Rudenko made reference to the presence of these features, Rudenko opposed Schurmanns view believing there to be no symbolism between the images. Rudenko believed the motifs were space-fillers used due to a miscalculation when the carpet was woven. Rudenko used this view to conclude that the carpet was not manufactured from a strict cartoon or plan, but was a more freely originated design. Rudenko stated,

> "However, as the carpet is not square, the horsemen in the vertical borders are shorter than those placed horizontally. Also, the makers of the carpet did not correctly calculate the size of the horsemen in one of the horizontal lines and as a result there is a larger space between the horses in one of the corners. This space has been filled with two rosettes. A similar gap is seen in the flower border, which has been filled with rows of triangles. From this, we can conclude that the carpet makers did not use a cartoon to copy the pattern." [Rudenko, 1968, pp.41-55]

Despite Rudenkos view, it seems unlikely that a carpet exhibiting such advanced control of space could possibly be executed without rigorous guidelines and a preset plan.

5.3.1.3 Horses and human figures

Within the next border are images of horses and riders. According to Schurmann symbolism can again be attached to these, although other scholars just regard the decoration for artistic requirements, with no hidden meaning. Around the border there are 27 horses and riders present. Each horse has what appears to be a saddle and a bridle, and a representation of what appears to be a braided tail. Each horse found within the kurgans of the Pazyryk valley also had a braided tail [Rudenko, 1953, p.119]. Within this border, on close inspection, all of the horses are of the same type, but the saddles have differences in decoration. Alternating around the border are horses being ridden, and horses being led by a rider stood to the side of the horse. Schurmann commented:

> "The widest border shows riders on horses alternating with horses that are led and both in the opposite direction to the bucks, that is to the right. All are massive stallions of greyish colour with bent necks, on their heads a tuft of feathers, and their tails knotted together by a thick band. Their bridles are shown in details." [Schurmann, 1982, p.12]

All of the horses have what is referred to as a saddle, although the description of a saddle would not elude to most modern saddles. The saddles that are featured appear to be some kind of textile, possibly that of a pile fabric or carpet, although this possibility will be discussed in more detail later. The saddles featured appear to be fringed blankets, with each having subtle differences to the next in the decoration contained. Schurmann referred to these 'saddles', "There are no saddles. Instead there are covers made of felt, with tapering fringes, in a variety of patterns based, in the main, on a stylised tree design." [Schurmann, 1982, p.12]

Rudenko also noted that all of the horses represented pictorially on the carpet do not have saddles as such, but appear to have sweat cloths or blankets, possibly pile carpets, or felt rugs, etc.. Rudenko believed them to be blankets rather than

saddles due to the missing feature of girth straps, characteristic of saddles. Another feature that points to the possibility of the blanket being a pile carpet is the presence of fringed edging, created possibly when the blanket was removed from the loom. Rudenko stated,

> "The saddles, as such, do not exist. Instead, on top of the sweat blanket, which is probably made of felt, there are small rugs, which also cover the breast. A small self coloured strip showing along the forward edge of the rug and also forming part of the breast covering indicates the existence of the sweat blanket. There is no saddle girth and the rug is held in place only by the sweat blanket to which it is probably firmly attached. The bottom and rear edges of the rug are fringed with festooned tassels. Apart from the main breast covering which tightly covers the horse, there is a loosely hanging, decorated breast weaving with central tassel, which is formed by an extension of the saddle rug. The rugs are all of the same type." [Rudenko, 1968, pp.41-55]

Of all the horses featured on the carpet, there appears to be three main types of decoration present. The first is that of a stylised tree, featured on many saddles, and may be representative of the tree of life. [Rudenko, 1953, p.303] The second design featured is that of a row of squares, which may be representative of a chequer board, as noted by Hubel, [Hubel, 1970, p.15]; this possibility will be discussed in more detail later in Section 5.4. The third main type of design is an S-shaped figure, and a rosette. Other remaining blankets have plain central ground. These features were recognised by Rudenko:

> "There are three variations of design on the central fields of these horse rugs.
> Var. 1-Schematic tree design: there are either two such designs on the right and left sides of the rug or one, which travelled horizontally across the rug. From this design we can assume that these rugs were made specifically for the horses rather than being cut from a larger piece.
> Var. 2-A row of small squares.
> Var. 3- An S-shaped figure accompanied by a rosette.
> There are also some rugs with a plain central field.
> A line containing a row of squares surrounds the central fields of these rugs. There is a border, also with a row of squares, which is fringed

> with the above-mentioned tassels. Although these rugs are the same basic type, there is a huge variation of colouring in the main fields as well as the ornamental details and tassels." [Rudenko, 1968, pp.41-55]

Each of the horses is depicted with a human figure. In some cases the figure is mounted on the horse, and in others it is stood to the side of the horse as if leading the horse. Each rider has a head dress on: this is referred to as a *"Bashlık'* [Schurmann, 1982, p.12]. This type of head-dress is not catalogued as one of the finds of the kurgans themselves, and the only relevant references made are to "Part of a man's pointed felt cap" [Rudenko, 1953, p.317]. This suggests that the people featured on the carpet, are not wearing the native costume of the people interred within the kurgans, possibly suggesting that the carpet was either a gift from a tribe of another area or was a result of trade.

Schurmann made detailed reference to the costume worn by the human figures associated with the horses, he noted differences between the colours of the trousers. Some of the people seated upon the horses have blue trousers, others have pale coloured trousers, and the people leading the horses appear to have patterned trousers, with checks and spot designs appearing frequently. Schurmann noted,

> "The riders are depicted schematically. The ones on foot walk left of the horses, the right hand with the bridle lies on the back of the horse, in fact on the felt rug. The headgear of all riders consists of the so-called Bashlik that is fastened under the chin. The trousers of those on horses are narrow and long. The background of this border is red, the figures of the riders are light blue, the band on the tail either in yellow, light blue or dark blue. The head-gear is yellow-orange, the face white, the hands yellow and the trousers of the riding one (except one) are all blue. The people leading the horses have trousers that are yellow with dark blue, red and white circles and squares." [Schurmann, 1982, p.12]

Rudenko noted that the riders are schematically represented, but all have a hood or a *Bashlık* upon their head. He noted further that these *bashlıks* are typical of the Medes and the Persians: "Their heads are covered in what looks like hoods

(*Bashlik*), which are tied under their chins. These hoods are very typical of the Medes and Persians..." [Rudenko, 1968, pp.41-55]

5.3.1.4 Main star border

In the next significant border, is a star feature about half the width of the previous border, and this echoes the feature found within the central ground.

Within this border a change occurs in half of the pattern, on the top edge of the border, for three-quarters of the left edge, and for half of the right edge, all of the motifs are identical. The symmetry of the carpet is further discussed in Chapter 7. However in the bottom half of the carpet, a change occurs, with the rosettes changing colour alternately, this is discussed in Chapter 7.

One possible explanation for the change in pattern could be just a selected variation by the weaver or weavers; another explanation may be that the whole border should contain counterchange. Possibly the dye has degraded in colour, therefore giving all of the crosses similar colour, this may be a viable suggestion due to the feature that some of the crosses in the upper sections have darkened edges, suggesting that maybe they were dark originally, and maybe degraded slightly due to time and conditions. Very little reference is made to this border, Schurmann acknowledged the different coloured crosses, but does not acknowledge the pattern, Schurmann noted, "The next border shows a pattern of leaves and flowers very similar to the ones in the centre of the rug. These flowers are light blue, dark red or dark blue, and are on yellow ground." [Schurmann, 1982, p.10] Possible suggestion of the representation of this motif is discussed in Section 5.3.2.

5.3.1.5 Animal borders and their interpretation

The next significant border contains the 'deer-like' animal; all of the animals are facing the same direction, all in the same position, as if eating from the ground, with their heads bowed. All have the same physical appearance, with similar antlers, and markings upon their bodies. Around the border there are a total of 24 deer, six on each side. According to Rudenko the image of a deer or elk is widely used in the Altai region, possibly due to the fact that they would have been part of the native wildlife, and frequently hunted by the local population. Rudenko stated,

> "The most richly represented among mammals in the art of the High Altai are ungulates, in the first place deer and elk. There is no need, it seems to me, to discuss whether it was intended to portray a reindeer or red deer, both would be well known to the population." [Rudenko, 1953, p.249]

Rudenko made further reference to the actual species of the deer. Originally they were believed to be representative of reindeer, but with zoological study it is noted that they are fringed-deer or *Cervus dama*, recognised due to the markings on their coats and relatively long tails. Rudenko noted,

> "At first sight these animals could be thought to be reindeer, but as a detailed analysis of their figures has confirmed, they are near-Asiatic fallow deer or, so called fringed deer (Cervus dama). The peculiar feature of this species are wide palmate antlers, spotted coat and comparatively long tail. All these features are clearly visible." [Rudenko, 1968, pp.41-55]

It was not only upon the Pazyryk carpet that the elk or deer featured, but it was represented pictorially at many points throughout the kurgans. It appears that the elk was a familiar and popular motif with artisans of the time, and this may be due to the awareness of the animal by the local population. The elk was not the only regularly appearing motif, others include goats, boars, rams, etc., but the elk is an important feature on the Pazyryk carpet. Rudenko noted: "The beautiful, fairly

realistic representations of elk, deer, mountain goats and rams, boars and saiga antelope indicate that the local inhabitants were thoroughly familiar with these animals." [Rudenko, 1953, p.59]

Hubel also made reference to the presence of elk within the design. The decoration of each follows the same basic pattern, with a black and white dotted stripe down the back, two circles on the shoulders, another on the rump, and a curve following the belly. Hubel believed that these echoed the internal muscular structure and skeleton of the animal, for example, the black and white dotted stripe was representative of the spine. Hubel related this feature to work regularly seen in the Achaemenid palaces of Darius. He observed:

> "The narrower band had a frieze running in the opposite direction showing grazing elk (red-deer stags, reindeer?) red on a light ground. The spotted elk bulls, six on each side, are depicted with the suggestion of internal organs drawn on shoulder and flank, like the winged bulls in the Achaemenid palaces of Darius in Susa and Perseopolis." [Hubel, 1970, p.14]

Schurmann made little reference to the presence of elk in the decoration of the carpet, but did believe that the stance of both the elk and horses suggest a Middle Eastern influence. He stated: "In the Pazyryk rug, however, the bucks seen to be grazing mournfully, relaxed and without tension; the horses trot along unexcited; all this belongs stylistically to the art of [the] Middle Eastern world." [Schurmann, 1982, p.31]

In the next significant border, there are 42 lozenges or medallions, echoing the same lozenges featured in the first border around the edge of the carpet. In this border the image in the centre of the medallion faces the opposite direction to its counterpart border around the edge. Again in this border all of the images are the same.

5.3.2 The central field of the Pazyryk carpet

The next area of the carpet is what will be referred to as the central ground. The pattern contained within this section echoes the motif contained in the third significant border. The central field contains 24 motifs arranged in 4 rows x 6 rows. The motifs themselves appear to be constructed of a combination of crosses around a central point. Bauman referred to the geometric decoration that forms the central ground, and believed that they were stylised flowers, agreeing with the work of other scholars. Bauman remarked: "The weaving is geometric with the central field divided into panels filled with stylised rosettes." [Bauman, 1987, p.14]

Schurmann perceived that the geometric central ground is based around nature, making the association to flowers. Although he further developed the link by stating that they are derived from an Assyrian design of a lotus flower and pine cone. Schurmann observed:

> "The centre shows 6 horizontal and 4 vertical rows of squares in which a cross-like ornament appears with 4 flowers with a little square in the centre and 4 diagonal leaves. It seems to be derived from the Assyrian design of pine cones and lotus." [Schurmann, 1982, p.9]

It does appear to be feasible that this central section may contain stylised flora and fauna. On many different items discovered within the kurgans, plant motifs were regularly used, as detailed by Rudenko, "A fair range of plant motifs were used, including multi-petalled flowers, rosettes, palmettes and, especially richly represented, lotus flowers." [Rudenko, 1953, p.244]

Both Schurmann and Rudenko suggested that this geometric motif may in fact be a stylised lotus flower, suggesting links with the Far East, Egypt, Assyria, Persia, and Scythia. Schurmann previously was quoted as implying an Assyrian lotus and pine cone motif. Rudenko also cited outside influences especially from Hither Asia, suggesting a cultural trade or borrowing, with one area or tribe adopting a motif from

another area, and maybe stylising the motif further to this process of diffusion. Rudenko stated:

> "The lotus, a sacred plant for the ancient peoples of the Nile and Ganges valleys, was widely employed as an ornamental motif in Egypt. Later we find it in Assyria, hence it was adopted by the Persians. Lotus ornament is well known in Persia from numerous examples in Perseopolis, Susa and at Naqsh-i-Rustam in the tomb of Darius. With other Hither Asia motifs the lotus penetrated to the Scyths, where it is found not only on objects of Iranic origin...but as a detail in articles of native manufacture. A very important factor in this matter is the following circumstance: in all examples cited, from Egypt, Assyria, Persia and Scythia, the lotus is plain, as in the shape in the human mask from barrow 1. Yet in a number of occurrences of lotus ornament in the Altain barrows we see examples of a subsequently developed form not found so far in the countries just enumerated; there can be no question of the Hither Asian lotus being merely borrowed...." [Rudenko, 1953, p.246]

Within this section of the chapter, the design structure of the Pazyryk carpet was described, and possible symbolism contained within the piece detailed. Following on from this research, the next section addresses the possible intended end-uses of such an influential piece.

5.4 The end-use of the Pazyryk carpet

The proposed end purpose of the Pazyryk carpet has been documented by many different scholars including Rudenko, and Schurmann. Many different proposed end-uses have been detailed. One of the proposed end-uses was described by Hubel, when he cited the work of Weisner, stating the belief that the squared and segregated nature of the central field, may have been used as a chequer board for games. He stated that the inclusion of a board game in the funeral possessions was widely accepted, and therefore the Pazyryk carpet was in fact a board for a game. Hubel commented,

> "Because of the interpretations in the three outer bands of the border- upper left with two rosettes, upper right with a cross band- Weisner suggests the possibility that the whole carpet is marked out as a dice board. It is an ancient oriental custom to place game boards among grave gifts. Even chess, which originated in the East, was at first a dice game. The large format of almost four square metres does not necessarily exclude its use as a gaming board, for game pieces of corresponding size have been found for later periods." [Hubel, 1970, p.15]

Other scholars believed that the Pazyryk carpet was intended solely as a rich floor covering, or wall hanging. Throughout history, until modern times, pile carpets were used as wall-hangings, or as table coverings. Other scholars explain the importance of the carpet in nomadic lifestyles, forming a vital part by use as floor covering, blanketing, for cover, etc.. Rudenko noted that often luxury goods, such as carpets and textiles were widely used for trade, thus explaining the presence of Chinese silks in barrow five, [Rudenko, 1953, p.325] and a Chinese mirror in barrow six [Rudenko, 1953, p.326]. Rudenko believed that the Pazyryk carpet came into the hands of people in the Altai region, as a result of trade, in exchange for furs, livestock, etc., the results of a nomadic lifestyle. Rudenko stated,

> "In return for precious textiles, carpets and other objects of luxury, leopard skins and seeds of cultivated coriander imported from the south, from the Altai there were sent back to the south probably furs and gold, possibly livestock and pastoral products." [Rudenko, 1953, p.225]

Like Rudenko, Bauman believed that the Pazyryk carpet was a result of trade, possibly as a gift. Bauman however accepted the possibly that it was woven locally, although most scholars do not believe it to be Altaian. Bauman noted:

> "The Pazyryk rug may have been manufactured locally, but it is equally possible that it was produced elsewhere and given to its Scythian owner as a tribute or a gift. Rug weaving may have begun much earlier and in another location, but temperature, humidity, insects and mildew have destroyed all the evidence." [Bauman, 1987, p.14]

Schurmann noted that the Pazyryk carpet was uncovered in the horse tomb, and not in the main burial chamber. Previous writers including Bauman believed it to be a personal gift to a Scythian chief or king. Schurmann noted that its importance may in fact be of a lower level, since it was found on top of a four-wheeled carriage in the northern horse chamber of kurgan five. Possibly the carpet was an accompaniment to the cart, as a covering possibly. He stated,

> "The rug was not found in the main chamber but in the side chamber to the north of the grave on top of the dismantled parts of a four-wheeled carriage. The carriage itself is unlike any other found in the Kurgans of the Altai. Its four wheels are more than 6 feet in diameter and parts of them are well-turned. That the rug was found with the carriage leaves no doubt to the conclusion that it was not solely a precious, private, property of the King, but that it always accompanied the carriage." [Schurmann, 1982, p.17]

Schurmann believed that the Pazyryk carpet may have been used to cover the base of the cart found with it in barrow five, or alternatively as a cover for the bodies to be interred during transportation to the burial site. Schurmann categorically believed that the body in barrow five was that of a Scythian king, and like Rudenko used the works of Herodotos, a Greek historian, to explain the possible purpose of the Pazyryk carpet. Schurmann stated that the Altai region was the traditional burial site of the Scythians, and the bodies were transported aboard a carriage or cart. Herodotus made reference to the Altai being the traditional burial site of the Scythian kings:

> "The burial-place of the Scythian kings is in the country of the Gerhhi, near the spot where the Borysthenes first become navigable. When a king dies, they dig a great square pit, and, when it is ready, they take up the corpse...it is carried in a wagon to a neighbouring tribe within the Scythian dominions, and then to another, taking the various tribes in turn..." [Herodotus, 1996, p.237]

This agrees with the findings of Rudenko, particularly the square nature of the burial chamber, and the findings of a cart within each burial chamber. Schurmann

believed that the carpet would cover the bodies, or be laid beneath them, when the bodies were displayed to neighbouring tribes. Schurmann commented:

> "While a great square pit is being prepared, they take the corpse, which has been previously conserved, and put it on a wagon to show it to all neighbouring tribes within the Scythian dominions until they get to the traditional burial place in the Altai. No doubt on the long journey, which may take many weeks, the bodies of the King and his wife (who must die with him) have to be protected against dust, heat and the other risks of the journey. The measurement of the Pazyryk rug corresponds exactly to the measurement of the carriage with the dead bodies that lay on it." [Schurmann, 1982, p.19]

From this reference, Schurmann appeared to believe that the carpet was purposely designed for the transportation of bodies to the burial site. Therefore he believed that the carpet was designed solely as a funeral accessory.

From the various sources and scholars, and Figure 5.7, it appears that the Pazyryk carpet is horse associated, not only on account of the decoration upon it, but also due to the location of its discovery. As stated previously the carpet was discovered in the horse burial chamber. However by referring to Figures 5.5 and 5.6, (reproduced from Rudenko [1953]) it can be seen that the carpet was found lying on top of or next to one of the horse bodies, and underneath the sections of cart. Not on top of the cart as stated by Schurmann, who noted that the piece was found on "...top of the dismantled parts of a four-wheeled carriage..." [Schurmann, 1982, p.17]

The discovery location of the carpet does create a number of queries. The carpet only remained in the kurgan due to its location in the horse chamber, which was undisturbed by the thieves, possibly due to the belief that all of the contents were of little value and horse associated. Rudenko stated, "In the second place it would be known to the thieves that they could count on finding nothing more valuable there than saddlery and a certain number of thin gold plates." [Rudenko, 1953, p.12]

It appeared that the Pazyryk carpet was an item of little relative value, and therefore the population who owned it regarded it as an everyday item, or an item of little regard. All items of high value (as regarded by the grave-robbers) would have been buried with the corpses in the main burial chamber. If the carpet was of high value (and it is difficult to believe that it was not), why was it buried in the horse tomb? Rudenko made particular reference to the areas of the carpet that exhibited high wear, and believed that the wear was caused by it lying on the floor of a wealthy house. He noted,

> "In rich houses carpets would not only hang on walls, but also cover the floors. In barrow five, besides the felt-wallhanging, there was a pile carpet showing signs of intensive wear, which had probably lain on a floor." [Rudenko, 1953, p.64]

The Pazyryk carpet may have had another end-use, possibly as a saddle, or a saddle-cloth. There are many arguments that justify this belief.

If a comparison is made of the horses featured as decoration on the Pazyryk carpet, it can be seen that each horse has a 'saddle' that appears to be a blanket or a fringed covering, possibly a carpet, not dissimilar to the Pazyryk carpet, just in a stylised form. None of the decorative horses have saddles as such that match the saddles found in any of the other barrows. Schurmann believed that the "saddles" as were in fact 'blankets' or 'covers' made of felt: "There are no saddles. Instead there are covers made of felt, with tapering fringes, in a variety of patterns based, in the main on a stylised tree design." [Schurmann, 1982, p.12] It could however be argued that a pile carpet was also a distinct possibility. If used as a saddle or blanket, the wear on the carpet would also be accountable to wear from the rider or luggage carried on the horses back.

5.5 The material structure of the Pazyryk carpet

The Pazyryk barrows were believed by Rudenko to be the burial sites of Iron-age horsemen. To reinforce this belief, and to achieve an accurate date on the barrows, all of the contents were removed, radio-carbon dated and the wooden material subjected to dendrochronology, to give dates for all of the main kurgans.

Prior to the radio-carbon dating, (which was not available until after Rudenko published his first findings on the Pazyryk valley), dating using the process of dendrochronology was carried out. This involves the examination of the logs used in the construction of the barrows. By comparing the markings of the rings on the logs it is possible to calculate the construction order of the barrows. This combined with the radio-carbon dating allows an accurate date to be placed on all of the tombs. Using this process Rudenko was able to rank the barrow construction, discovering kurgan one was the first to be built, and then the barrows were constructed in the following order, two, four, three and then barrow five. By comparing the five main barrows it was discovered that there was 48 years difference between the construction of barrow one, and barrow five. Thompson explained:

> "The first, dendrochronology, depends on the synchronisation of years of poor growth in trees...At Pazyryk it indicated that barrows 1 and 2 were constructed in the same year; barrow 4 was constructed next after an interval of seven years, barrow 3 next after thirty years and barrow 5 after eleven years. In other words the erection of the five barrows spanned a period of forty-eight years." [Rudenko, 1953, p.xxix]

After the original publication of Rudenko's work, more advanced and accurate radio-carbon dating was carried out on some of the contents of the kurgans. By combining these data, with the data attained from the dendrochronology, dates were obtained for all of the barrows. The barrows had the average date of 430B.C.E.. Thompson commented:

> "Since the first edition of this book a radio-carbon dating of the Pazyryk barrows has been made, which gave an average age of 2,395years before the present, or 430B.C.. Thanks to the beautiful survival of the logs in all the barrows it has been possible to define their relative age with precision down to a year by means of tree-ring dating. It was shown that the first two Pazyryk barrows were thrown up in the same year, then the third and fourth, and last of all the fifth, forty-eight years after the first two." [Rudenko, 1953, p.xxxvi]

Both Schurmann and Bauman made reference to the fibre content, knot structure and weave construction of the carpet. Both the warp, weft and pile were constructed of wool. The carpet was made using the symmetrical knot, (Figure 5.8) also known as the Turkish or Ghiordes knot, at a density of 3,600 knots per square decimetre. The carpet is therefore of very fine construction, if compared to carpets made in fifth and sixth centuries C.E. which have a density of only 500 knots per square dm. [Hubel, 1970, p.19]. Between the majority of rows of knots in the Pazyryk carpet there were three shots of weft, although occasionally four shots of weft were used. Schurmann noted:

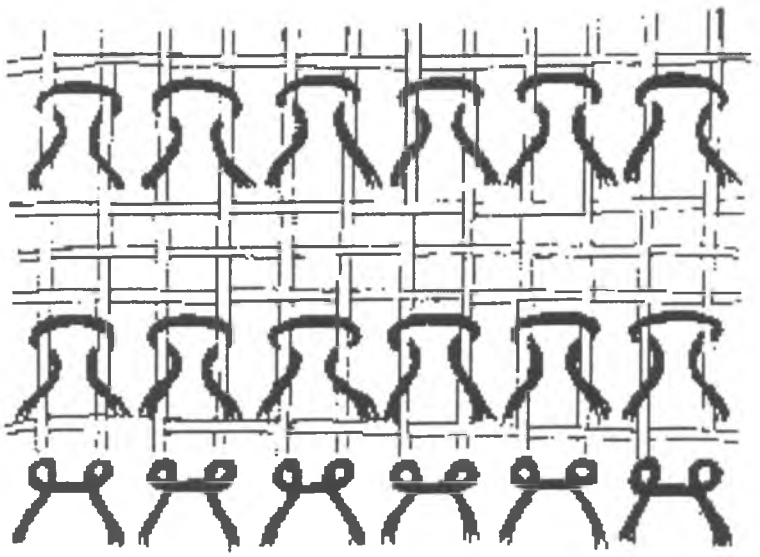
> "The whole rug is made of wool, that is, the warp, the weft, as well as the pile. The number of knots is approximately 3,600 per sq. decimetre and there are 3 sometimes 4 weft shots per row. The knot is of the symmetrical type usually found south of the Caucasus up to our times." [Schurmann, 1982, p.14]

Bauman made reference to the same structural features as Schurmann, but noted that the Pazyryk carpet was produced using the symmetrical knot, whereas all other pile fragments found in the Pazyryk kurgans were produced using the asymmetrical knot, suggesting a different weaving location to the Pazyryk carpet. This increases the evidence to support the suggestion that the Pazyryk carpet was transported from another region, and therefore was a possible result of trade between different cultures or the diffusion of an alternative knotting technique from elsewhere.. Bauman observed:

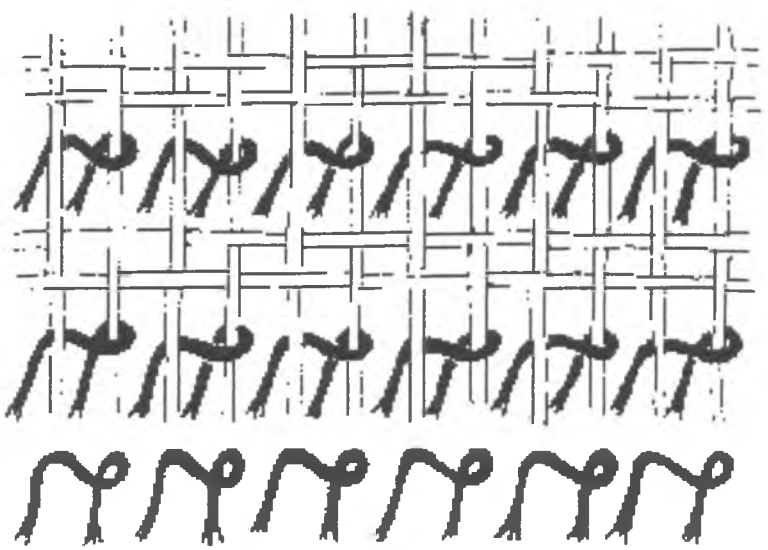
> "The so-called Pazyryk rug is datable to the 5th century B.C.. It is

approximately two metres square and is made entirely of wool with about 3,600 symmetric knots per square decimetre. Other carpet fragments found in the same mound were more densely woven with the asymmetric knot." [Bauman, 1987, p.14]

Figure 5.8 Knot structure of the Pazyryk carpet



Turkish knot (symmetrical knot)



Persian knot (asymmetrical knot)

5.6 The origin of the Pazyryk carpet

The origin of the Pazyryk carpet has been debated by many scholars. The principle elements of this debate are presented below.

Bauman recognised the two obvious possibilities:

> "The Pazyryk rug may have been manufactured locally, but it is equally possible that it was produced elsewhere and given to its Scythian owner as a tribute or gift. Rug weaving may have begun much earlier and in another location but temperature, humidity, insects and mildew have destroyed all the evidence." [Bauman, 1987, p.14]

Schurmann recognised that the only real clues can be gained by comparing the carpet to other pieces of art or writings from around the same period, in this case 500B.C.E.. Schurmann stated that the comparison of material features of the carpet, such as weave, knot style, and dyes, are not possible since no examples have been discovered which predated the Pazyryk carpet. Therefore, according to Schurmann, with current physical evidence it is not possible to pin point the exact location and time of the origin of, for example, the symmetrical knot. He commented:

> "Since there are no known rugs of comparable age, the study of the materials used, of the techniques of weaving, of the nature of the dye-stuffs is a purely academic and sterile exercise. The sole criterion which is available to us at the moment is that of design for here we can compare what the weaver has achieved in her (or his) work with what contemporary craftsmen had achieved in parallel fields at around the same period in time, viz. approximately 500B.C.." [Schurmann, 1982, p.23]

In contrast to Schurmanns belief that dyes cannot be used as an indication of origin, Hubel considered the dyes within the carpet (such as the celadon green and cochineal red) as potential indicators of location of manufacture. Using Herodotus as a principle source, Hubel hypothesised that the carpet was made in Armenia which, at the given point in time, was ruled over by Persia. Hubel noted,

> "In style the Pazyryk carpet differs so markedly from all the other

> examples of Scythian art - The steppe is no cultural waste- that it is justifiable to consider Iran as the area of its origin. The celadon green and even more the cochineal red are characteristic of the Karabagh carpets point to Armenia. Armenia (Azerbaijan), whose people were celebrated by Herodotus for their talents in producing dyes and in dyeing cloth, had belonged to Persia since the early Iranian period." [Hubel, 1970, p.15]

Making comparisons with other decorated objects, Hubel maintained that the motifs and decoration did not appear to be Scythian. The Pazyryk carpet appears to be foreign to the area. All of the decorative elements point strongly to the carpet being Persian, and the expertise of the Armenians for dye production appears to have been utilised in its manufacture.

Schurmann agreed with Hubel, believing that the carpet was not Scythian. He presented two arguments. Firstly, he argued that the Scythians were not skilled in the manufacture of pile carpets. Instead they were highly skilled in producing felt rugs. This is further reinforced by the many examples of highly decorative felt rugs discovered in many of the barrows of the Pazyryk valley. Second, he believed the decoration of the carpet is not Scythian, as the animals are represented in naturalistic form, as would be seen in the wild. Typically, the Scythian representation, depicted on items from the kurgans, was characteristically more stylistic in nature, with coiled animals, as if ready to jump or run. He stated that the animals are produced in a style that is typically Middle Eastern. He elaborated as follows:

> "The Scyths in the Altai itself were as far as we can make out unskilled in weaving pile carpets; they excelled, however, in making felt rugs of great beauty and variety. The animals in the Pazyryk rug do not correspond stylistically with the known artistic styles of the Scythians whose principal characteristic is one of great tension. This is most noticeable in their gold and woodwork where strangely coiled animals look reposed yet still remain ready to spring. In the Pazyryk rug, however, the bucks seem to be grazing mournfully, relaxed, and without tension; the horses trot along unexcited; all this belongs stylistically to the art of Middle Eastern world." [Schurmann, 1982, p.31]

As previously stated, the deer represented on the carpet are fringed deer of a Near-Asiatic species, this was deduced by the physiological representation of the animal. If the markings are examined on the animal, such as the circles and pear-shaped figures present upon their rumps and shoulders, they are characteristic of Achaemenid Persia. Rudenko observed:

> "Firstly, the images of fallow deer on the carpet demand attention. The build of these animals, the shape of their heads, the spots, the palmate antlers and the comparatively long tails, in combination together, as was mentioned above, indicate male deer of a Near Asiatic species...We should also pay attention to the ornaments on these animals' bodies, the pear and apple shaped figures on their shoulders, the circle (spot), in parenthesis on their rumps and the narrow line which runs from the forward circle, backwards along the belly. These details are characteristic of the images of animals in Assyrian and Persian art of the Achaemenids." [Rudenko, 1968, pp.41-55]

By studying the decoration of the horses, the plumed headdress, saddle-rugs and the way the tails are braided, it does indeed appear that these decorations are not representative of the Altai region, but again of Near Asia, and in particular Persia. The head plumes featured, are seen regularly in the bas-reliefs of Persepolis. Rudenko stated however that while the horses' plumes and tails were apparently Persian, the saddle cloths were Assyrian. He expanded as follows,

> "The images of the horses- their particular harnesses, their plumed head dresses, their bow-tied tails and saddle rugs are typical of Near Asia and not of the Altai Mountain region...The actual horses present confusing signs, with their typically Assyrian saddle rugs and breast-cloths, but their obviously later Persian tail-knotting. The same type of bow and head plumes can be seen on the bas-reliefs of Persepolis, on numerous Persian seals, on Achaemenidian coinage and finally on a silver disk from Central Asia. On this disk, we can see the same saddle rug and breast cloth as on the Pazyryk carpet." [Rudenko, 1968, pp.41-55]

Schurmann stated that after the dissociation of the Kingdom of Urartu around 590B.C.E., the area became a huge melting pot of culture. He believed that these people gained the expertise of the Urartuan people towards art and the skills to

manipulate the plentiful supplies of wool in the area. Schurmann argued that over time the skills would have developed to the height seen in the carpet itself. The remaining Scyths may have ordered influence in the design. Therefore, for example, the carpet may have been produced purposefully for a Scythian king, to order. But if it was so influential or important, why was it deposited in the horse tomb? Schurmann commented:

> "After the Kingdom of Urartu had been dissolved around 590B.C. the population consisted of various tribes mixed with Scythians and out of this melting pot arose the nation of Armenians. No one will be surprised if they inherited the magnificent attitude of the Urartuan people to art not that products of sheep's wool, which was plentiful in their country, allowed them to make extraordinary rugs. More than 150 years gave them sufficient time to develop their own style combined with copying such exact Scythians details as may have been ordered," [Schurmann, 1982, p.33]

Schurmann further referred to the Scythian and Urartu reference in the Pazyryk carpet. He examined the *bashliks* worn by the riders on the carpet, believing them to be stereotypical of a Scythian tribe resident in the Urartu region. Using two examples of art as a comparison, he believed that the riders depicted were Scythian. It may be possible that the carpet, was a gift to a Scythian king, and therefore the inclusion of the *bashliks* may have been intended as a tribute. Alternately the carpet may have been produced to order for the Scythians, therefore explaining the presence of these typically Scythian items. Schurmann stated that,

> "It came to my mind that the Bashliks shown in the Pazyryk rug belong to a tribe of Scyths that were resident in the former Urartu region and I have found two seals that seem to support my idea. One is a rolling seal showing a bow-shooting warrior on his horse. The other one, apparently a signet ring, shows a kingly personage on a boar hunt. Could it perhaps be the king or prince who is buried in the V. kurgan? " [Schurmann, 1982, p.28]

Rudenko believed that the Pazyryk carpet has Achaemenid Persian influences, and noted that within the Pazyryk barrows there was direct evidence of

trade and connections with other cultures. Examples include Chinese and Persian imports within the tombs. Rudenko noted:

> "In a Bronze Age barrow in Siberia it is unlikely that there will be even the slightest indication of connections with ancient civilisations, but in the Pazyryk barrows there are actual Persian and Chinese imports, while the influence of Achaemenid Persia permeate the decorative motifs employed on other objects." [Rudenko, 1953, p.xxvi]

It does indeed appear to be the case that a number of Persian motifs featured widely in the kurgans of the Pazyryk valley. For example the cock motif, which featured widely on many items within the tombs. It may have been used because it was considered to be a sacred bird in Persia, used at funerals, hence its presence in the barrows. The cock was one of three motifs that were considered to be protectors by the Persians, the others being fire, and the dog. Rudenko made reference to the fact that in the sixth century B.C.E. chickens penetrated from Persia into Greece, and may have also by this point have reached the Altai region of Siberia, again strengthening this Persian link to the Pazyryk valley. Rudenko stated that,

> "It is well known that Zend speakers honoured the cock, believing its crowing drove off evil spirits of the night. The cock was considered a sacred bird in Persia, where it figured at funerals. Fire, the dog, and cock were regarded by the Persians as the three protectors. In the sixth century B.C. chickens penetrated from Persia through Asia Minor into Greece, and it is not improbable that at about the same time they reached the Altai." [Rudenko, 1953, p.59]

Rudenko believed that the sheared pile on the carpet strengthened the view that the carpet is Persian in origin. He maintained that in the palaces of Alexander the Great, great sheared pile carpets which were decorated with animals and figures were laid on the floor. This type of carpet sounds very similar to the Pazyryk carpet, therefore predating all previous evidence, and strengthening the argument that at the point in history in question, pile carpets were being produced in Persia. He also noted that pile carpets may have been used in place of saddles, making the carpet a highly utilitarian piece, further strengthening the previous argument on the

end-use of the Pazyryk carpet. Rudenko noted that,

> "There is no certain proof that the carpets just referred to were sheared smooth; more probably they had been made in the Gobelin technique, which could have reached a high degree of perfection by this time. The mats used to cover a horse in lieu of a saddle would in all probability have been pile made. At all events in Achaemenian Persia they produced sheared pile carpets; Xenophon reported that the city of Sard prided itself on its sheared carpets on which at the Persian court only the king had the right to tread.... Later, in the time of Alexander the Great and his successors, in the palace they spread before the bed long-pile carpets of fine wool, dyed purple, which alternated with sheared carpets of Persian origin decorated with animals or other figures." [Rudenko, 1953, p.299]

Rudenko as well as noting that the carpet was laid upon floors, and also used in place of saddles, further noted that the king was the only member of the court to actually step on the carpet. This observation strengthens further the view that the body within the fifth kurgan was that of a king.

Making reference to the motifs within the borders, and in particular the horses, and their carpet saddles, Rudenko argued that the decoration suggested that the carpet was of Assyrian production. However the tail appears to be braided in a style typically Persian, and not Assyrian. He used illustrations of pieces of art from Persepolis as evidence. For example he maintained that the style of the riders walking alongside the horses were represented widely at Persepolis, adding further weight to the belief that the origin of the carpet is Persian. He observed further:

> "The horse has a sharply bent neck, trimmed mane, forelock shaped into a plume and tail knotted into a bow. Instead of a saddle there is a carpet-like fringed shabrack with a broad chest-band. Such representations of war riding-horses, especially wearing carpet shabracks with chest-bands, are typical of Assyria. Nevertheless a series of features, especially the method of tying the tail into a knot, are not Assyrian but later Persian. We can see such a knot and plumed forelock on bas-reliefs at Persepolis... and, finally, in the hunting scene on the silver disk in the Oxus treasure, where we see, just as on our carpet, a representation of a carpet-like shabrack and broad chest-bands...." [Rudenko, 1953, p.304]

A final feature that suggests a Persian origin for the carpet is the discovery of embalmed bodies in the Pazyryk tombs. Herodotus made reference to the preparation of bodies for funerals, and stated that the Scythians used to coat bodies with wax. Herodotus stated,

> "When a king dies... they take up the corpse, which has been previously prepared in the following way: the belly is split open, cleaned out, and filled with various aromatic substances, crushed galingale, parsley-seed, and anise; it is then sewn up again and the whole body coated over with wax." [Herodotus, 1996, p.237]

During the period to which the Pazyryk tombs were dated, the preparation of bodies for the tomb was widely used in Egypt, as well as Assyria, Media, and Persia. Many of the bodies in the tombs had been embalmed, involving the skin being split open, then the muscles were removed, and local grasses, etc., were used to stuff the formed cavities. [Rudenko, 1953, p.283][Herodotus, 1996, p.237] Rudenko used the work of Herodotus to explain the embalmment of the dead of the tribes of the area. Rudenko noted,

> "As is well known the practice of embalmment was widespread at the period of the construction of the Pazyryk barrows. Outside Egypt, where Herodotus described in detail the various methods of embalming bodies, embalmment was practised in Assyria, Media and Persia in the middle of the last millennium B.C.. Of the Black Sea Scyths Herodotus wrote: 'After the death of a king [*basileus*] they at once excavate a large square hole; in preparation the corpse is taken and covered with wax, but prior to this they slit open its stomach, clean it and fill it with chopped cypress, frankincense, seeds of parsley and anise, sew it up and bear it on a wagon." [Rudenko, 1953, p.282]

It may well be the case that embalming using wax was a technique which diffused to the Altai area from Persia (or some adjacent are). This being the case, there is every likelihood that other items, techniques, or forms of decoration may also have diffused from similar sources. Diffusion of beliefs, and practices occur across groups of people. Evidence is available for the diffusion of beliefs and practices into the Pazyryk valley. The fact that many of the bodies discovered in the kurgans had

undergone some form of embalming, showing that the practice had transferred that far north. In summary, it does appear highly possible that the carpet was of Persian origin. This conclusion was also reached by Rudenko and Schurmann.

5.7 Cultural aspects of the Pazyryk carpet

The decorative elements on the Pazyryk carpet do appear to bear significance to the tribes associated with the Altai region around 500B.C.E.. Horses were a very significant feature of life for the people of the Altai. Rudenko stated that the people at that time led a nomadic style of life, with the horse being the animal of central importance, used for transport, food, trade, and as a way of life. Rudenko believed that the horse was regarded so highly at that time, that horses were considered equivalent to man. Rudenko stated,

> "On the excavation evidence first place among domestic animals was held by the horse...The significance of this animal in the life of pastoral people can be appreciated by observing the life of the eastern Kazakhs and Kirgiz. The horse was the basic unit of exchange, the value of large- and small-horned animals being assessed in direct proportion to this unit. The brides' dowry (kalym) was counted out in horses, the fines for murder and wounding were assessed in horses. The horse was the only animal the value of which was reckoned as equivalent to that of man." [Rudenko, 1953, p.55]

If the horse was considered such an important feature of life for the people of the steppe, it is not surprising that it would be represented in various art forms, and depicted decoratively on elaborate textile pieces. The horse presence in the tomb itself is not surprising. The horse plays such a central role in the life of nomadic people, it is considered that life cannot carry on into the next world without the accompaniment of horses. Therefore in every main kurgan in the Pazyryk valley, horse bodies were found, with horse associated items such as saddles and bridles. The horse as well as being a utilitarian object also appears to play a spiritual role for

the people of the High Altai. Rudenko commented:

> "The ridden horse was one of the important prerequisites of the development of pastoral herding. As we know, the people of the steppes, and consequently the Altai tribes also, have for a long time been predominantly an equestrian society. In the Altai the life of everybody, men and women, was so closely bound up with horses that these animals had to accompany the dead into the next world." [Rudenko, 1953, p.56]

The horses featured on the Pazyryk carpet have their manes trimmed, which Rudenko believed to be of importance. The horses used in the Altai would have been herd or draught animals, and would not have had trimmed manes. At that time this practice was carried out predominantly in Hither Asia, usually Assyria, or Achaemenid Persia, further weighting the argument, that the carpet was produced in one of these regions, and not in the Altai. Rudenko observed, "The ridden horse illustrated on the carpet from barrow number five has its mane trimmed. Judging by surviving representations it seems that the ridden horse in Hither Asia, in particular Assyria, and in Achaemenid Persia, had its mane trimmed..." [Rudenko, 1953, p.119]

The horse was so significant in the life of the Altai, that a whole way of life was built up around it. The horse allowed for the creation of a nomadic pastoral lifestyle in the Altai, that was facilitated by the changing seasons. The horse was an exceptional feature of the lifestyle, and therefore demanded a central role, and so formed an obligatory part of the funeral. Rudenko noted this,

> "The obligatory burial of horses in all the barrows with the human burial without exception regardless of sex or social position, either draught- or riding-animals, indicates the quite exceptional significance these creatures had at this period as a means of locomotion... In the last millennium B.C. the horse was ridden not only in war but in normal life, and was used also for draught purposes. All the pastoral tribes were preeminently riders. This is quite natural, since it was only horse-riding that made possible the creation of that pastoral, nomadic way of life in the steppes and foothills of eastern Europe and Asia,..." [Rudenko, 1953, p.117]

It is assumed all of the objects that were in the tombs had significant meaning,

including the horses. It appears that the tribes of the Altai had significant religious views, believing heavily in an afterlife. Therefore all of the objects were included as requirements to aid transition into the next life. This practice was widely undertaken in the area, and was practised up until the end of the nineteenth century, again a feature identified by Rudenko,

> "Corresponding with this view about the continuation of life after its apparent end they continued to 'feed' a dead man up to his burial...They placed the necessary dress for the dead man in the tomb, as well as objects of a domestic nature, weapons, a concubine, horses and saddlery...The custom of burying a horse with its rider persisted for a very long time in the Altai. We meet it among Turks in the first millennium A.D. and in eastern Altai among the Telesi up to the end of the nineteenth century." [Rudenko, 1953, p.283]

As noted previously, Rudenko believed that horses had religious significance as well as a utilitarian one. It is believed that they were sacrificed for funerals, not just to accompany the dead into the next world, but also as a gift to a god of some sort. Herodotus made reference to the sacrificial gifts presented to various gods within the Scythian tribes. He stated:

> "The only gods the Scythians worship are Hestia (their chief deity), Zeus and Earth (whom they believe to be the wife of Zeus),...It is not their custom to make statues, or to build altars and temples...The method of sacrifice is everywhere and in every case the same..." [Herodotus, 1996, p.234]

He proposed that horses were sacrificed to the sun god due to their associated speed. Rudenko noted that, "For sacrificial purposes all the domestic animals were used, especially horses. 'The Massagetae[18] sacrifice horses to the sun-god, the significance of this is that the swiftest of gods should be offered the swiftest of animals.'" [Rudenko, 1953, p.291] This feature was also noted by Herodotus, when he stated that, "The only god they worship is the sun, to which they sacrifice horses: the idea behind this is to offer the swiftest of mortal creatures to the swiftest of the

[18] Herodotus and Rudenko refer to the Massagetae, as these were the closet neighbours to the Scythians, both geographically, and also behaviourally. Herodotus noted, "In dress and way of living the Massagetae are like Scythians..." [Herodotus, 1996, p.84]

gods." [Herodotus, 1996, p.85]

Often comment is made upon the design structure, in particular the presence of two wheels with the horse border, and a line with triangles within the star-filled border. The presence of these has been identified by many scholars including Rudenko, and Schurmann. Most believe them to be a mistake due to the mis-spacing of the images. Rudenko believed this to be the case, and noted this feature was widely used by Caucasian weavers. Schurmann believed the wheels to be symbolic of a funeral rite and cited Herodotus [book 4, chapter 72]. Schurmann maintained that the dimensions of the main images were adapted deliberately to allow for the inclusion of these symbols. This possibility is supported by the view that the Pazyryk carpet is a highly sophisticated and crafted item, and not just a roughly produced nomadic object. Schurmann commented:

> "Returning to the unusual interruption of the design of the main border of riders and horses, at first I shared the opinion of Rudenko that one horse was shortened inadvertently: The weaver, realising that she was shorter on one side of the vertical border than on the other, inserted two rosettes to fill the gap. This is a well-known method, used over the centuries by Caucasian weavers if the design was not correctly followed. In this case, however this rug is no nomadic rug it is not a rug conceived by a simple weaver, on the contrary it is a highly sophisticated, extraordinary, piece of art. Consequently the last horse in the row has been shortened deliberately and the two motives are not rosettes at all but wheels, and wheels of terrible meaning..." [Schurmann, 1982, p.20]

The funeral rite was detailed by Schurmann [Schurmann, 1982, p.21], aided by reference to Herodotus. It is possible that the carpet was just an accessory to the funeral. Possibly each of the riders and horses featured were representational of one of the sacrificed servants and horses, described by Herodotus. The carpet may have been used in place of the actual sacrifice, as symbolic, and representational of the previous funeral actions. Maybe the images were used to replace the actual death and placement of the horses and servants. Herodotus commented:

> "At the end of a year another ceremony takes place: They take fifty of the best of the Kings remaining servants, strangle and gut them, stuff the bodies with chaff, and sew them up again. These servants are native Scythians, for the King has no bought slaves, but chooses people to serve him from amongst his subjects. Fifty of the finest horse are then subjected to the same treatment... The next step is to cut a number of wheels in half and to fix them in pairs, rim downwards, to stakes driven into the ground, two stakes to each half wheel; then stout poles are driven lengthwise through the horses from tail to neck, and by means of these the horses are mounted on the wheels, in such a way that the front pairs support the shoulders and the rear pairs the belly between the thighs...All four legs are left dangling clear of the ground. Each horse is bitted and bridled, the bridle being led forward and pegged down. The bodies of the men are dealt with in a similar way: straight poles are driven up through the neck, parallel with the spine, and the lower protruding ends fitted into sockets in the stakes which run through the horses; thus each horse is provided with one of the young servants to ride him. When horses and riders are all in place around the tomb, they are left there, and the mourners go away." [Herodotus, 1996, p.238]

A number of resultant queries arise from the above quotation. If it is the case that sacrificed servants and horses were placed around the tomb, why were bodies not found outside the kurgans themselves? All the bodies detailed by Rudenko [1953] were located only inside the burial chambers. Second, Schurmann stated that this funeral rite was carried out for a Scythian king. It may be plausible therefore that the body within kurgan five is not that of a king at all, just a Scythian tribe leader or tribesman, as all members of a tribe received a similar burial, with the inclusion of horses. This was further noted by Rudenko, "The large number of horses buried in a single barrow is noticeable; in an ordinary barrow one to three horses and in a rich barrow (of a tribal clan chief or elder) seven to fourteen horses, and in one case even sixteen." [Rudenko, 1953, p.117] Within barrow five there were nine horse bodies [Rudenko, 1953, p.325], which according to the views expressed by Rudenko would make the man buried in kurgan five (a rich barrow) a tribal elder or chieftain, but not necessarily a king, and therefore not eligible for the funeral rite described by Herodotus.

If Schurmann is correct, and barrow five contained the grave of a Scythian king, it may be that the carpet held the symbols of the funeral rite described above. The horses and riders depicted on the carpet may have been symbolic of those used to protect the tomb. Therefore the purpose of the carpet may have been as a totem, an object to protect the dead into the next world. Maybe reducing the requirement for the death of all of the servants. The carpet may have been used in place of the actual sacrifice. In many religions the drawn image is considered as powerful as the human figure, and possibly this was the case in the Altai. Possibly the Pazyryk carpet was considered a pictorial protective item for the burial site. The idea of the horses and riders being a protective totem, and the wheels, etc. used as funeral accessories, was recognised by Schurmann:

> "The column of riders and horses, and the two wheels, therefore show the end of the whole funeral ceremony and the palisade-like design in the inner border of the flowers at the same upper end, as the wheels, should give an idea of the wooden poles that form the first protection inside the grave. The horrible dead figures of horses and riders form the outermost protection of it... The rug is in fact an allegorical copy of the grave. The centre of the flowered squares meant for the dead, the borders for the various protecting mythical animals, the main border for the guarding riders on horseback." [Schurmann, 1982, p.22]

Schurmann believed that certain motifs present on the carpet increased the validity of the carpet being purely a funeral accessory. The presence of the buck in one border, and possibly the griffin in another are examples. These motifs had Scythian associations and symbolism, and were believed to be symbolic of the transition from life into death. The elk, deer, and griffins motifs featured widely as decoration within the kurgans, as for example in the form of decoration on bridles. [Rudenko, 1953, p.313] Schurmann observed:

> "A further clue to the rug as a funeral and ceremonial object is the design. According to the Scythians beliefs, the buck and the griffin are expressions of life passing over to death. Therefore the main row of the spotted bucks and the two accompanying borders of the griffins are the indication of the artist that the rug was meant as a funeral

item." [Schurmann, 1982, p.19]

Whilst Schurmann stressed the importance of symbolism, Rudenko maintained that the primary function of the animal motifs was decoration, although he did make reference to the work of Lappo-Danilevsky [Rudenko, 1953, p.287] who associated animal motifs with gods. For example, Lappo-Danilevsky proposed that the lion was an attribute of the Scythian god Artimpasa, and the griffin an attribute of the sun god Oetosyrus, and also recognised the importance of other images such as the cock for warding off evil spirits. In general Rudenko took a different perspective to that taken by Schurmann, and proposed that the motifs on the Pazyryk carpet were of purely decorative value, and that they had no hidden totemic meaning. Rudenko elaborated:

> "Neither the Greek historians nor the Chinese chroniclers make any reference to an animal cult among the Scyths and other pastoral tribes. With regard to the lion and griffin Lappo-Danilevsky made the suggestion that the lion was an attribute of the Scythian god Artimpasa and the griffin an attribute of the sun god Oetosyrus...Although animals depicted on weapons and other utilitarian objects could be totemic, this would only have been the case in earlier stages of economic and social development among hunting peoples and not among people at the social level of Altaians. So if this or that animal was depicted on the riding equipment or other articles it can only be regarded as a survival of a long-vanished past and not as expressing the contemporary ideology of the time...This lends weight to our inference about the impossibility of the animals having a totemic significance." [Rudenko, 1953, p.287]

In a later work, Rudenko appears to contradict his previously expressed beliefs, and stated that animal representation had a special place, and although not necessarily totemic, were connected to the beliefs of the time. However Rudenko still maintained the view that geometric and floral forms had no associated significance. He elaborated as follows:

> "Therefore, all Near Asian art is the result of the influence and creativity of many different tribes and people over many centuries. The analysis of the arts of Babylon, Assyria, Urart, Mann, and Medo-

> Persia is the province of specialised research. For our purposes, the establishment of connections between the art of the Altai mountains and contemporary art of Near Asia, it is important only to distinguish general trends and some stylistic details. In Persian art,...the motifs of the animal world have a special place. Various animals, such as lions, mountain goats, rams, fallow deer and wild bulls were depicted as single figures, heraldic figures and also in lines. Besides the depictions of the typical fauna of Near Asia, there were also depictions of fantastic creatures such as big-eared griffins, eagle- and lion-griffins. The most typical compositions are scenes of carnivorous animals, mainly lions, attacking various ungulates, hunting scenes, military scenes, and other compositions with religious content. Geometrical forms and floral motifs play an insignificant role. This is a characteristic, not only of Persia, but also of the whole of Near Asia." [Rudenko, 1968, pp.41-55]

5.8 Summary

It is generally accepted that the amazing preservation of the Pazyryk carpet occurred due to barrow congelation after the kurgan was ransacked by thieves. Preservation was also aided by the location of the carpet in the horse chamber of kurgan five, which was left untouched by the robbers, for possibly two reasons. Firstly, the chambers were believed to contain horse-related items which were not regarded as valuable. Second, since the horse bodies were large and cumbersome, and therefore difficult to move, the horse chambers were left untouched. This observation raises questions about the purpose and value of the carpet. Due to the fact that the carpet was discovered in the horse chamber, it may have had an intended horse associated end-use, and was therefore of little interest to the robbers. For example the carpet may have been used as a saddle cloth of the type represented on the carpet itself.

The carpet has been dated to be about 500B.C.E., based on the use of dendrochronology and radio-carbon dating. Many scholars have discussed the origin of the Pazyryk carpet, by examining its structure, and by making a comparison with artifacts from a similar date. It is generally accepted that the carpet is Achaemenid

Persian or possibly Armenian.

Schurmann believed that the Pazyryk carpet was purely a funeral accessory, possibly used in place of a large-scale human and animal sacrifice. His views were supported by reference to the potential symbolism contained within the carpets design structure. Rudenko in his earlier works opposed this view, believing that animal symbolism was not used by the Persians at this point in history. In his later work, however, he maintained that each animal had some form of religious connotation, originating from the diffusion of belief and culture that occurred in the Near Asian region, citing influence such as Egypt, the Greeks, Syrians, Scythians, Medians and Babylonians.

Chapter 6 The Ardabil Carpets

6.1 Introduction

The 'Ardabil' carpets are a pair of sixteenth century Safavid carpets, believed to originate in Persia, and frequently referred to as '*the Holy Mosque carpets of the Shrine at Ardabil*' [Stebbing, 1892]. The two carpets are now placed separately, the first in the Victoria and Albert Museum (V&A), London, and the second in the Los Angeles County Museum of Art (LACMA), in Los Angeles. The carpets are accredited as the oldest dated pair of Persian carpets. From cartouches contained within their design, the carpets are datable to 946A.H., or 1539/40C.E. [King, 1996, p.89]. Ittig made reference to the V&A Ardabil, and stated that it was,

> "Arguably the world's most famous oriental carpet, it is remarkable not only for its virtuosity of design and fineness of weave, but also for the dated inscription cartouche it bears. Although this carpet, and a second, similar piece in the Los Angeles County Museum of Art, have traditionally been linked to the shrine of Shaikh Safi in Ardabil, northwest Iran, their origins remain controversial." [Ittig, 1993, p.81]

The carpets are very rare examples of Safavid weaving, made special due to the inclusion of an inscription woven into their structure, giving the date, names, etc.. Due to these inclusions they are classified with seven other carpets as being..."part of the eight most influential and artistic triumphs of carpet design." [Stead, 1974, p.8][19]

This chapter deals with what many scholars categorise as being the most influential period in the history of carpet production. It was widely assumed (until

[19] The eight most influential carpets as listed by Stead [1974, p.8] are: the Anhalt Northwest Persian Medallion and Arabesque carpet held in the Metropolitan Museum of Art, the Northwest Medallion and Tree carpet held in the Philadelphia Museum of Art, the pair of white-grounded Medallion and Tree carpets with Animals and Figures held in the Los Angeles County Museum of Art and the Berlin Museum, the Hunting Carpet held in the Museo Poldi Pezzoli in Milan, the Multiple Medallion and Animal carpet held in the Victoria and Albert Museum, and the Ardabil carpets held in the Victoria and Albert Museum, and the Los Angeles County Museum of Art.

the discovery of the Pazyryk carpet) that carpet production, and the skills associated with it, developed in sixteenth century Persia, in particular under the direct supervision of the Safavid dynasty. This chapter is primarily concerned with this period in history, and two carpets associated with it. In order to enhance the knowledge of the carpets, reference is made to the religion of the time, the shrine at Ardabil, and the dominant Safavid dynasty (1501-1722C.E.)[Canby, 1999, p.6]. Stead referred to the importance of this period, when he stated,

> "Although weavers in many regions of the Near and Middle East have produced carpets of distinction, few approach the consummate artistic genius and workmanship of sixteenth- and seventeenth-century Persian production." [Stead, 1974, p.8]

With the above considerations in mind, the objectives of this chapter are:

(i) to discuss the construction of the carpets, with particular attention focused on the symbolism contained within the pieces;

(ii) due to the importance of the inscription cartouche, to discuss the design composition of the carpets;

(iii) to consider the actual origin of the carpets, their purpose for production, their intended location within the shrine complex, and the possible events that lead to their departure from the shrine complex.

6.2 The Ardabil shrine and its heritage

The Ardabil carpets are believed by many scholars, including Stead [1974] and King [1996], to have been produced purposely for the shrine at Ardabil. The shrine at Ardabil is noted as the burial place for Sheikh Safi in 1334 [Morton, 1974, p.45]. Over a period of time, various buildings were developed to enable it to become an important religious site for Muslims. The location of Ardabil can be seen by referring to Figure 6.1, and a photograph of the shrine complex is presented in Figure

6.2. The importance of Ardabil, was recognised by Stead, when he stated that,

> "Sheikh Safi died in 1334 and was buried at Ardabil. In time a tall tower was erected, embellished with the name of Allah, and the site became increasingly sacred to the Shi'ite pilgrims. Around the tower, in succeeding years, a complex of buildings developed. These included a prayer hall, a library, a Sufi dervish monastry, a mosque, courtyards, and appropriate related structures. A burial area accepted the remains of various of the Sheikh's family and descendants and of religious leaders close to the Shrine...Thus Ardabil has its intimate relationship with the rise of the Safavid Dynasty and the Shia sect." [Stead, 1974, p.6]

Figure 6.1 Map showing location of Ardabil

Figure 6.2 Photograph of the shrine at Ardabil
reproduced from [Canby, 1999, p.11]

The Safavid dynasty emerged at the beginning of the sixteenth century, and was strongly linked to the Shi'ite (Shia) doctrine of Islam, and is of importance in the history of Persian carpet production. Relevant Safavid rulers were detailed by Robinson, and can be seen in Table 6.1.

Table 6.1 : The Safavid Dynasty within Iran
source: [Robinson, 1998, p.310]

1501	Ismail I	
1524	Tahmasp I	
1576	Ismail II	
1578	Muhammad Khudabanda	
1588	Abbas I	
1629	Safi I	
1642	Abbas II	
1666	Sulayman I (Safi II)	
1694	Husayn I	
1722	Tahmasp II	
1732	Abbas III	*(nominal ruler in certain parts of Persia only)*
1749	Sulayman II	*(nominal ruler in certain parts of Persia only)*
1750	Ismail III	*(nominal ruler in certain parts of Persia only)*
1753	Husayn II	*(nominal ruler in certain parts of Persia only)*
1786	Muhammad	*(nominal ruler in certain parts of Persia only)*

The Safavid dynasty was dominant for over 176 years. This chapter is concerned with the formation and utilisation of the 'shrine of Ardabil', and the history of the Ardabil carpets. Therefore only the early Safavids are referred to within this chapter, from the reign of Ismail I to the Great Abbas (Abbas I).

The Safavid dynasty is regarded by many, including Stead, as an important period for the production of premier examples of Persian carpets, especially court carpets. The carpets from this period are so prized, reproductions are still produced today. The carpets from the sixteenth century Safavid period are certainly collectable and it is estimated that 1,500 examples are still held in collections [Stead, 1974, p8]. Even those of the highest value, including the famous Hunting carpet, kept at the Museo Poldi Pezzoli in Milan, and the Northwest Medallion and Tree carpet, owned by the Philadelphia Museum of Art, are all accountable to this period of carpet manufacture [Stead, 1974, p.8]. Stead recognised the importance, when he noted,

> "By best estimate, some 1,500 Safavid period carpets and carpet fragments have survived into our own times. That so many have endured and come down to us over the centuries, despite vicissitudes of fire, climate, war, insects, wear, and time itself is almost miraculous...The existence of so many examples is clear tribute to the excellence of sixteenth- and seventeenth-century Persian carpet production. The human inclination is to cherish excellent things, whether a splendid Shang bronze or a brilliant Safavid court carpet, and to guard them and pass them safely from one generation to the next." [Stead, 1974, p.8]

Within the next section a summary of the background information on Islam, and the Safavids is presented, aiming to produce an underlying knowledge, to facilitate a better understanding of the importance of Ardabil.

6.2.1 The Islamic heritage

After the death of the prophet Mohammed 30,000 Arab soldiers, under the

dictatorship of Saad Ibn Waqqus, reached Persia with details of the Islamic way of life [Ruthven, 2000, p.67]. By 644C.E.[20] a broken Persian empire collapsed due to repeated Arab assaults and invasions, and it was in this climate that Islam was adopted [Ruthven, 2000, p.67]. Stead noted that,

> "The conquerors, driven by fanatic belief in the righteousness of their cause, had already begun Persia's conversion to the Islamic faith - from Fars in the south, long a stronghold of Zoroastrianism to Azerbaijan in the northwest and Khurasan in the northeast." [Stead, 1974, p.10]

Subsequent to the death of Mohammed in 632C.E., Abu Bakr was elected as first caliph [Ruthven, 2000, p.69]. He was said to have been chosen as the successor due to his strong ability as a leader. Ruthven observed:

> "...Abu Bakr emerged as the obvious choice: a Quraishi, one of the first converts to Islam and father of Muhhamad's favourite wife 'Aisha, he had been chosen by the Prophet himself to lead the pilgrimage of 631 and to act as Imam during his final prayers." [Ruthven, 2000, p.69]

Abu Bakr died in 634C.E. [Ruthven, 2000, p.69] and the subsequent selections of caliphs left a deep seated schism in the Islamic world [Ruthven, 2000, p.73]. This developed around Ali, the nephew of the Prophets uncle, Abu Talib. It was felt by a large sector of believers, that Ali, who married Mohammed's favourite daughter, Fatima, was the only legitimate successor. Ali became the fourth caliph, and his followers became known as the Shi'ites. The followers of this sector believed that only the direct descendants of Ali could be the true caliphs. Robinson explains:

> "The Shiites, or members of the party (shia) of Ali, held that the prophet designated Ali his successor, meaning that the first three caliphs were usurpers and that Ali's descendants were the only rightful claimants to the caliphate." [Robinson, 1988, p.18]

This belief lead to widespread disagreements between the Shi'ites and the

[20] C.E. is representative of the 'common era', and provides an alternative date system, to the widely accepted A.D., which is representative of 'Anno Domini', and is based upon the Christian calendar and faith. In the context of this chapter A.D. is not suitable, due to this section being based upon the Islamic faith.

Sunni's (the traditionalists), leading to deep-seated intra-Islamic hostilities. Stead made reference to the importance of Shi'itism within Persia,

> "In Persia it manifested itself many times. More than in any other Islamic land, the Persians were attracted to Shi'ite Mohammedism, considering it the true faith, nurturing it through various orders, including Sufiism." [Stead, 1974, p.10]

This section was intended to provide a brief explanation of the split in the Islamic faith, creating the Sunni and Shi'ite doctrines. It is the Shi'ite doctrine that is the concern of this chapter. Ardabil was a Shi'ite shrine, and therefore the Ardabil carpets are believed to be associated with the Shi'ite sector of the faith. The next section aims to describe the Safavids in more detail, thus providing a historical background to the Ardabil carpets.

6.2.2 The Safavids

The Safavids, (also referred to as 'Safawids' [Robinson, 1998]), were the dominant ruling dynasty in Persia during the sixteenth century, having first come to power in a small area of Azerbaijan known as Ardabil, during the fourteenth century. Robinson noted,

> "The Safawids first gained prominence as leaders of a Sufi order in the small Azerbaijani town of Ardabil during Mongol rule in Iran in the thirteenth and fourteenth centuries. Initially led by shaykhs with an eclectic, quasi-messianic religious message, including even Jewish and Christian references, the Safawids increasingly inclined to Shia beliefs during the fifteenth century." [Robinson, 1998, p.71]

After the first Arab invasion of 644 C.E., Persia was under the rule of Umayyad Caliphate of Damascus, then subsequently ruled by Abbasid Caliphate of Baghdad [Stead, 1974, p.11]. Further invasions into the region were carried out by the Seljuks, Mongols, Timurids, Samanids, Ghazavids, Buvayhids, and Ottoman

Turks [Stead, 1974, p.11]. Finally in the onset of the sixteenth century Ismail became the first Safavid Shah by drawing power from the tribes in the Persian provinces of Azerbaijan and Gilan [Stead, 1974, p.11]. Robinson observed that the Safavid leaders were charismatic people who could unite nomadic tribes, to form social cohesion [Robinson, 1998, p.71]. Through this mechanism they formed a strong political power, which developed through the unlikely coalition of Azerbaijani and eastern Anatolian Turkic tribes [Stead, 1974, p.11].

Ismail I is recognised as being the first Safavid ruler, and was also recognised as being the warrior king, and spent long periods of his reign maintaining his power over outside forces, such as the Central Asian Uzbegs and the Near Eastern Ottoman Turks. Finally further conflict erupted in the regions, after Ismail I decreed that the Shia doctrine was the Persian state religion [Ruthven, 2000, p.211]. Ismail I's allegiance to the Shi'ite sect was deep seated, and all of his direct ancestors had been loyal to Ali, including the fourteenth century Sufi, Sheikh Safi ad-Din, (whose name translated means "purity of the faith" [Stead, 1974, p.10]). So strong was the support for Safi, that the name was adopted for the dynasty, hence Safavid. Canby commented: "The name Safavid derives from that of Shaykh Safi, who founded and presided over a dervish order in the late thirteenth- early fourteenth century at Ardabil to the west of the Caspian Sea." [Canby, 1999, p.8]

When Sheikh Safi died in 1334, he was buried at Ardabil. From this time on, Ardabil became a religious site of importance for the Shi'ite doctrine, and became the regular burial site of all subsequent Safavid leaders, including Safi, Ismail, Tahmasp, and the Great Abbas [Canby, 1999, p.12]. The importance of Ardabil was recognised by Canby when she stated: "Over the course of the fourteenth and fifteenth centuries, the influence and wealth of the Safavid order grew, as did the shrine complex at Ardabil." [Canby, 1999, p.8]

Ismail was the first Safavid Shah at the start of the sixteenth century, and was

thus assigned as the first Safavid ruler [Stead, 1974, p.11][Canby, 1988, p.8]. Tahmasp was the son of Ismail and became ruler of the Safavid dynasty at the age of ten. He ruled for more than fifty years, and was recognised as the second Safavid ruler [Stead, 1974, p.11]. However a period of unrest followed, and the next recognised Safavid ruler was the Great Abbas (Abbas I), who succeeded Tahmasp. The Great Abbas was in fact Tahmasp's grandson. The details of the bloodline of the Safavids was described by Stead [Stead, 1974, p.11].

Tahmasp suffered the same conflicts as his father, Ismail I, and at many points in history, his capital, Tabriz was captured by the Turks [Stead, 1974, p.13]. However Tahmasp was not a warrior like his ancestors. Instead, as noted by Stead, he was a diplomat, with the ability to form links with many outside countries [Stead, 1974, p.13]. It was under Tahmasp that the Persian links with India were formed, and hence an Indian influence upon the art of Persia developed. There is much evidence for these links, typified, for example, by gifts to the shrine at Ardabil catalogued as coming from countries such as India. An example cited, a gift of a heavily jewelled tomb cover for Sheikh Safi's shrine [Stead, 1974, p.13]. This shows that by this point in the history of Persia, heavy trade links were already well established, allowing routes for cultural diffusion.

Both Ismail and Tahmasp are accredited with the development and renaissance of ancient Persian art. It is written that under the rule of Ismail, painters from Herat were brought to Tabriz, with the intention of creating art, a tradition established by Ismail I [Stead, 1974, p.13]. Throughout history it was a widely accepted tradition that artists and artisans, would be chosen, and moved to centres of excellence. This was the case with Ismail and Tahmasp, with artists from Herat being moved to Tabriz. Stead made reference to this trade in skill, when he stated:

> "Throughout the history of the Near and Middle East, artists and artisans have been moved about to enrich a court or capital. The tradition is ancient: Cyrus the Great, the first Achaemenid, used Ionian

> masons in the construction of his first capital at Pasargadae; and later these and other non-Persian artisans carried out the construction of the vast ritual centre at Takht-i-jamshid, which we know as Persepolis." [Stead, 1974, p.13]

During Safavid times, carpets were used as a rich tool of trade. Stead made reference to correspondence with Sulayman the Magnificent, about a gift of carpets made specifically for designated rooms [Stead, 1974, p.13]. Shah Tahmasp so greatly valued the Persian carpets made within his courts, that they were offered as highly prized gifts [Stead, 1974, p.13]. Gifts were also offered to the shrine at Ardabil. Stead made reference to a number of offerings to the shrine, such as a magnificent library, which was a gift of the Shah Abbas, and a large selection of Ming Dynasty (1368-1644C.E.) porcelain, believed to have been a royal gift, from the Chinese Emperor Wan Li [Stead, 1974, p.13]. It was customary for gifts to be presented in Iran. Therefore the importance of Ardabil to the Shi'ite doctrine, meant that it became an obvious magnet for these gifts of trade, and this may be how the carpets came to be in the possession of Ardabil. Suggestions as to how the carpets came to be in the possession of Ardabil is detailed in Section 6.5. Stead made reference to the offering of gifts to shrines:

> "It has long been the custom in Iran to present offerings to shrines, mosques, and other sacred places. Ardabil, as a Shi'ite Shrine, was a particular magnet for such gifts, or *waqf*. Princes and other donors made gifts to the Shrine's inventory of lamps and candlesticks, carpets and silk brocades. Tradition declares that the famed Ardabil carpets were in this manner presented to the Shrine." [Stead, 1974, p.13]

6.2.3 The Ardabil shrine

This section will describe the main buildings of the shrine, and try to attach dates to the actual construction, evidence will be presented pictorially, to show the changes of the structure of the shrine complex. This section provides only a brief summary, as a

background for the subject matter, the reader is directed towards the work of Morton [1974, 1975], for a more in depth discussion. Morton is regarded as the premier authority on the history and construction of the actual shrine site.

The shrine complex at Ardabil has been widely documented by many scholars including Weaver [1984], King [1986], Canby [1999], and Morton [1974, 1975]. Published work on the shrine complex dates back to the work of Sarre in 1897 [Morton, 1974, p.31]. The first published mention of the shrine complex dates back to the Persian writings of Ismail Dibaj in 1334/1955 [Morton, 1974, p.31]. No comprehensive written history of the shrine complex survives, but plentiful evidence covering various periods is provided by secondary sources, although in certain circumstances their validity is questionable.

Sarre cited evidence provided by four Europeans, who visited the site. The four visitors were Della Valle (visited the shrine in 1619 [Morton, 1974, p.37]), Olearius (visited in 1637 [Morton, 1974, p.37]), Tavernier (visited the shrine complex and Iran between 1631 and 1667 [Morton, 1974, p.37]), and de Bruin (visited the shrine in 1703 [Morton, 1974, p.34]). All of these sources therefore visited the shrine site whilst it was under Safavid rule between 1501-1786 [Morton, 1974, p.32]. Morton in his study on the site, utilised a further source of evidence, the *Sarih al-Mılk*. This document contains details of the *waqf*[21]. Morton stated, "...the term *Sarih al-Milk* was a common noun which could refer to any similar register of real property." [Morton, 1974, p.33]

Morton provided a translation of the *Sarih al-Milk*, listing some of their buildings, their inscriptions, and their purposes within the shrine site [Morton, 1974, p.39-44]. Dates are difficult to attach accurately to the buildings due to renovations,

[21] "Basically, a waqf is a pious endowment such as a mosque, school, or public drinking fountain...Waqfs were originally institutions for the poor and needy. Endowed by wealthy rulers or merchants, they were at the core of the mediaeval system of public welfare which exceeded anything outside the Muslim world before the twentieth century. In theory, the property held by a *waqf* had been 'given to God' and was therefore in alienable. The income from it belonged to the poor. However, wealthy families were sometimes able to use the *waqf* system to avoid parcelling property in accordance with the inheritance laws stipulated in the Shari'a." [Ruthven, 2000, p 158]

and a lack of accurate datable evidence, Morton stated, "...difficult to use as a means of dating the original construction of particular buildings because many of them have been restored or altered in the past, and much of the present tile work is modern." [Morton, 1974, p.44]

Attention is focused below on a pair of carpets (Figure 6.3) traditionally associated with the Ardabil shrine.

6.3 The Ardabil carpets

The Ardabil carpets, are two specific carpets, the first of the two is the Victoria and Albert Museums (V&A) carpet, [Acc. No. 272-1893], and the second carpet is held in the Los Angeles County Museum of Art, [Acc. No. 53.50.2].

For the remainder of this chapter these carpets will be examined, and discussed. They are two specific examples, not to be confused with a Persian type of carpet, often referred to as 'Ardabil'. Often carpets have generic names, which are not necessarily accurate. The two examples examined within this section are referred to as 'Ardabil', specifically because it is believed that they were purposely woven, or were resident, at the 'Shrine of Ardabil'.

The history of the Ardabil carpets has been widely catalogued by many scholars including King, Stead, Ittig and Weaver. A far more detailed history of the two carpets can be seen by referring to the published work of these individuals. For the purpose of this thesis, a brief outline of the more important historical aspects of the carpets is presented.

Figure 6.3 The Ardabil carpets

Victoria & Albert Museums
Ardabil Carpet

Los Angeles County Museums
Ardabil Carpet

6.3.1 Brief history of the Ardabil carpets

The exact origin of the Ardabil carpets has remained a mystery since they were acquired by the V&A, and LACMA museums [Ittig, 1993, p.81]. Very little was known about the carpets before their departure from Iran in the late 1800s [King, 1996, p.89][Weaver, 1984, p.43]. Stead stated, "We are on surer footing in tracing the carpets after their departure from Iran...In following them, we encounter some bizarre circumstances- notably, deliberate concealment of the existence of the Los Angeles Ardabil..." [Stead, 1974, p.31].

The Ardabil carpets were discovered in the late 1800s [King, 1996, p.89]. There was a very strong market and trade in oriental carpets, therefore carpets were in demand and highly prized. Fuelled by trade, objects were transferred to Europe, further markets developed, and oriental, especially Persian carpets became highly desirable. Stead made reference to this growing demand for artifacts from the Orient, when he noted:

> "Since the time that Persian carpets began appearing in the courts of Europe, they have been particularly favoured by English collectors. A strong British market for Oriental and especially Persian carpets existed from Elizabethan through Edwardian times and certainly until mass-produced Axminster and Wilton carpeting and the exigencies of twentieth-century war and depression joined forces to diminish the demand." [Stead, 1974, p.31]

In late 1886, one of the Ardabil carpets was purchased by Vincent Robinson and Company of London, from a Manchester-based firm, by the name of Ziegler and Company [King, 1996, p.91]. Ziegler and Co. were established importers of foreign rugs, with offices in Tabriz, Sultanabad, and elsewhere in Persia [Ittig, 1993, p.82][Stead, 1974, p.31].

The trade in Persian carpets had become increasingly valuable [Stead, 1974, p.31]. Carpets had become popularised and were regarded as a sign of wealth, within

the upper circles of society. Changes in society during the nineteenth century, and in particular, improvements in mass-communication, had allowed people to become aware of other cultures and their arts. The public were spending more time in museums, etc., and therefore a mass growth in knowledge was underway, education, and changes in society were allowing for the popularisation of art. These changes in society, increased the pressure on the South Kensington Museum to buy the Ardabil carpet. Ittig stated,

> "Zieglers were a Manchester-based concern involved in the trade of both new and antique carpets from Iran to Europe and America. They played a very significant role in the tremendous increase in Persian carpet exports to Western markets in the late 19th century- the so-called Persian carpet boom. Some of the factors that contributed to the popularisation of new and antique oriental carpets- the great World's fairs and museum exhibitions, as well as the revival of interest in the decorative arts, known as the Arts and Crafts movement in England- also influenced the Museum's purchase of the 'Ardabil' carpet." [Ittig, 1993, p.82]

The carpet was catalogued by Robinson and Company as the "Holy Carpet of the Mosque at Ardabil" [Stead, 1974, p.31]. After a busy press interest in Robinson and their recent acquisition, John Edward Taylor drew the attention of the South Kensington Museum to the presence of this carpet [Stead, 1974, p.32]. Stead stated, "...it was he who offered to raise £500 in public contributions if the museum would pay £1,500 toward the purchase price of £2,000." [Stead, 1974, p.32] The cause was widely supported by the likes of William Morris [Stead, 1974, p.32]. However public subscription could not match the level required. It was in March 1893 that the museum was asked to increase their contribution to £1,750 [King, 1996, p.91]. The carpet was acquired by the South Kensington Museum on March 30th, 1893 [Stead, 1974, p.32][King, 1996, p.89][Ittig, 1993, p.81].

Up until this point in the history of the carpets, no mention had been made of the existence of a second Ardabil. However in June 1903, Mr.Shmavon Malayantz

offered to sell the museum an Ardabil fragment for £25 [Weaver, 1984, p.48][Stead, 1974, p.33]. Stead made reference to this visit:

> "The visitor claimed knowledge of other fragments in Persia and presumably was prepared to obtain them if the museum purchased his small section. But Mr.A.F.Kendrick, then the keeper of textiles, decided that the price asked 'places its acquisition out of the question'." [Stead, 1974, p.33]

With the existence of other Ardabil fragments being brought to the attention of the V&A [Weaver, 1984, p.48], the records remained blank as to any ensuing investigation, it appeared the museum disregarded the possibility of another matching carpet. Even when the Ardabil in the V&A was examined, it was clear that in areas the pile was orientated in two directions, suggesting a piecing of the carpet during repairs. It appeared that no queries were brought forward, or alternatively the museum chose to ignore the possibility of a second surviving Ardabil. Stead noted:

> "There is nothing to indicate, for example, that any systematic investigation was carried out, although Sarre, in his work *Old Oriental Carpets*, observed that larger and smaller fragments of a similar carpet had been inserted, often with the warp in the wrong direction. Even today a careful lay observer can detect a number of areas on the London carpet that are obviously alien to the original. That this was not apparent to the museum from the beginning is hard to believe. We can only surmise that the increasing evidence of a second Ardabil carpet was distasteful to the Director and Trustees, and that by tacit agreement it was deemed prudent to maintain silence." [Stead, 1974, p.33]

In the following years, various fragments of carpet were offered to various museums and collectors, including the Los Angeles County Museum of Art. Mr. Eric Binns of Surrey offered a fragment to the museum. He inherited the fragment from his father, who was an agent for Ziegler and Company, this was noted by Stead, "The elder Binns had obtained it in Tabriz, about fifty years ago, from 'someone in the carpet trade...who may have been connected with the first surgical and restoration operation when this was underway in Turkey'." [Stead, 1974, p.34]

The LACMA Ardabil was first owned by an American multi-millionaire, by the name of Charles Tyson Yerkes [Stead, 1974, p.34], who was a famous collector of lavish and exotic objects. Stead commented on Yerkes' purchase of one of the Ardabil carpets:

> "In an issue of American Art News, dated December 1, 1919 is correct, Yerkes purchased his Ardabil from Vincent Robinson and Company in 1892 for the staggering sum of $80,000, or approximately £76,000 more than that paid by the South Kensington Museum for the larger London version..." [Stead, 1974, p.34]

The LACMA carpet then passed through the hands of a number of people. In 1910, Joseph Raphael De Lamar, purchased it for $27,000 [Stead, 1974, p.35]. However he died in 1918. In 1919, it passed into the hands of the Duveen brothers. Joseph Duveen was so eager to gain ownership, agents were instructed to pay up to $250,000, but the final price was $57,000 [Stead, 1974, p.35]. The carpet was then lent to a number of exhibitions by the permission of the Duveens [Stead, 1974, p.35]. Firstly in 1931 it was at a Persian art exhibition at Burlington House in London, then in 1938 it was loaned to the Bibliotheque Nationale in Paris [Stead, 1974, p.35]. It was at this exhibition that Mr. Jean Paul Getty, first saw the second Ardabil carpet. Getty was a well known decorative art collector, and set his sights on the purchase of this artifact. Finally the carpet was sold to Getty in 1938 for just under $70,000, and was used in his Los Angeles apartment [Stead, 1974, p.36]. In 1940 it was lent to the New York exhibition of the Iranian Institute, where it drew the attention and admiration of the Egyptian King Farouk [Stead, 1974, p.36]. Stead stated, "Mr. Getty relates that he declined Farouk's offer of more than a quarter of a million dollars for his Ardabil, which the Egyptian monarch wished to give the royal couple as a singularly appropriate wedding gift..." [Stead, 1974, p.36] Finally in 1953, Getty donated the carpet as a gift to the Los Angeles County Museum of Art [King, 1996, p.89].

6.3.2 Material construction of the Ardabil carpets

Within this section the material construction of the two carpets will be described. Both carpets are believed to have been stored for a long period of time at the same location, believed to be the shrine at Ardabil. Figure 6.4 shows the data ascertaining to the material construction of the two Ardabils, reconstructed from the work of Stead, [Stead, 1974, p.49].

		Los Angeles (Acc. 53.50.2)	London (Acc.272-1893)
Present dimensions:		length : 23'11"	length : 34'6"
		width : 13'5"	width : 17'6"
Materials:	warp	silk, Z spun, 2-ply, S, undyed	cream, Z spun, 2-ply
	weft	silk, unspun, paired, undyed	3 shoots cream silk, each shoot of paired ends
	pile	wool, unspun (slight Z)	wool, unspun
	colours	black, blue, dark blue	black, blue, dark blue
		light blue, green, blue-red,	light blue, green, blue-red,
		light blue-red, orange-red, white, yellow.	light blue-red, orange-red, white, yellow.
Structure :	weave	3 (paired) weft yarns between each set of knots,	3 (paired) weft yarns between each set of knots
warp yarn count		33-35 per inch	28-32 per inch
weft yarn count		56-62 per inch	52-58 per inch
	knot type	Persian	Persian
	knot count	19-20 per longitudinal inch	17-18 per longitudinal inch
		20-21 per latitudinal inch	+ or - 18 per latitudinal inch
		380-420 per square inch	297-324 per square inch

Figure 6.4 Comparison and technical analyses of the London and Los Angeles Ardabil carpets

Both of the carpets were produced with wool pile yarns, knotted using the Persian (senneh/senha) knot (Figure 5.8), on undyed silk warps, and each row of pile was separated with three shots of undyed silk weft.

It can be seen that the LACMA museum's carpet is significantly smaller than

the V&As carpet. It is believed by many, including Stead, that the borders were removed from the LACMA carpet, to repair and renovate the V&A carpet, shortly after their purchase from the shrine. Despite these missing sections, it is accepted that the carpets are almost identical, and therefore belong together as a pair. Stead acknowledged this feature, when he noted that, "...the carpets are a nearly identical pair." [Stead, 1974, p.17] When Stead stated that the carpets were almost identical, it is assumed that this was in relation to the design structure, and not the technical analyses. By referring to Figure 6.4 a large variation in the number of knots per square inch is apparent, and therefore the carpets are not identical. The LACMA carpet has 380-420 knots per square inch, while the V&A carpet has 297-324 knots per square inch. The LACMA carpet is the finer of the two.

Many scholars including King and Stead, believed that the V&A and LACMA carpets were always intended to be a pair, and therefore it is possible that they were woven simultaneously, possibly side by side. As observed by Stead, the practice of weaving carpets simultaneously as a pair often occurred in Persia during the sixteenth century. He stated that, "The weaving of important carpets in pairs was not an unusual circumstance in sixteenth-century Persia." [Stead, 1974, p.17]. Many features of the Ardabil carpet pertain to the simultaneous weaving of the pair. For example, the same faults occur at the same points from carpet to carpet, such as faults in fibre dyeings.

King recognised that the wool from the carpets when compared, was identical, even to the extent that where the carpet had faults in the dyeing quality, they appeared in the same place from carpet to carpet. King believed that this could be explained, by the fact that the carpets were woven simultaneously, side by side, using the same supplies of raw materials. King stated,

> "...motifs, and indeed, all details of the pattern recur identically in both carpets; even random variations in the colours are similar in both. The two carpets are almost exact replicas and must surely have been woven

concurrently, using the same batches of dyed wool." [King, 1996, p.89]

Stead however, did not accept this belief, he accepted that certain features of the carpets were the same, such as the placements of design elements, but this could have been created just by using the same cartoon for both carpets. But he noted subtle technical differences between the carpets, such as knot count, warp and weft count, etc. Stead stated,

> "While some features and placements in both Ardabils are phenomenally duplicated- for example, the central sunburst medallion in each work measures precisely 5'10" by 5'8.5"- there are variations in weaving technique and wool quality, along with minor changes in design." [Stead, 1974, p.17]

By referring to Figure 6.4, the differences between the two carpets are clearly evident. As noted previously, the LACMA carpet has more knots per square inch that the V&A carpet [Stead, 1974, p.17]. This feature brings into doubt the validity of the belief that the two carpets were woven simultaneously, even though they bear the same date. Stead stated, "If nothing else, this discrepancy rules out conjecture that the carpets were woven simultaneously, although they bear the same date. The writer is inclined to believe that the finer weaving of the Los Angeles Ardabil makes it the older of the pair." [Stead, 1974, p.17]

The Ardabil carpets are very finely knotted, both are very fine in comparison to a normal Persian carpet. Stead compared the Ardabils to a present-day Persian carpet:

> "Allowing for the curious difference in the number of hand-tied knots per square inch in both Ardabils, it can be estimated that the Los Angeles Ardabil, before it was shorn of its outer borders and lower field, contained approximately 35,00,000 knots. The London Ardabil has been traditionally credited with 33,000,000. Present-day Persian carpet standards are in terms of *reghs*: the number of knots to a seven-centimetre lineal measurement. In this respect, the Ardabils are fifty-three to fifty-five *regh* carpets. The normal *regh* count for a good contemporary carpet is twenty-five to thirty." [Stead, 1974, p.30]

The above information further strengthens the belief that the carpets are objects of very high craftsmanship, and were obviously always destined for a prestigious location, possibly the shrine at Ardabil.

Scholars have considered the length of time that it may have taken to weave one of the Ardabil carpets. One suggestion that has been widely referenced is the belief that Maqsud[22] produced both carpets solely, and spent the majority of his working life working solely on this project [Stead, 1974, p.30]. This suggestion appears doubtful. Surely if this was the case, there would be some form of reference to such an undertaking. Stead made reference to the work of Jacoby [1938], who believed that a group of weavers would have worked simultaneously on the production of the carpets. He estimated that it would have taken a group of eight to ten men approximately three and a half years to produce a carpet to the standard of the Ardabils. Stead stated,

> "By the time that *A Survey of Persian Art* was published in 1938, carpet specialist Heinrich Jacoby ventured that a crew of weavers, their speed governed by the slowest worker, might have progressed at the rate of 3/8" per day. He allowed for eight or ten men at the loom and, considering also the time required for preparation, shearing, and finishing, estimated a need for at least three and one-half years of work for each carpet." [Stead, 1974, p.30]

If the writings of Stead are to be believed then the differences in material structure does appear to imply that the carpets were in fact woven separately. Stead noted that if the two carpets were examined under a strong light source, the two different qualities in the pile would be clearly evident. When the borders of the LACMA carpet had been transplanted to fully renovate the V&A carpet, the difference in pile quality was clearly visible. Stead noted that the LACMA carpet's pile is far more lustrous and softer, and the dyes more vibrant. He noted that the

[22] Maqsud is the name accredited on the inscription cartouche of both carpets, this will be discussed in more detail in Section 6.4.3.

V&A carpet is closer to the original condition, as the LACMA carpet has been recorded as having undergone some form of cleaning treatment at least three times since the 1920s. Stead made reference to these features,

> "Close examination under a strong light indicates the same pile direction in both carpets, although there is a contrast in pile quality and length. This observation carries over even to the outer borders of the London carpet, despite the presumption that they were 'transplanted' from the Los Angeles work in the process of the late nineteenth-century repairs to the London Ardabil. In general, the pile quality of the London carpet is harsher, shorter, stronger and more densely packed. The pile of the Los Angeles mate appears softer and more lustrous and is somewhat longer. The fact that the Los Angeles work is known to have been cleaned at least three times since 1920 could account for its more supple quality and its seemingly more vibrant colouring. Still, this would have no bearing on the pile length- a matter of trimming with shears and knife after the weaving process." [Stead, 1974, p.19]

Stead made no reference to the fact that the two carpets have exactly the same degree of aging, caused primarily by the effects to light. This suggests that the carpets were kept together as a pair; if they had been separate they would show distinctly different effects. Stead noted, "...both versions have virtually identical colouring. Age, climatic conditions and light exposure have inevitably caused fading." [Stead, 1974, p.19] This reference does appear to suggest that not only have the carpets been kept together for a long period of their history, but also that they must have been woven at the same time, possibly in the same area. If not woven together, both were woven using the same supplies of raw material. Different fleeces would show different dye effects, as different wools uptake dyes at different rates. However the pile on the carpets has the same colouring suggesting that the carpets were woven using the same supplies of fleece.

The Ardabil carpets are a remarkable pair of carpets, and believed to be the most valuable carpets in the world. Many believed that the second carpet was sacrificed to restore the first. Those from the V&A believe that the restoration was

correct, while those who have dealings with the LACMA carpet, believe it was 'sacrificed' or 'cannibalised' in order to restore the V&A version. Weardon commented:

> "At the time the London Ardabil carpet was accessioned, the existence of its pair was not generally known, and the fact that it might have been repaired with pieces from a second carpet was not considered. A subsequent comparison of the two carpets, one in the Victoria and Albert Museum, and the other in the Los Angeles County Museum of Art, has shown that the LA Ardabil carpet is reduced in length and that its main and outer borders are missing. This has led to the use of emotive phrases, condemning the 'cannibalisation' of the LACMA carpet to reconstruct the one in the V&A. It has often been suggested that both carpets when first discovered were 'badly dilapidated', in 'ruins' and 'tatters'..." [Weardon, Issue 80, p.103]

The significant differing size, (refer to Figure 6.4), is believed to be accountable to the fact that the LACMA carpet was cut up in order to restore the V&A carpet, a point made by Stead [1974], King [1996], and Ittig [1993]. Inconsistencies within the V&A carpet, are believed to be from the repairs carried out at the cost of the partial sacrifice of the LACMA carpet. Ittig stated:

> "Certain inconsistencies in the London carpet's design are attributable to restorations prior to its acquisition by the Museum. It is generally believed that much of the restoration of the London 'Ardabil', particularly of its border, was accomplished with sections taken from the LACMA piece, which is significantly reduced in length." [Ittig, 1993, p.81]

King studied the two carpets, examining the extent of the piecing between the two. It appeared from his work that basically the bottom end of the LACMA carpet was amputated [King, 1996, p.89]. The bottom end of the V&A carpet was highly pieced. There are a possible number of reasons for these findings. The first is that the LACMA carpet was cut up solely to repair the V&A version. Secondly and alternatively, the LACMA carpet had already been cut in half to allow it to be placed in the shrine complex, (a point which will be discussed more extensibly later in this

chapter). Referring to the amputation of the lower section of the LACMA Ardabil, King commented:

> "In the Los Angeles carpet, at the top end, sections of the quadrants, pointed ovals and background pattern have been excised; the whole of the bottom end has been amputated. The bottom end of the London carpet, ostensibly complete, is a patchwork..." [King, 1996, p.89]

The accuracy of the carpets therefore is brought into question, both carpets are recognised as being essentially a jigsaw of pieces. For example sections of the LACMA carpet are from a modern Feraghan pieced into the original. King recognised this feature, and observed:

> "The orange-red outer guard stripe of the London carpet, with a symmetrical pattern and angled corner motifs at the top, is partly original, but extensibly patched with pieces of a matching stripe, presumably from the Los Angeles carpet. In the latter it was replaced by two guard stripes, now reduced to one, identified as modern Feraghan." [King, 1996, p.90]

King gives details of the restoration, and piecing of the two carpets [King, 1996], and believed that it was not just the LACMA carpet that had the lower section amputated, but that the V&A carpet had undergone the same treatment. King stated,

> "Obviously the bottom extremity of the field was missing from both carpets and its reconstruction for the London carpet had to be improvised by assembling patches of more or less appropriate design and colour, cut from both ends of the second carpet." [King, 1996, p.90]

King recognised that areas of both carpets are still missing, and that the cream guard stripe, had been partially replaced by the left stripe from the LACMA carpet. In order to recreate the LACMA carpet, King believed that originally a stripe from a modern carpet was included, in a similar way to the inclusion of the Feraghan, but this was then replaced with extensive reweaving following the original pattern [King,

1996, p.90]. King recognised that the LACMA carpet was sacrificed for the restoration of the V&A carpet. By doing so the carpets were able to be presented as one full-sized Ardabil, and a smaller version, but even so the two carpets are still remarkable and powerful examples of Safavid court carpets. King commented:

> "Evidently two worn and tattered carpets, both lacking the bottom end of the field and the adjacent borders and guard stripes, have been transformed by restoration into one apparently complete carpet, about 10.5m x 5.3m, and another obviously incomplete, but still impressive carpet, about 7.3m x 4.1m. Before these repairs the two carpets, both minus the bottom ends, may have measured- judging from the parts of their pattern that are preserved and those that are missing- roughly 9.0m x 5.3m. The restoration work is said to have taken more than four years, presumably 1887-1891." [King, 1996, p.90]

6.3.3 Design construction of the Ardabil carpets

The Ardabil carpets belong to a wider class of carpets referred to as "Northwest Medallion carpets" [Stead, 1974, p.14]. A Northwest medallion carpet is characterised by having a central medallion, and then quarter sections of the centre medallion echoed and repeated in the four corners of the field of the carpet. Stead noted:

> "By virtue of their design the Ardabil Carpets belong to a class known as Northwest Medallion carpets, one of about thirty basic classifications for Persian carpets. Logically enough, they are given this title because their design is generally dominated by a central medallion. A favoured treatment, seen also in the Ardabil design, repeats quarter-sections of the medallion in the corners of the field. At times more than one medallion may occupy the field." [Stead, 1974, p.14]

Both the V&A and the LACMA Ardabil, had ten colours used in their construction, including a white or natural coloured fibre. Stead believed that all of the dyes within the Ardabil carpets would have been naturally derived, he stated, "Ten colours were used in the Ardabil design. These, except for the possibility of undyed

yarn used in white ground areas, were derived from natural bases, perhaps all vegetable." [Stead, 1974, p.19]

Stead provided justification for natural dye usage, it was decreed by the Persian government that aniline dyes were illegal, therefore all dyes used in this period would be of natural origin. The various dyes came from various sources; the three shades of blue were all derived from indigo, with the increased number of presentations to the dye bath being accountable for the different shades of blue and black. The green may have been derived from either a combination of blue and yellow, or have come directly from ripe turmeric berries. The yellow dye was extracted from either pomegranate or saffron. The red was from wild madder, and finally the white or cream came from natural or undyed wool [Stead, 1974, p.20].

6.4 Symbolism

In order to discuss this and the subsequent sections more fully, the term 'symbolism', will be defined. Tulloch offered the following: "...the use of symbols to represent ideas. An artistic and poetic movement or style using symbols and indirect suggestion to express ideas, emotions, etc." [Tulloch, 1993, p.1581]

Often the design of objects goes beyond the purely function and decorative to include (possibly at a sub-conscious or subliminal levels) elements with inherent symbolism or hidden (at least to the uninitiated) meaning. Culture plays an important role in the initiation and/or understanding of symbolism.

Humans learn culture, it is an educated entity. The culture that an individual is associated with affects their views on the outside world, and therefore their interpretation of situations. For example, a 'westerner' has a different belief system to an individual from the 'orient'; the former will not fully understand oriental traditions, and therefore cannot interpret designs and symbolism in the same way.

Symbolism and its interpretation is culture dependent. Cammann commented:

> "Any foreign tongue can seem to be a meaningless jumble of odd noises- until one begins to hear distinct sounds, then clusters of sounds, and finally words with apparent meanings... Similarly, the language of pictured symbols in the art of an alien culture can present a meaningless confusion of sight impressions, until one gradually notes repeating elements in certain patterns, traces how these were combined into larger units of design, and finally comes to see that certain units seem to be expressing definite ideas, interrelating with others to express broader meanings...real understanding of a given pattern only comes after one has first learned the grammar and syntax of symbols: that is to say, the system that governs their use and determines which ones can be combined, and in what ways." [Cammann, 1973, p.6]

Cammann believed that symbolism must be learnt, the methods for the usage of pattern must be understood, before any real meanings of symbolism can become apparent. Due to this feature often various different meanings can be fixed to one object, none may be correct, but not wrong either, for symbolism is often personal. Unless an individual is tightly connected to the symbol-producing group, actual meaning may never be known, it is little more than assumption and thought. The importance of symbolism in today's world maybe less than in past generations. With increases in mass communication, the role of symbolism may have declined. Also the widespread use and understanding of written language has depreciated the role of symbolism. In past cultures, where the mass population could not write, images took on a far more valued and important role; that is, they conveyed messages. Cammann commented on the importance of art, and its interpretation:

> "In a living tradition, Art was a means of communication, another kind of language, a way of conveying without words some basic concepts of Philosophy and Religion- to educate or to inspire, to help put the individual in harmony with the universe, or to give him magic protection. The vocabulary of that language consisted of symbols- in actual images or abstract motifs- and aesthetic pleasure could come as a by-product, from seeing how cleverly the desired meanings were conveyed..." [Cammann, 1973, p.6]

Symbolism can be easily interpreted, associated meanings are passed from generation to generation. Symbolism and its meanings can be maintained in a surviving culture. However the cultures that are discussed in this thesis, are passed cultures, they do not survive in the same form today, as they were when the carpets were manufactured. For example, Persian culture does not exist today as it did in the sixteenth century. The culture of the population has changed, therefore its belief system has adapted, and so the interpretation of symbolism will also have adapted. As the culture changes so the interpretation of symbolism does also, and the understanding is never noted. Cammann stated,

> "...as long as a great tradition was alive nobody bothered to record the significance of things. Meanings were taken for granted, and it was assumed that everyone knew them. Then, when the tradition is broken and its language of symbols is dead, it becomes extremely difficult for outsiders to reconstruct it to the point where it is possible to recover specific meanings." [Cammann, 1973, p.7]

Cammann noted that there are three main reasons why symbolism and its meanings are lost. Cammann primarily believed that the meanings behind the symbolism were just not important enough to be preserved along with the carpets. Secondly the ability to interpret the pictorial images has declined, symbolism is a culturally sensitive tool of communication. Another point made by Cammann of particular importance to this chapter, was that many orthodox Muslims were opposed to pictorial art, allowing only natural forms to be portrayed, such as flowers, etc.. These Muslims spurned all forms of pictorial symbolism. Cammann stated,

> "...most of the rugs were woven in the Islamic world, by Muslims for Muslims; but Muslim scholars have never considered the subject of rugs worth writing about...Secondly, so very many people in the Islamic world have now lost touch with their religion, except for the outward observances required by local custom, and therefore have no real knowledge of the old religious traditions; while most of the rug dealers who served as middlemen for the West have been Armenians, hence

> Christians, who never knew- or cared to know- very much about the old Islamic traditions and folklore. Thirdly, the most rigidly orthodox Muslims themselves have always spurned pictorial art, refusing to accept pictures of any living things except flowers and trees, and thus naturally rejected any type of symbolism that involved direct representations of birds, beasts, or men. Western scholars, knowing this, have simply assumed that the Islamic civilisations in general had no pictorial symbols to be expressed on the rugs..." [Cammann, 1973, p.6]

Although it is widely accepted that Muslims did not utilise pictorial symbolism, as in the use of figures, it would be wrong to assume that no meanings were attached at all. Cammann believed that Muslims used a different form of symbolism, utilising the metaphor, such as meanings behind words of objects, etc.. Symbolism is multi-faceted, multi-interpretational, and the true meaning may never be understood. Cammann stated,

> "...although the Orthodox Muslims have generally avoided direct pictorial symbolism- this does not mean that they did not possess symbolism of other kind, quite capable of expressing a full range of ideas. The mainstream of Islamic tradition has always included a fondness for metaphor, which is boldly evident in Muslim literature, and this also found expression in patterns and designs, gradually developing into forms of graphic symbolism." [Cammann, 1973, p.6]

Symbolism and pictorial representation are very personal; we can never claim to understand and interpret them without the possibility of doubt. Therefore within the next sections possible occurrences of symbolism and possible interpretations are discussed.

6.4.1 Structural symbolism within the Ardabil carpets

Cammann believed that symbolism was present not only in the actual patterns contained within the Ardabil carpets, but also in the structure of the carpet He argued that it was cultural beliefs that were represented in the designs, with the

importance being placed mainly on the religious symbolism. Cammann made reference to the purpose behind all symbolism and design: "The basic patterns and motives for all the arts and crafts drew primarily on one fundamental, all-pervading inspiration: the spiritual ideas and beliefs of the common faith." [Cammann, 1973, p.8]

Unlike the majority of scholars, Cammann believed that there was symbolism contained in the structure of most Islamic rugs. The fact that the majority of carpets, especially Persian carpets, have a central field and borders, is significant. The central field of a carpet, is very free flowing, far more naturalistic area than the borders. In fact in the majority of cases, the main field appears to carry on beyond the border, as though the pattern continues into infinity. In comparison the border is far more regimental and static. Cammann maintained that,

> "...the background of the field- especially on plainer rugs with more abstract decoration- seems much looser and less disciplined...this field pattern does not stop neatly at the border; instead, it seems to run on endlessly under and beyond it, as though it could continue on forever." [Cammann, 1973, p.8]

Cammann believed that this was representative of the Islamic belief of the *concept of endlessness*: "We meet the concept of endlessness very frequently in Islamic thought. God- under the name of Allah- is described as having Limitless Transcendence, Boundless Power, Infinite Mercy and Compassion, and His spiritual world above was believed to share in that Divine Infinity." [Cammann, 1973, p.8] The fact that the pattern continues or appears to continue into infinity is significant; the pattern is representative of Allah, and his powers, with infinite belief and influence. Cammann noted, "Patterns of Infinity have been very frequently used in the rug patterns of Persia and the adjoining lands to the north and east." [Cammann, 1973, p.8]

The presence of symbolism within the Safavid carpets does appear to have

some sort of importance. It was a widely accepted principle behind the Sufi views of Islam, that the followers must examine further than the surface, suggesting the presence of hidden meanings and symbolism. Cammann commented: "It was by means of such paradoxes that the Sufi teachers of Islam- like other Eastern sages- taught their disciples to glimpse reality behind surface appearances." [Cammann, 1973, p.9]

Cammann believed that Islamic religious beliefs are behind the actual structure of carpets, with the possibility of the *dissolution of matter* being portrayed. The Muslims believed that no mortal could ever portray the deity, so they could only describe what was not part of the transcendent unity. Cammann stated,

> "Another aspect of the spiritual world, in Muslim thinking, was its Indefinability. They felt that no mortal could define or describe the Transcendent Unity, which was God, any more than he could put imagined limits to Transcendence; and the same applied to the Spiritual Reality behind the illusory surface feature in His creation. In words, one could only express all this by dealing in negatives, indirectly defining the Indefinable by saying what it was not; but in patterns and designs on things, the idea of Divine Indefinability and the essential indefinability of the Life of the Spirit, the Muslims felt, could be best suggested by emphasising 'the Dissolution of Matter'." [Cammann, 1973, p.9]

Cammann believed that the principle of 'dissolution of matter' was represented as arabesques, ogees, and cloud bands on carpets. Previously it was used to produce stunning effects on walls, domes of mosques, and the tiling effects, such as those seen at the Alhambra palace at Granada [Cammann, 1973, p.9]. Intricate tilings were not used in Persia. Therefore Persia may have been the country of origin of carpet production, with carpets produced instead of producing highly decorative tiled floors.

The border pattern also has significance, functioning as a frame to the centre section, and acting as a door or gate to the central field. Cammann believed that the

structure of repetition within the border areas is representative of the passage of time, with motifs repeated at regular intervals. Cammann commented: "The rhythmically recurring elements of the border designs, parading in continuous succession, suggested the orderly progress of Time, as it proceeds in regularly recurring cycles." [Cammann, 1973, p.14] Cammann noted that in the repetition of motifs around a border, often a colour change occurs, such as black to white, representative of the changes of day and night. Cammann noted,

> "..the regular succession of repeated elements in the border, was further enhanced by inverting every second motif- sometimes giving this a darker colour as well- which added a suggestion of the alternating contrast between night and day in the everlasting round." [Cammann, 1973, p.14]

Carpet borders often have representations of a vine, one of the most widely used metaphors for the passage of time, and the continuity of life. He recognised that this feature was prevalent not only in Islamic art, but also in the art of China:

> "One of the most widespread and obvious metaphors for passing Time was an endless vine giving off flowers or leaves at regular intervals. Border motifs were based on this were very popular in China, where they were interpreted as conveying the idea of Everlasting life or Immortality for an individual, or as expressing the continuity of his family- or the race- giving forth at intervals a new child, or another generation, symbolised by the flowers or seed-crammed fruits that sprang from the vine." [Cammann, 1973, p.14]

Cammann stated that the two principal parts of a carpets structure, the border and the central field, although possibly of a very different stylistic nature, were still heavily interrelated, believing the border to present the 'mortal' idea of time, and the central field the 'heavenly' aspect. He stated that,

> "...even though the border and the field pattern of an Oriental rug each expressed a different order of existence- one concerned with Time, in contrast to timeless Heaven- they were intimately related...Thus, the rug was in this sense a Universe in miniature." [Cammann, 1973, p.14]

With the structure of time-related borders surrounding central infinity, an old

Asian ideal comes into operation, and that is the principle of the *Sky Door*. This is a gateway through which the mortal glances heaven. Cammann believed that the borders are serving as the sky door, and therefore a window through which to glance. The border is serving as a protective frame around the inner field, and therefore the totemic protective forces of carpets are again brought into perspective. Cammann stated,

> "The Old Asian idea of the Universe led the men of old to think that heaven beyond the Sky was separated from our human world by a gate in the Sky, the mythical 'Sky Door'. Therefore, since the rug-border, on which the time-bands were figured, served as a frame through which to catch a glimpse of the Heavenly World as symbolised by the inner field, it was natural for them to regard the entire border as representing the Sky-Door...In terms of this same Old Asian cosmology, the World of the Spirit which was symbolised by the inner field was considered to be the source of Divine Protection, the Fountain of Wisdom, the Ultimate Destination, and the Guarantor of Success in marriage, war, hunting, trading ventures, etc..." [Cammann, 1973, p.14]

Having considered the structural symbolism of oriental carpets, within the next section attention is focused on the pictorial symbolism contained within the Ardabil carpets.

6.4.2 Pictorial symbolism within the Ardabil carpets

Various scholars who have spent any length of time looking at the Ardabil carpet, appear to agree in the presence of symbolism and outside influences in the actual designs contained within the Ardabil carpets. The basic design structure of the Ardabil carpet is a central medallion that is surrounded by red, green, and cream ogees. Throughout the whole of the design the central medallion is echoed in the four corners of the central field. This characteristic is typical of the 'Northwest medallion carpets' [Stead, 1974, p.20]. Stead referred to the multi-faceted design, within which

appears to be a number of levels of pattern, producing the illusion of a three-dimensional design. He noted that,

> "The regal Ardabils have a multilevel design that gives the viewer an almost three-dimensional impression: this is caused by the fugue-like intricacy of the master design, in which the main medallion with its sixteen ogival appendages appears to float on a field of floral traceries, all this against a vibrant and pulsating blue background of varying tonality." [Stead, 1974, p.19]

Referring to the central medallion, Stead noted that the image is overlaid with a series of forms that intertwine throughout the whole carpet. Stead believed that these forms were representational of *tchi*, the Chinese cloud-band motif. He commented:

> "The medallion itself is overlaid with interlocking rose-blue arabesques which, in turn, interrupt a loose, yet always symmetrical arrangement of pale blue, undulating forms. These appear as sashes in the wind but are variations of *tchi*, the Chinese cloud-band motif brought to Iran by the Mongols." [Stead, 1974, p.20]

Stead believed that the central medallion was symbolic. The central medallion is made up of two forms overlapping each other, making a framed medallion in the centre section. With this feature, Stead believed that this central medallion is representational of a walled pool in the centre of a large garden. The whole of this area is covered in flowers, both around the edges of the pool and also floating upon its surface, further developing the view that the carpet is representational of a beautiful garden. Stead observed:

> "In the centre of the medallion, not instantly recognisable because it appears almost as an inner medallion within the larger one, is a roundel that suggests a walled garden pool. On its light blue surface float open lotus blossoms, these enhanced with decorative rhizomes that seem, magically, below the water's surface. The pool is edged with flowering plants on a burgundy ground." [Stead, 1974, p.20]

Stead believed that the central field was based upon a book cover as a source

of inspiration for the design. He used the presence of mosque lamps on the vertical axis as evidence of this. Such a feature was regularly used upon the covers of prayer books, etc., during the Safavid period. Stead used the work of Pope as a source of evidence for the suggestion that the design structure of the Ardabils was based upon the covers of ancient books. He stated that,

> "It was Pope's suggestion that inspiration for design of the Ardabils can be traced to the art of the book and, in particular, to book covers. The writer has been unable to locate a specific example in the Gulbenkian Collection that he once mentioned..." [Stead, 1974, p.26]

Stead referred to the two mosque lamps that are suspended from the central medallion along the longitudinal axis. The two lamps are of differing size, and it is this feature that he believed was adopted from the design structure of book covers. The lamps are suspended from the top and bottom point of the central medallion by the means of a lotus blossom. He commented:

> "...mosque lamps of different style are suspended outward from the uppermost and lowermost of the ogival panels which in turn radiate outward from stylised lotus blossoms that spring from the tips of equidistant minaret-type projections from the central medallion." [Stead, 1974, p.22]

The religious significance of the carpets does appear to have been increased by the presence of both the minarets within the structure of the carpet, and also the more prominent presence of the two mosque lamps. Both mosque lamps and minarets are highly religious items associated with the Islamic faith, and therefore suggest that the carpets were destined for a shrine or other place of religious importance. There seems little potential that either of the carpets were designed for the purpose of a prayer rug, due to the lack of presence of a *mihrab* or archway. All prayer rugs have some form of arch present with their design structure to allow for the point of the arch to be directed towards Mecca for the five times daily ritual of prayer.

The general design structure of the Ardabil carpets is based around a botanical theme, with no part of the design static. Instead it is very naturalistic, with flowers appearing to be randomly scattered on the main field, although this is very deceiving, as the carpets are no doubt objects of highly considered design, and not objects of random craft. Regular motifs appear within the structure of the central field, the first main feature of the botanicals are lotus blossoms, which Stead believed to be derived from Chinese peonies. He stated that,

> "The blossoms are a typical sixteenth-century Persian motif: the traditional Sassanian lotus palmette crossed with a Chinese peony. These Safavid creations appear full-throated in some instances and as barely emerging from bud stage in others. While balanced with astonishing precision, their arrangement is not rigid- they appear to have been scattered on the field. The serrated leaves, botanically impossible in the manner they vary on what are ostensibly related vines, resembling rose leave." [Stead, 1974, p.22]

Within the actual patterns contained in the central field, the dissolution of matter is also used. However in these pattern areas, it is referred to as the *denaturalisation of nature*. It was deemed offensive to portray objects of nature as they appeared, as this was only possible by the creator, Allah. Therefore artists were required to stylise objects. Cammann noted that,

> "...they generally expected the artists and decorators to avoid painting pictures of living things, meaning men or animals. Even when people did plants or trees, they were encouraged to represent them in a rather severely stylised manner, so as to alter or dissolve the actual forms, and make them decorative rather than pictorial." [Cammann, 1973,p.11]

When artists produced flowers, they were unable to be viewed purely as natural flowers. Instead strange hybrids began to appear, and occasionally flowers were simply represented as star-like forms. However with the medium of carpet production, a certain degree of image manipulation occurs simply due to the nature of production, the method of knotting produces far less fluid forms, than other forms of

craft, such as painting.

Another object of symbolism that occurs within the Ardabil carpet is the presence of the floral chains within the borders, and guard stripes. Cammann believed that within the borders are always a pointed item both pointing in towards the central field, and also pointing away from the central field, he believed that these perform a protective function, protecting the heavenly aspect of the design. He stated that,

> "...the very shapes of these various kinds of projections makes them look defensive, as though they were meant to ward off something- as indeed they were. Those facing out were symbolically intended to hold at bay any threatening forces or demonic influences exerted by evil jinns; while the inward-pointng ones had a rather different purpose. The latter were symbolically included to restrain, or keep in, the good Spiritual powers associated with the Heavenly pattern of the inner field, to prevent their life-enriching energies from escaping." [Cammann, 1973, p.15]

The LACMA and V&A carpets are full of rich colours and abundant images, that are representational of wealth and plenty. They are valuable carpets, which are perceived to have been created for a rich property, such as the shrine at Ardabil. Stead believed that the carpets were representational of a garden, which he noted is the same word used for 'paradise'. He believed that all of the images within the carpet were placed to portray, or be representational of paradise, with an abundance of flowers, and a beautiful walled pool. He noted:

> "In all, the Ardabil design bespeaks abundance, fertility, paradise. And surely this was the intention. Paradise, after all, is a Persian word for garden: *peri-deisa*, adopted by the Greeks and then put into our own language. The concept of paradise is dear to the Shi'ite, no less to any Persian. It runs as a strain through the poetry of Hafiz and Sa'adi; it is extolled in the Persian miniature; it is exemplified in the renowned Persian garden." [Stead, 1974, p.26]

The presence of the two hanging lamps in the scrolling blooms, does appear

slightly out of place, but the reason for their presence has been suggested by many scholars including Humphries, and partially by Stead. Both of these writers believed that the lamps were representational of the Sheikh and Shah, for whom the carpets were intended, one for Ismail, and the other for Safi. Stead stated, "In 1910, Sydney Humphries suggested that the lamps symbolised Sheikh Safi and Shah Ismail, an imaginative but not entirely convincing speculation." [Stead, 1974, p.26] If this is the case then the belief that the carpets were commissioned by Tahmasp may be justified. Both Ismail and Safi were Tahmasp's direct ancestors, and he was following in their steps, and by creating a *waqf* in their honour, a fitting memorial, and a sign of his great respect for his forefathers.

Another suggestion is that the carpets were representational of a significant piece of architecture, and therefore their design structure is supposed to mirror the building to which they were intended. Stead used the work of Tattersall [1931], Kendrick [1919, 1922] and Ettinghausen [1940, 1970], to justify this belief, arguing that the design of the carpets was based upon the ceiling of the Madir-i-Shah in Isfahan. However this building was not erected until 160 years after the date of the Ardabils, and therefore this suggestion is highly unlikely. Unless it was in fact the other way around, and the room echoed the designs of the already existing carpets. Stead stated that,

> "...suggestions by Tattersall, Kendrick, and Ettinghausen that the design repeats architectural features of the vast room for which the Ardabils were created. Seen in this context, the carpets may well 'reflect' a high ceiling above, with the central medallion and its surrounding units mirroring a dome, the two lamps hanging down from either side." [Stead, 1974, p.26]

This suggestion that the carpets mirrored the architecture for which they were intended, was further supported by the work of Martin [1908] and Dilley [1959], and although they disagreed with the location that was selected by Tattersall,

Kendrick,and Ettinghausen, they proposed that the Blue mosque at Tabriz was the more viable option. This building was built in 1465, before the Ardabil carpets, and the building was also at Tabriz, that many scholars believed was the location of the manufacture of the Ardabil carpets (discussed more fully in section 6.5). However this suggestion will always remain a conjecture, unfortunately the building was badly damaged, and therefore very little survives, and the remains at the site are not conclusive. Stead commented: "Martin and Dilley suggested the Blue Mosque at Tabriz, completed in 1465, [was]... an inspiration for the Ardabil design; but not enough of this magnificent building, now earthquake ravaged, remains to confirm the notion." [Stead, 1974, p.26]

Ittigs concurred with Stead, and noted that frequently the same artists that designed book covers were also used to design the cartoons for court carpets. She noted that carpet design may be based on Islamic book covers, but she also agreed with Steads views that the design may also be based around architectural structures. She commented:

> "Many writers have noted similarities of the 'Ardabil' medallion and the corner format to the designs of 16th and 17th century book covers and to layouts of domed architectural interiors. Indeed, in the literature it is usually assumed that the designs for Safavid carpets were created by the same court craftsmen who were responsible for the arts of the book and for painted architectural decoration." [Ittig, 1993, p.81]

Within this section, certain aspects of pictorial symbolism within the Ardabil carpets have been discussed. The next section deals with the unique feature that makes the Ardabil carpets so special, the inscription cartouche.

6.4.3 Details of the carpets inscription

The Ardabil carpets as well as having a host of conventional decoration, and being highly crafted objects, are made even more special due to the presence of an

inscription, including the presence of a date, on both carpets. The inclusion of a date is an indicator of the probable period of manufacture and in addition allows the dating of similarly styled carpets. Referring to both the LACMA and the V&A carpets, Stead commented:

> "Yet they are also signed and dated, which makes them all the more unique and significant. Their dating (946 after the Hegira, or A.D.1540 in terms of the Christian calendar) is important not only in clarifying the Ardabils' history, but also in establishing the approximate ages of undated Persian carpets of similar styles." [Stead, 1974, p.29]

The inclusion of a date is generally a more modern feature, and apparently only eight examples of dated Safavid carpets are held in collections, the oldest being the 'Hunting carpet" in Milan. The fact that both the Ardabils have dates (946 after the Hegira, or 1540 C.E.) present makes them special. It seems that the Ardabils are among the oldest examples of dated carpets [Stead, 1974, p.29], and are in fact the oldest pair of dated and signed carpets. The oldest dated individual carpet is the "Hunting carpet" mentioned above, which is dated to 1522 C.E. Stead commented:

> "Signed and dated Persian carpets are known more from recent times than from the Safavid period. Only about eight or nine Safavid examples are known to western specialists. These include the splendid Hunting carpet now in Milan, dated 925A.H. (or A.D.1522) and signed Ghiyath ad-din Jami, actually the oldest known and dated Persian carpet." [Stead, 1974, p.29]

Both the LACMA Ardabil and the V&A carpet have exactly the same inscription contained within their design. Ittig refers to the presence of a cartouches at one end of the V&A Ardabil containing an inscription including a date and name, Ittig noted:

> "At one end of the field of the London carpet is an ivory cartouche containing two lines of poetry from the Divan of Hadiz, as well as a signature and a date. The inscription has been interpreted as : *'Joz astan-e to-am dar jahan panah-i nist sar-e mara be-joz in dar Hawala-gah-I nist. Amal-e banda-ye dargah Maqsud Kashani. Sana 946.'*

> This translates as : 'I have no refuge in the world other than thy threshold. My head has no protection other than this porch way. The work of a servant of the court, Maqsud Kashani, 946' (1539-40A.D.)." [Ittig, 1993, p.81]

Stebbing is acknowledged as having translated the inscription, used (above) by Ittig [Ittig, 1993, p.81]. This (apparently completed in 1892) has for a long period of time been an accepted version. Stead noted that the first two lines of the inscription come from a *ghazal* or an ode by Hafiz [Stead, 1974, p.29], and provided an alternative translation, as follows:

> "Except for thy haven, there is no refuge for me in this world;
> Other than here, there is no place for my head.
> Work of a servant of the court, Maqsud of Kashan, 946."
> [Stead, 1974, p.29]

With either translation the role of Maqsud is as a dominion, performing a role, for a far greater power. This inscription does imply that the carpets' were intended for a powerful position, possibly a highly regarded gift to the shrine at Ardabil. By referring to himself as a lower placed individual the named person is portraying respect. Stead stated that this was "...obviously... a gesture intended only to assert the donor's low position in the scheme of things: low in the presence of the Shah, lower still in the presence of Allah." [Stead, 1974, p.30]

The next query that is produced by the inscription, is who exactly was Maqsud [of] Kashani, was he a member of the shrine at Ardabil, or a weaver, or master weaver at the location where the carpets were produced? Most scholars who have made reference to the Ardabil carpets in literature have discussed the role of Maqsud.

Ittig made reference to the role of Maqsud [of] Kashani, when she stated that although the date and signature within the design of the carpet make it increasingly special, they are not conclusive, and with the queries surrounding the role of Maqsud

Kashani, they still have to be treated with care. Ittig does suggest a number of possible roles for Maqsud Kashani, which were previously acknowledged by Stead. She commented:

> "It is often assumed that the inclusion of a date and/or a signature in a carpet permits its precise placement in time and specifically identifies its manufacturer. Yet although a Safavid dating for the London 'Ardabil' is accepted, the identity of Maqsud Kashani remains unclear. It has been suggested that he was, among other possibilities, the shrine's custodian, the commissioner of the carpet, a courtier, or a weaver. The last role may be the most easily dismissed." [Ittig, 1993, p.81]

Ittig stated that the probability of the weaver placing his name upon such a carpet is very small, and rarely permitted. Surely the name contained on the carpet would be of someone of a higher rank than just a manufacturer. No real evidence survives that can actually pin-point Maqsud Kashani's definitive role within the court, or his role in the manufacture of this pair of carpets. Ittig noted,

> "Given the cost and labour involved in weaving an 'Ardabil' carpet, it is unlikely that the *bayt* to be woven so prominently into its inscription cartouches would have been chosen casually. Accordingly, both *astan*, 'threshold', and *dar hawala-gah*, 'porch way', may be references to Maqsud's rank, as both are key terms in the description of the responsibilities of one of the Great Amirs of Court, the *Ishik-Aqasi-Bashi*, 'Head of the Masters of the Household." [Ittig, 1993, p.81]

Maqsud is not accounted in any of the shrine's inventory. Many shrines kept very detailed records of gifts, and objects contained within them, and although many of these inventories survive from Safavid times, nothing is accountable to Maqsud [Stead, 1974, p.30]. Scholars such as Pope and Stead, made reference to the actual name of Maqsud Kashani, stating that Maqsud may have been the master weaver rather than a donor of a gift to the shrine, and that Kashani, may not have been his name but instead may refer to the place of production, or even where Maqsud received his initial training. Stead noted,

> "This writer assumes, as did Pope, that Maqsud was the master

> weaver-designer, not the donor. His *nisbah* ('of Kashan' actually *Maqsud Kashani*) is an indication of his place place of origin, not necessarily that of the carpet. Kashan was also a vital carpet-weaving centre- where Maqsud doubtless received his early training- but a weaver of such excellence, together with his entourage of workers, might well have been summoned to Tahmasp's capital." [Stead, 1974, p.30]

Having discussed the content of the inscription cartouches, and the questions associated with them. Another question has been brouht to the fore, and that is the origin of the Ardabil carpets. This question is addressed in the next section.

6.5 Origin of the Ardabil carpets

The pair of carpets have been referred to and classified as the "Ardabil carpets" specifically because it is believed that they were purposely woven for the Shrine of Ardabil, where many authorities such as Stead [1974], believed they remained until the 1800s, when they were sold to a carpet dealer in Britain. Although woven for this site, it does appear to be very unlikely that they were actually woven at Ardabil. The more viable option is that they were woven elsewhere, in locations such as Tabriz or Kashan. As noted in Section 6.2.2, the centre of Tabriz, was highly regarded as a centre for the manufacture of carpets, and was also the favoured location for the selected artists of both the Shahs Tahmasp and Ismail. Stead commented:

> "The fact that the carpets under study are commonly known as the Ardabil Carpets has only one significance: a long-held belief that they were woven for the Shrine at Ardabil and remained there for more than three centuries until their transfer to England in the late 1800s. There were and are looms at Ardabil, but there is no evidence that this Azerbaijan city ever developed the more important reputation of cities like Tabriz and Kashan for carpet production, and one therefore assumes that the carpet must have been woven at one of these latter two sites." [Stead, 1974, p.14]

At the historical point in question, as recognised by Stead, Tabriz was widely recognised as a base for the imperial looms: "Tabriz, despite states of siege and periodic occupation by the Ottoman Turks, was a site of royal looms during the early Safavid period." [Stead, 1974, p.15]

Many sumptuous carpets are attributed to Tabriz, especially during the reign of Shah Tahmasp, which conforms to the date associated with the carpets themselves. It is accepted that the Ardabil carpets are excellent examples of court carpets, which were explained by Stead as follows:

> "The phrase 'court carpet' is not another classification, but applies to carpets of any design made to the commission of the court or royal looms. Just as emperors of ancient China maintained royal factories for the production of ceramics, silks, and other works for court use and presentation, so did the Shahs of Persia." [Stead, 1974, p.15]

From this statement it can be seen that specific looms were used only for the production of prestigious carpets. This manufacturing method was to maintain the quality and exclusiveness of the Persian court carpets, and therefore the imperial looms at Tabriz were reserved exclusively for the manufacture of such items. As well as having designated looms there were also imperial herds. The quality of sheeps' is heavily influenced by the grazing available; therefore imperial flocks were maintained in the Ahar district, known for high quality grazing. Wool from these flocks was of the finest quality, and the imperial supply far surpassed the wool from the usual nomadic fleeces, and so the quality of the carpet produced would also surpass nomadic carpets. The Ardabil carpets were not of nomadic production, but produced by a settled population, and possibly accountable to the imperial looms of Tabriz. Stead summarised the situation as follows:

> "Tabriz has been favoured as the birthplace of the Ardabil Carpets for several reasons. First sumptuous carpets of related design have traditionally been attributed to Tabriz, more especially those woven during the reign of Shah Tahmasp. Second, even as royal looms were maintained, so were imperial herds. On the basis of an Ardabil fragment

> in his possession, Pope related its wool type to the wool of royal herds once maintained in the Ahar district, northwest of Tabriz. The grazing grounds of sheep have a definite effect on the quality of their wool, and the diet found in imperial grazing grounds might well be expected to surpass that of nomadic terrain." [Stead, 1974, p.15]

The Ardabils were not created by village or nomadic weavers but on a royal loom, possibly produced to a strict pattern, known as a cartoon or a *naqsh*. Therefore the designs were entirely planned with no degree of randomness about their structure. Such prized pieces would have been designed for a specific end location. It is regularly assumed that carpets of such a standard would have been produced by a team of weavers, under the direct guidance of a master-weaver or possibly a master-artist. These masters would most probably have been brought specifically to these centres of excellence under the guidance of either Shah Ismail or Shah Tahmasp. Stead made reference to all of these features:

> "Although nomadic and village weavers work traditional designs by rote, sometimes singing out the colour changes, they seldom use cartoons or sketches as an aid. Carpets of Ardabil stature, produced on royal and town looms, clearly required cartoons, or *naqsh*. Such aids, squared off to scale, permitted the team of weavers to proceed under the direction of a master weaver, confident that they were faithful to the intended design. Ideally the *naqsh* was the creation of a *naqsh-kas*, or specialised carpet designer, totally familiar with the unique requirements of weaving and preferably a weaver himself... The complex design of the Ardabils, and especially of their fields of balanced and interlocking flowering vines, could only have been created by a man who has the rare combination of master weaver and master artist." [Stead, 1974, p.29]

Stead therefore noted the difference between the court carpets and the nomadic produced carpets. The court carpets were highly regarded, with their production highly organised and precisely planned. A nomadically produced carpet, on the other hand, would probably have been produced solely using home-produced raw materials, and possibly intended for personal use. A court carpet would have been produced to order for prestigious locations, with a team working on the carpet.

Many suggestions have been put forward as to how the carpets came to be at the Ardabil shrine, if they were in fact manufactured away from the Shrine site itself. Stebbing suggests that they may in fact have been commissioned by Shah Tahmasp for the tomb of his father, Shah Ismail. However there is doubt as to the validity of this suggestion, for the actual tomb room of Ismail is not large enough to accommodate the carpets either singly or as a pair. It has been presumed that they may in fact have been designed as a memorial gift for Shah Ismail by Shah Tahmasp, but being too large for the intended room were then placed elsewhere within the Ardabil complex. Stead commented:

> "Stebbing and others have intimated that they were commissioned by Tahmasp to grace the tomb of his father. Yet the tomb chamber, which still exists, is not large enough for one, much less the pair. They might have been placed elsewhere in the complex, in a building that either no longer exists or has since been remodelled..." [Stead, 1974, p.14]

Weaver also looked at the possibility of the carpets being produced in Tabriz. However at the point in history when the carpets were actually manufactured, the Tabriz region, and Ardabil, were in an area of unrest. Close to the troubled Turco-Persian frontier line, transporting carpets, from an outside region into the area, would have presented difficulties. It is also debatable whether highly trained and valued weavers, used to produce the carpet, would have been sent into an area of serious civil unrest. Weaver commented:

> "It has been justifiably pointed out by some authorities that Tabriz was in a zone of unrest in the opening years of the reign of Shah Tahmasp, and one may conclude that it is thus impossible for the carpet(s) to have been made in Tabriz. The same reservation applies to Ardabil. It is unlikely that the best carpet weavers in the country would be sent into a potential war zone to settle down to the long task of weaving such immense and valuable carpets. Even if one accepts that the carpets were made elsewhere; it is almost ridiculous to expect that the carpets would be sent into a zone where there was a strong risk that they would be plundered by Sunni Turks. Quite apart from the hazards of war, the hazards of the roads should have been enough to rule this out;

the carpets sheer size makes them difficult to move even today." [Weaver 1984, p.46]

It seems therefore that there is a comprehensive, though inconclusive, debate on the origin of the Ardabil carpets and their association with the shrine. Further points of relevance to the debate are presented below.

6.6 Location of the carpets at Ardabil

Although frequently referenced as the '*Holy Carpets of the Mosque at Ardabil*', and accepted as such by many scholars, no concrete evidence is available to categorically conclude that the carpets were at the shrine of Ardabil. Frequently, contradictory arguments become apparent. Ittig observed that:

> "Much of the early literature on the London carpet indicates that it was brought from the shrine in Ardabil, but this theory remains a matter of controversy. In support of the Ardabil source is the oft-cited 1843 report by Holmes, whose description of the shrine mentions the remnants of a once magnificent carpet bearing the date of manufacture of some 300 years earlier. More specific are Abbott's notes, also dating from 1843: 'In the Apartment devoted to prayer there is a carpet bearing the date 946 of the Hejira woven in with the pattern- as it is now the 1259th year of the era the carpet must have been manufactured 313 lunar years ago'." [Ittig, 1993, p.82]

Ittig noted that there is only mention of one carpet and not the pair of Ardabil carpets, and also used the Ardabil Shrine inventory of 1759, to put further doubt on the presence of the Ardabil carpets in the shrine complex. She maintained that in 1759 there was no mention in the catalogue of a carpet that fits to the description or size of the Ardabil carpet, let alone a pair:

> "Yet, curiously, none of the carpets listed in the 1759 inventory of the shrine are identifiable as the 'Ardabils'. Furthermore, studies indicate that only one building in the shrine complex, the *Masjid-i Jannat-sara*, could have accommodated them. Of the various alternative sources, the

> shrine of Imam Riza at Mashhad has been most frequently suggested, as it is of sufficient size to have held both carpets. Study of the shrine's inventories would be essential to confirm this hypothesis." [Ittig, 1993, p.83]

Although Stead used the word "Ardabil", when referring to the carpets, he does not believe that this was their origin. He stated that the carpets were not holy, and that they were simply utilitarian objects of great craftsmanship and judgment. He believed the carpets to be Persian, due to the floral nature of their design, and maintained that:

> "A Moslem may have prayer carpets, and carpets may be woven or presented for mosque use, but this does not make them holy. The fact that the Ardabils are without human or animal design content has often been cited as 'proof' they are mosque carpets. This, however, is a weak contention, for in Persia, stronghold of the Shi'ite sect, there are certainly instances of birds, animals, and humans in mosque tiles and carpets, a break with the stricter Sunni tradition of other Islamic lands." [Stead, 1974, p.36]

It has been noted that certain scholars [Stead, 1974, and Weaver, 1984] recognised that the actual shrine complex at Ardabil was not large enough to accommodate both carpets. A schematic diagram of the shrine complex and possible locations for the carpets is presented in Figure 6.5. At the time the carpets were produced Ardabil was not a mosque, but a shrine [Stead, 1974, p.36]. A mosque was constructed in the shrine complex at a later date, and was referred to as the *Masjid-i-Janat Sara*. This octagonal building was one of the larger structures with a domed roof. This room may have possibly been home to the carpets, but unfortunately it collapsed in the early nineteenth century following successive earthquakes. Stead noted:

> "From his careful research, Mr. Weaver has also determined that a carpet the size of the Ardabil could not be placed or hung in any presently existing room of the complex without being folded or obstructed, and this is to say nothing of two such carpets, generally

placed alongside or flanking each other when paired, as in this instance." [Stead, 1974, p.36]

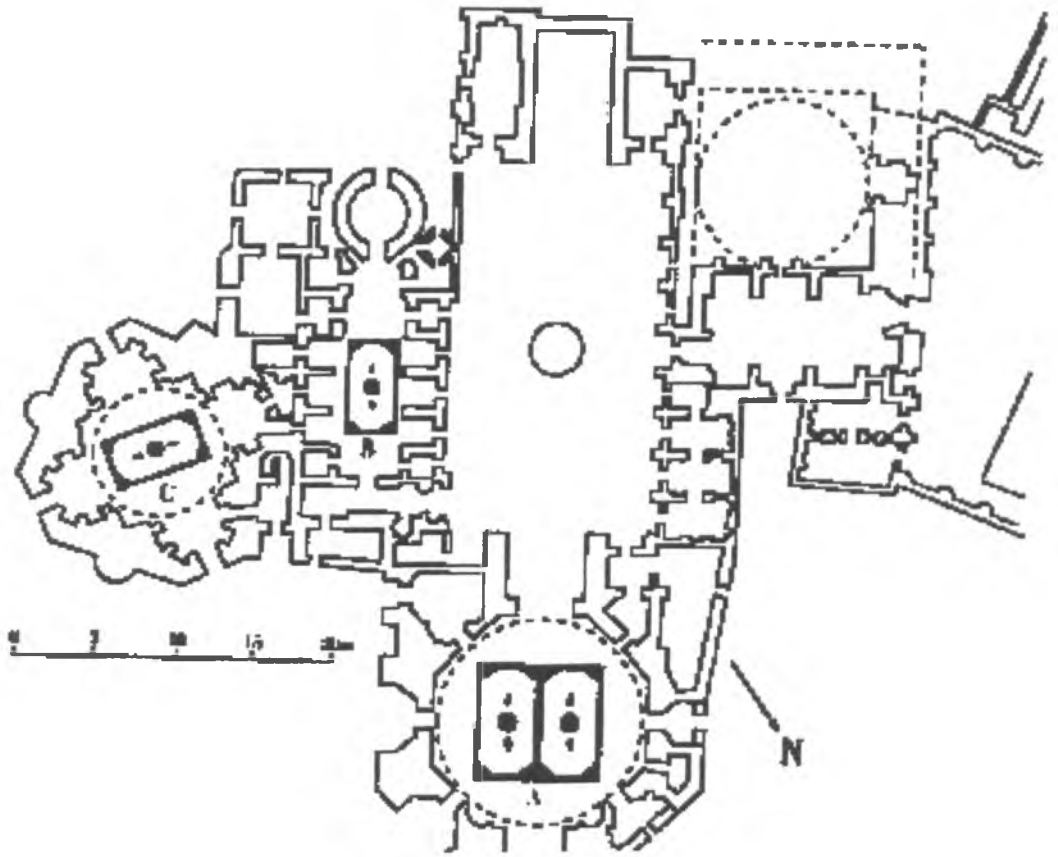


Figure 6.5 Plan of the main buildings of the Ardabil Shrine. [King, 1996, p.92] The medallion carpets are shown in different possible locations, the carpets in the Jannat-sara (A), then after being shortened to fit the Dar al-Huffaz (B), and possibly for the Chini-khana (C).

There is therefore much controversy concerning whether the Ardabil carpets were ever resident at the shrine at Ardabil, as it is widely believed that there was no singular room in the complex large enough to house both of the carpets simultaneously. After studying the shrine complex, Weaver believed that there were only four rooms in the complex that were capable of housing one or both of the carpets:

"...only four buildings in the shrine were ever large enough to have

> contained one or both of the Ardabil carpets, and even then some folding of the carpet(s) would have been required in the case of at least one building. These buildings were the so-called *Masjid-i Jannat-sara*, which lies at the northeast end of the inner court; the *Dar al-Huffaz*, or prayer hall, which is situated on the east side of the same court; the *Chini-khana*, or great porcelain house, which adjoins the east side of the *Dar al-Huffaz*, and the new *Chilli-khana*, which is now in ruins and lies behind the southwestern facade of the inner court. The new *Chilli-khana* was built during the period when Sadr al-Din was shaikh at Ardabil (1334-1391/2). Its dome was replaced during the reign of Shah Tahmasp (1524-1576), and was still in tact when Adam Olearius visited the building in 1637. The dome collapsed sometime between 1703 and 1758." [Weaver, 1984, p.43]

King believed that the carpets were originally made specifically for the *Jannat-sara*, and may have had such a special importance, that they were only laid out for the most special court occasions. Their usage as a pair were brought to an end when either the dome collapsed, or due to the decline of the Safavid dynasty. He commented:

> "The history of the Ardabil medallion carpets falls into three phases, each inaugurated by shaping them for a particular purpose. Made in 1539/40 for the Jannat-sara, they were probably displayed there as pair on special occasions such as visits of the Shah. This usage was brought to an end, perhaps by the collapse of the dome, perhaps by the fall of the Safavid dynasty in 1722." [King, 1996, p.92]

At some point in the carpets history, the two carpets were both cut in half, creating four large pieces of Ardabil carpet, King believed that this was carried out to allow the carpets to be placed elsewhere within the shrine complex. However, it is also possible that the carpets may have been produced in 'half' parts, (a common practice in the production of 19th century Kashmir shawls) that may have been previously utilised in the production of large-scale carpets, however without firm evidence, this is pure conjecture. At their original dimensions the carpets were far too large to be housed in any of the other rooms at the shrine complex. Finally the carpets, according to King, came to leave Ardabil, as the revenue generated from their

sale allowed for renovations on the dome of the complex. He observed:

> "By 1759, and perhaps earlier, they had been cut into four pieces, two large and two small, so that they could be used in other buildings at the shrine, none of which was large enough to house even one of the carpets in its entirety. In 1843 the main piece of one of them was on the floor of the Dar al-Huffaz. After the vault of this building collapsed in the 1870s or 1880s, the main pieces of both carpets were sold, probably to raise funds for the necessary structural repairs." [King, 1996, p.92]

Weaver [1984] examined the possible locations of the carpets. The relevant rooms can be seen in Figure 6.5. The first possible location is the *Jannat-sara*, which was believed to have been completed around 1540. Weaver commented:

> "...it is possible that the two carpets were commissioned for the Jannat-sara by Tahmasp, perhaps when he thought that the building might be his tomb. In later years when the dome of the Jannat-sara collapsed as a result of an earthquake, the remains of the carpet(s) might have been transferred to the smaller Dar al-Huffaz..." [Weaver, 1984, p.49]

The *Dar al-Huffaz* is the prayer hall at Ardabil, and was believed to have been built in the reign of Shaikh Sar al-Din Musa, around the early 14th century. This building was known as the Dome of the Princes [Weaver, 1984, p.44], and was the predecessor to the *Chini-khana*. Although a number of scholars have stated that the carpets could have been placed in the *Dar al-Huffaz*, this seems highly unlikely as the dimensions of the carpets do not correspond to the room sizes. Weaver commented:

> "...trying to 'fit' the carpet into the various rooms of the shrine on the basis of a large scale plan, the carpet's dimensions are larger than the current dimensions of any room in the shrine, with the exception of the Masjid-i Jannat-sara. What is more, despite what many people have surmised, it is highly unlikely that the carpet would have been laid on the floor of the Dar al-Huffaz, because to do so would have required that the ends and even parts of the carpet's sides to be folded under." [Weaver, 1984, p.45]

The *Dar al-Huffaz* and the *Chini-khana* are too small to house both carpets. The *Dar al-Huffaz* measured 8.9m x 5.8m, and the *Chini-khana* measured only 9.7m

x 9.7m. However these measurements should be accepted with caution, for it is feasible that the shrine complex has been changed in structure, and therefore dimensions of the room may also have changed significantly. Weaver commented:

> "Neither the Prayer hall main floor nor the Chini-khana main floor, then, as currently constructed, is large enough to accommodate the carpet. Moreover, recall that it appears that the two Ardabil carpets were once identical twins. When a pair of carpets was dedicated to a mosque, it was usual for them to be laid side by side, which, in the case of the Ardabil Carpets, would make a square measuring 10.52m. The Masjid-i Jannat-sara would be just large enough for the pair of carpets to be laid together. However, the building has an octagonal plan, and it seems strange that such sumptuous carpets would be commissioned and made to such large dimensions and yet still not fit the floor properly. The octagonal plan even means that there would be four odd areas of floor left uncovered." [Weaver, 1984, p.45]

The most feasible suggestion is that the carpets were intended for the Jannat-sara, however changes to the structure of the shrine complex meant that they possibly became resident in a number of locations at successive points in time.

6.7 Summary

The production and material construction of the Ardabil carpets are considered in this chapter. The symbolism associated both with the figured decoration as well as the structural composition have been examined. Reference was made to the Safavid dynasty, and the production of carpets at that time. The origin and intended end-use of the carpets were reviewed. It may well have been the case that one of the carpets was used as a 'pilot' sample, or trial run, to examine the overall design effect of the carpets decoration. If this was the case it could be argued that the V&A Ardabil was produced first due to the lower knot count, and the LACMA carpet was produced later, with a higher number of knots per square inch, making it the higher quality carpet. This would appear to be feasible, in view of the possibility that one carpet

was intended as a tribute to Ismail and Safi, and would have been required to be as near perfect as possible, in order to be a fitting tribute to Tahmasps ancestors. Such a possibility would of course rule out the case for the carpets being manufactured with the intention of them being used as a pair.

It appears that the most likely source of production was the imperial looms at Tabriz, as these looms were reserved exclusively for the production of the highest quality carpets, and the Ardabil carpets appear to fit into this bracket. This would be the case, especially if they were commissioned by Tahmasp with the sole intention of being placed in the shrine at Ardabil.

The carpets are excellent examples of Persian court carpets, and therefore the actual design structure of the carpets is characteristic of a Persian carpet with borders, a central field, and a medallion. Within this chapter the work of Stead [1974], Cammann [1973], and Ittig [1993], were reviewed and attention was focused on the symbolism within the pieces.

Making reference to the work of King [1996], Weaver [1984], Stead [1974], Morton [1974, 1975], and Ittig [1993], possible locations in the shrine for the carpets were considered. The most likely case is that the carpets were originally intended for the Jannat-sara also known as the the dome of Maqsura of the Jannat-sara [Morton, 1974, p.48]. Assuming that the intention was to use the carpets as a pair, this was the only room in the complex where both could be accommodated side by side. After damage resulting from earthquakes, and the subsequent collapse of the dome, it may have been the case that the carpets were cut in half and moved elsewhere in the complex, before being sold to Ziegler and Company.

Therefore in conclusion, it is believed that the carpets were commissioned by Tahmasp, as a waqf in honour of Ismail and Safi for the Jannat-sara at the Ardabil shrine.

Chapter 7 Geometry of the Surface Decoration of the Pazyryk and Ardabil Carpets

7.1 Introduction

This chapter develops further the discussion of symmetry in Persian and Anatolian carpets, presented in Chapter 4. All of the symmetries contained within the carpets were catalogued, a statistical analysis was undertaken, and comparisons and conclusions were drawn (Section 4.4).

Using the perspectives developed previously by Washburn and Crowe [1988], and Hann and Thomson [1992], this chapter makes a comparison of the symmetries of the two case study carpets: the Pazyryk carpet, and the Ardabil carpet:[23]

The Pazyryk carpet dates back to around 500B.C.E., while the Ardabil carpet is believed to be an example of Safavid weaving (1501C.E.-1786C.E.). A comparison of the symmetry and other structural characteristics of the two carpets, may help to identify the persistence of certain design elements and the development of others. The identification of similarities or differences may also enhance the understanding of whether or not symmetry in pattern design is a learnt or developed feature (ie. a question of nature versus nurture).

With the above considerations in mind, the objectives of this chapter are:

(i) to apply the principles of symmetry to the classification of patterns contained within the design structures of the Pazyryk and Ardabil carpets;

(ii) to undertake a comparative analysis of the two carpets;

[23] The carpets studied are the Pazyryk carpet, currently in the Hermitage Museum, St.Petersburg, Russia, and the Ardabil carpet, held in the Victoria and Albert Museum (V&A), London, United Kingdom. Although two Ardabil carpets do exist; the V&A example, and the Los Angeles County Museums of Art's (LACMA) carpet; it is felt that the V&A example will present a better piece for study, due to its more complete nature. The LACMA carpet is significantly smaller, and sections have been amputated [Wearden, Hali 80, p.103]. Therefore this piece would not present an accurate comparison. Although the V&A Ardabil has undergone large scale piecing and renovation, it is widely believed that the carpet is as close to its original design structure as possible Therefore providing a better exhibit by which to carry out a valid comparison of design structure.

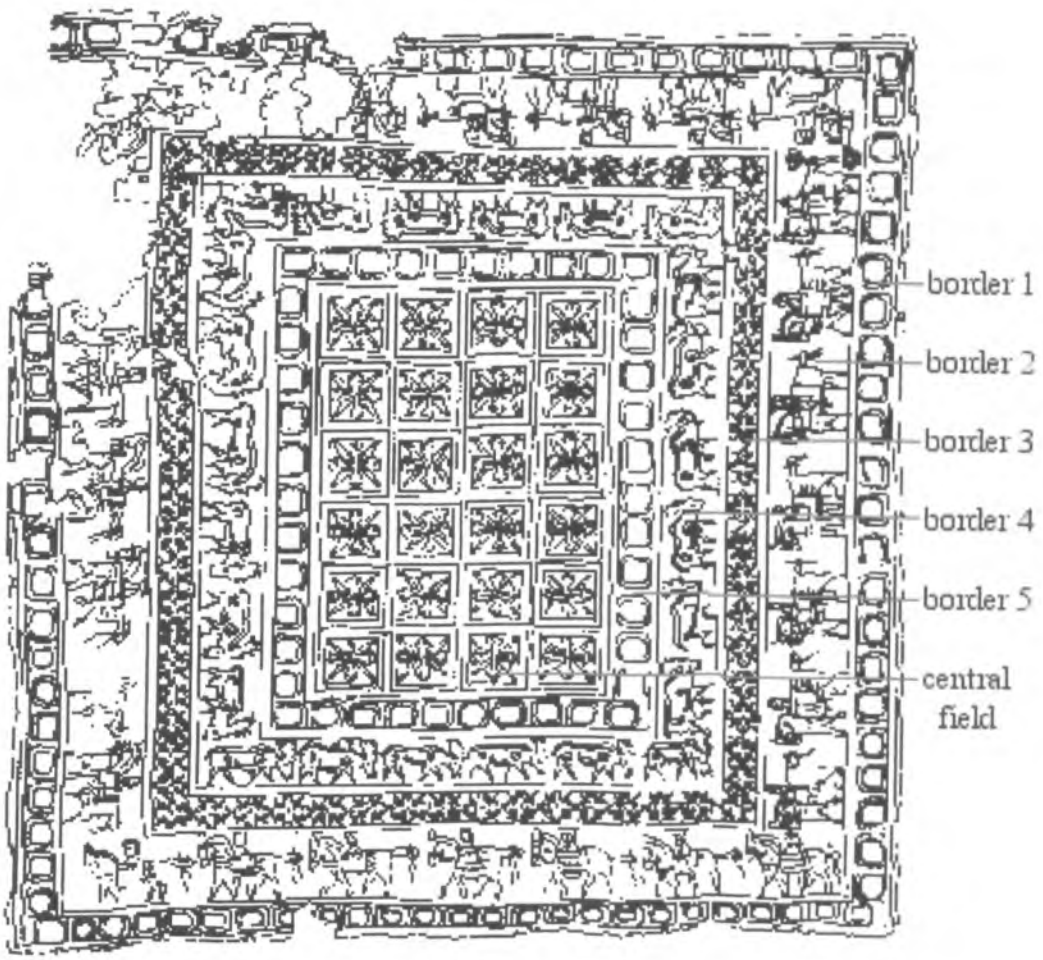
(iii) to supplement the data with the results (where appropriate) from the general survey of the symmetry characteristics of both Anatolian and Persian carpet types presented in Chapter 4.

7.2 A comparison of the borders

Within this section the borders of both carpets are considered and described geometrically. The Pazyryk carpet, the older of the two, is considered first.

Figure 7.1 shows the Pazyryk carpet with all of the significant borders indicated, this will be referred to later.

Figure 7.1 Pazyryk carpet (with significant borders and central field indicated)



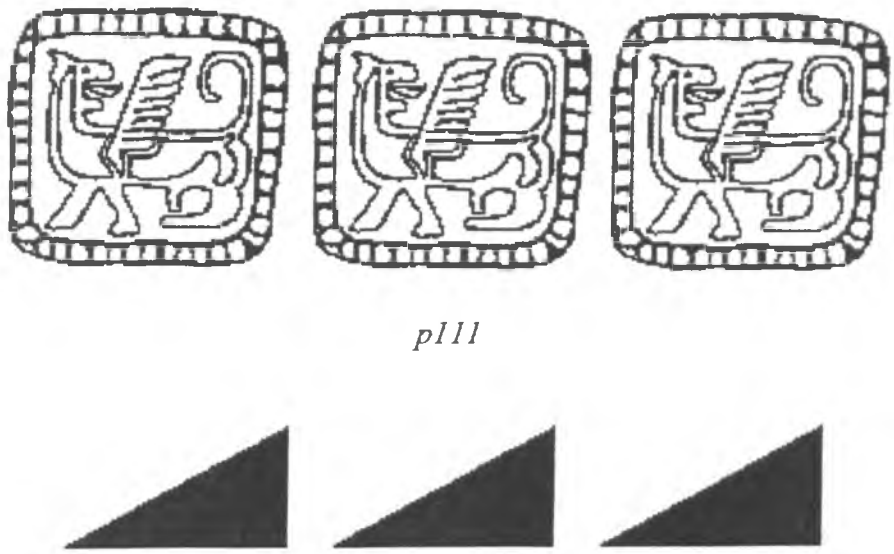
7.2.1 Borders contained within the Pazyryk carpet

The Pazyryk carpet has eleven borders.[24] Of these eleven borders only five can be classified as significant (Figure 7.1), as the others are best described as separating borders. These separating borders consist of alternating coloured blocks, which change systematically in sequence from black to white, to red, to white, and back to the beginning of the sequence. It is therefore a regular repeating sequence.

Border number 1 (Figure 7.1)(Figure 7.2) has medallions present which were previously described in sub-section 5.3.1.1. Each medallion is surrounded by a frame of black and white alternating dots. These dots exhibit a form of colour counterchange, alternating from black to white, etc., and can therefore be classified as border class *p'111*. The colour counterchange occurs across the translation, with the dots changing from black to white, back to black, etc. If we examine the medallion as a whole motif, all of those in the carpet are identical, any tiny differences here are exempt, and classified simply as being faults generated due to the nature of weaving. This border can be classified simply as a *p111* border, with translation across one axis only.

[24] A complete illustration of the carpet is present in Figure 5.7.

Figure 7.2 Medallion border exhibiting p111 symmetry and associated symmetry group



p111

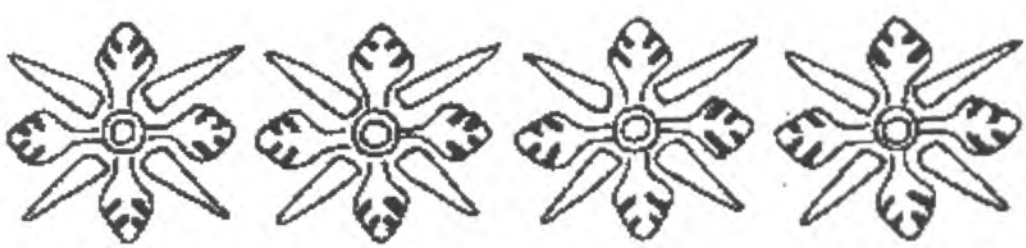
Border number 2 (Figure 7.1) has depictions of horses and riders (Figure 7.3); further comment on the nature of these was made in Sub-section 5.3.1.3. In terms of their representation, all of the 27 horses are exactly the same, with the same stance, etc. However some decoration on the blankets does vary, with some of the horses having human figures stood alongside, whilst others have seated riders. This border cannot be classified as a one-dimensional pattern, due to the variations in the motifs.

Figure 7.3 Border of horses and riders

The border, therefore contains simply singular motifs, or asymmetrical finite figures (c1), with each treated separately to the next. Careful consideration suggests that these horse motifs have a randomly selected order, and no clear sequence is evident. One explanation for this sequence of asymmetrical figures, is that frequently groups of crafts people worked simultaneously on pieces such as the Pazyryk carpet, and therefore each motif may have been knotted by an individual artisan, hence the tiny differences from figure to figure.

Border number 3 (Figure 7.1) is comprised of star-like motifs, described by many as being representative of lotus flowers [Schurmann, 1982, p.10], (discussed further in sub-section 5.3.1.4). As shown in Figure 7.4 this border exhibits translation, along with two-fold rotation, horizontal and vertical reflection. This border can therefore be classified as a *pmm2* one-dimensional pattern. Again any accidental variations from motif to motif have been ignored and assumed to be faults generated from the weaving process.

Figure 7.4 Lotus flower border and associated symmetry group

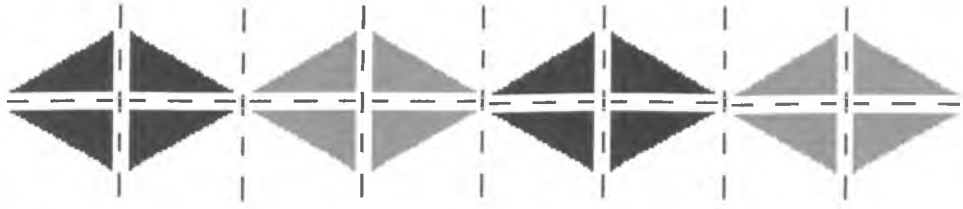


pmm2

Although this border has been classified as a *pmm2* border generally, there is a change that occurs within one section of the border. Towards the bottom half of the pattern the colours of the motifs suddenly change, a variation occurs, and both red and black motifs are present. Twenty-eight of the figures undergo this alternating colour-change, which occurs alternatively around the lower section of the carpet, suggesting a presence of colour-counterchange (Figure 7.5). Suddenly the sequence becomes black cross, red cross, etc... Therefore this section can be classified as a *p'mm2* border pattern, with the colour change associated with translation.

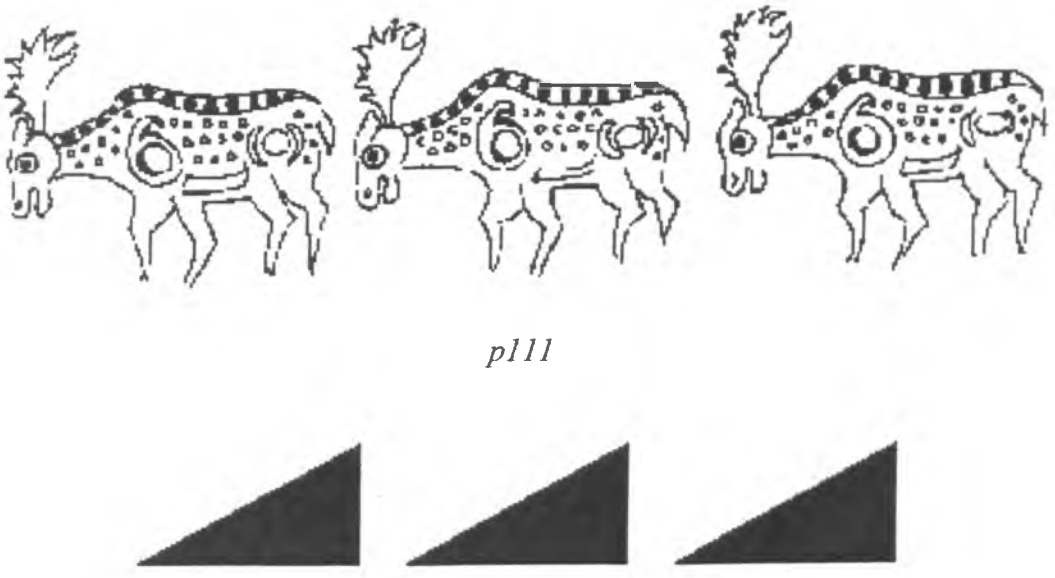
Figure 7.5 Lotus flower border exhibiting colour-counterchange

p'mm2



Border number 4 (Figure 7.1) of the Pazyryk carpet, is the border containing the deer or elk (Figure 7.6), as described previously in sub-section 5.3.1.5. All of the animal motifs within this border are exactly the same, with similar markings on their bodies, and with similar stance. This border exhibits translation symmetry only, and therefore can be classified as a *p111* one-dimensional border pattern.

Figure 7.6 Elk or deer border and associated symmetry group



p111

Border number 5 (Figure 7.1) on the Pazyryk carpet again is the same as the first significant border (Figure 7.2), containing the same medallions. The only difference is that they are reversed, with the central image facing the opposite direction to those in the first border. This border is classified again as being a *p111* one-dimensional pattern (Figure 7.2).

7.2.2 Borders contained within the Ardabil carpet

Having considered the borders contained within the Pazyryk carpet, attention is now drawn to the borders of the Ardabil carpet.

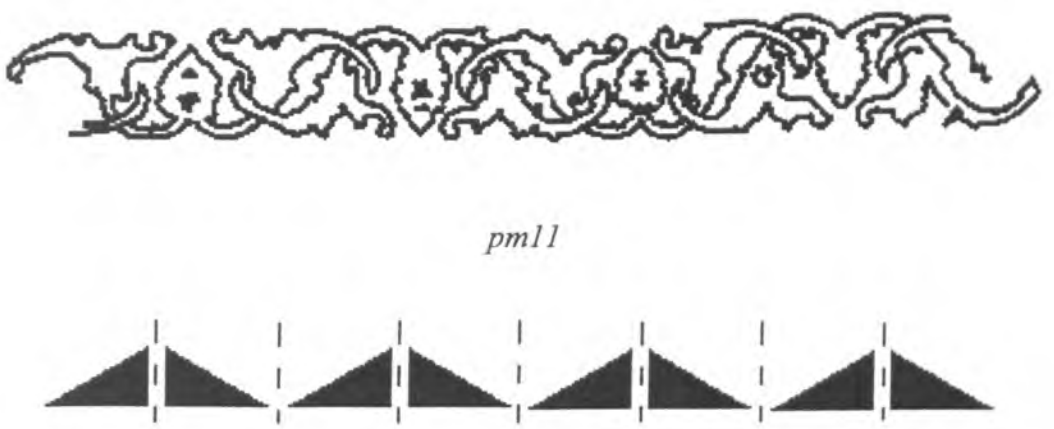
The Ardabil carpet has four borders within its design structure.[25] Unlike the Pazyryk carpet, all of these can be described as significant borders. Each differs in terms of design, structure and motif. Only the second and largest border fully echoes the design of the central field, and the other three show similarities to the central field, and are based on organic motifs. It appears that the designer simply intended

[25] A complete illustration of the carpet is present in Figure 6.7.

them to frame and supplement the central field. Each of these four borders will be described in turn, and assigned a symmetry classification.

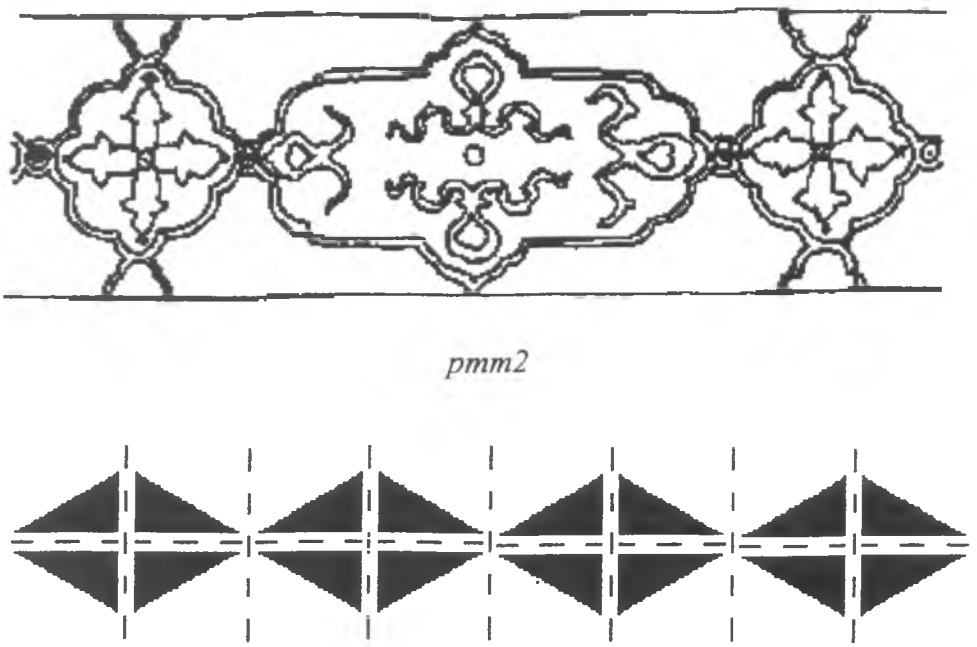
The outer border of the Ardabil carpet (Figure 7.7), contains a floral based motif, composed of twisting tendrils and flower buds. At first sight it appeared that a glide-reflection axis is present. However with closer inspection, it can be seen that the flower buds do vary in design, and as a result the border can be classified as a *pm11* border pattern, with a vertical reflection axis present.

Figure 7.7 Ardabil border 1



The next border contained within the design is the largest of the four borders (Figure 7.8). It is the only border that appears to be directly related to the motifs used in the design of the central field of the carpet. For example this border contains the same design of flower buds contained within the ground of the central field, and consists of a medallion and lozenge design, occurring alternatively all around the border on a base of flower buds and stems. This border can be classified as class *pmm2*, with both vertical and horizontal reflection axes present.

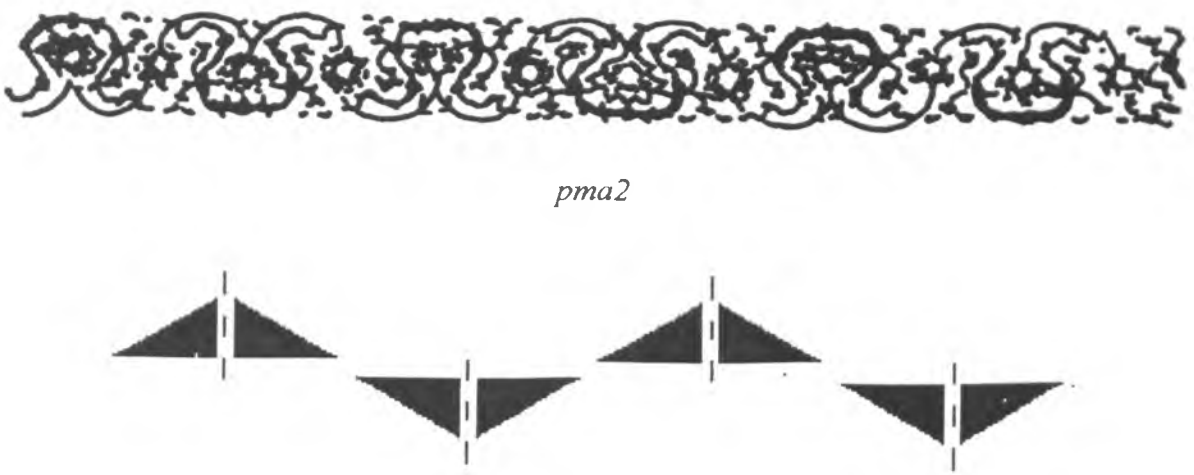
Figure 7.8 Ardabil border 2



pmm2

The third border contains a design consisting once again of flower buds and tendrils or cloud bands (Figure 7.9). The pattern has a vertical reflection axis present, as well as two-fold rotation and glide-reflection, characteristics which allow it to be classified as a *pma2* border design.

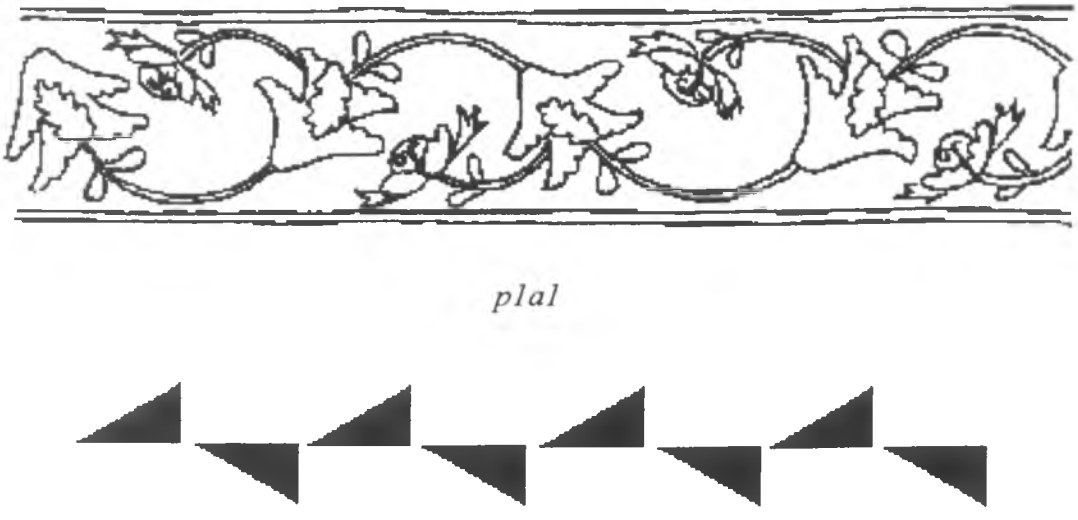
Figure 7.9 Ardabil border 3



pma2

The fourth border of the carpet (Figure 7.10) is composed of a motif of a flower bud, with foliage and tendrils linking the buds together. There is no reflection, or rotational axis present within the structure. This border appears to exhibit glide-reflection properties only, and therefore is classified as a *plal* border pattern.

Figure 7.10 Ardabil border 4



From examining all four borders of the Ardabil carpet there was no evidence of any colour-counterchange, all of the borders can be classified using the primary one-dimensional (border) pattern classes only.

7.2.3 A comparison of the borders contained within the two carpets

Having classified the border symmetries of both the Pazyryk and Ardabil carpets individually, a comparison of the symmetry characteristics of the two is presented below.

Obviously, the numbers of borders contained within each carpet did differ. The Pazyryk carpet contained eleven borders, although only five of these were

classified as significant borders, and others were simply regarded as guard stripes. The Ardabil carpet had no guard stripes present; instead the design consisted simply of four main borders. By comparing these findings with those of the Persian carpets in Chapter 4, the Pazyryk carpet fell into a very small category of Persian carpets to have eleven borders; only 1.8% of the sample accounted for this group. When compared to the Turkish sample of carpets, it was found that only 0.2% of the sample had eleven borders, suggesting that the Pazyryk carpet was more characteristic of a Persian produced carpet. The Ardabil carpet had only four borders, and this showed a similarity to 14% of the Persian carpets, and 10% of the Turkish carpets surveyed previously. Therefore from these data, it appears that the Ardabil carpet is more characteristic of Persian carpet type, a view which is further reinforced by the finding that the mean number of borders exhibited by the Persian sample (Sub-section 4.3.1) was 4.586.

When examining the actual symmetry classifications of the borders, only the significant borders for the Pazyryk carpet were examined. From these five borders, four of the borders were assigned with border classifications, one of the borders was classified as a finite design (*c1*) due to motif variation. Only two of the seven one-dimensional border classifications were present within the Pazyryk carpet, and four in the Ardabil carpet. Both the Ardabil and the Pazyryk carpets had *pmm2* classification present. When compared to the findings in Chapter 4 (Section 4.3.2), *pmm2* accounted for 11.6% of the Persian sample and 15.9% of the Turkish sample, a frequently utilised group within both carpet producing centres. The Pazyryk carpet also had the *p111* classification group present, accounting for 17.9% of the Persian sample, and 14.5% of the Turkish sample in Chapter 4. The Ardabil carpet also had *pma2*, *p1a1* and *pm11* classifications present; these groups accounted for 18.8%, 9.7% and 30.6% of the Persian sample, and 8.8%, 8.5%, and 23% of the Turkish sample in Chapter 4 respectively. Once again the Ardabil carpet in this

category appears more characteristic of a typically Persian carpet, by utilising all four of the most popular one-dimensional patterns in its border design structure, although it also utilises many of the popular classifications within the Turkish carpet sample.

The final comparison with respect to the borders is the presence of colour-counterchange. The Pazyryk carpet did exhibit some form of colour-counterchange. The *pmm2* border did show alternating colour changes from motif to motif, and was therefore classified as *p'mm2*. However this only occurred in a small section of the design, and it cannot be assumed that it was an intended design feature. There was no evidence of colour-counterchange within the borders of the Ardabil carpet. By comparing these to the findings of Chapter 4 (Section 4.3.4), 38.6% of the Persian carpets, and 33.2% of the Turkish sample exhibited some form of colour-counterchange, with 96.8% of these occurrences in the Persian carpet sample, and 96.4% of the Turkish sample occurrences being in the border designs. The *p'mm2* classification accounted for 10.7% of the Persian sample, and 35.7% of the Turkish sample, a popularly utilised group within Turkish carpet designs.

7.3 A comparison of the central fields

Continuing from the previous section, which dealt entirely with the significant borders of the two carpets, this section deals solely with the area that is known as the 'central field' (shown schematically in Figure 4.1, showing the structure of an oriental carpet). The central field is the area that is contained within the borders, and forms the main focal point of the carpet. It comprises the main body of the carpet, and can include a medallion, as is evident on the Ardabil carpet. The borders of the carpet are intended to supplement, frame and guide the eye into the central section [Cecil-Edwards, 1975, p.36]. Within the structure of many oriental carpets, in

particular Persian carpets, the design contained within the central field is intended and designed to appear as if it continues on to infinity, past the multiple borders, that usually frame the carpet. The central field of each carpet is considered below.

7.3.1 Central field of the Pazyryk carpet

The pattern contained in the central field of the Pazyryk carpet echoes the pattern found in the third significant border, see Figure 7.4. All of the flowers are contained within boxes. Each box is framed by a border of black, white, red, white...alternating dots, in the same way as those that were contained within the separating borders or guard stripes, as described in Section 7.2.

The main motifs within the boxes are composed of a series of crosses. Each motif exhibits 4-fold rotation, along with vertical, and horizontal reflection, and may thus be individually classified as *d4* motifs.

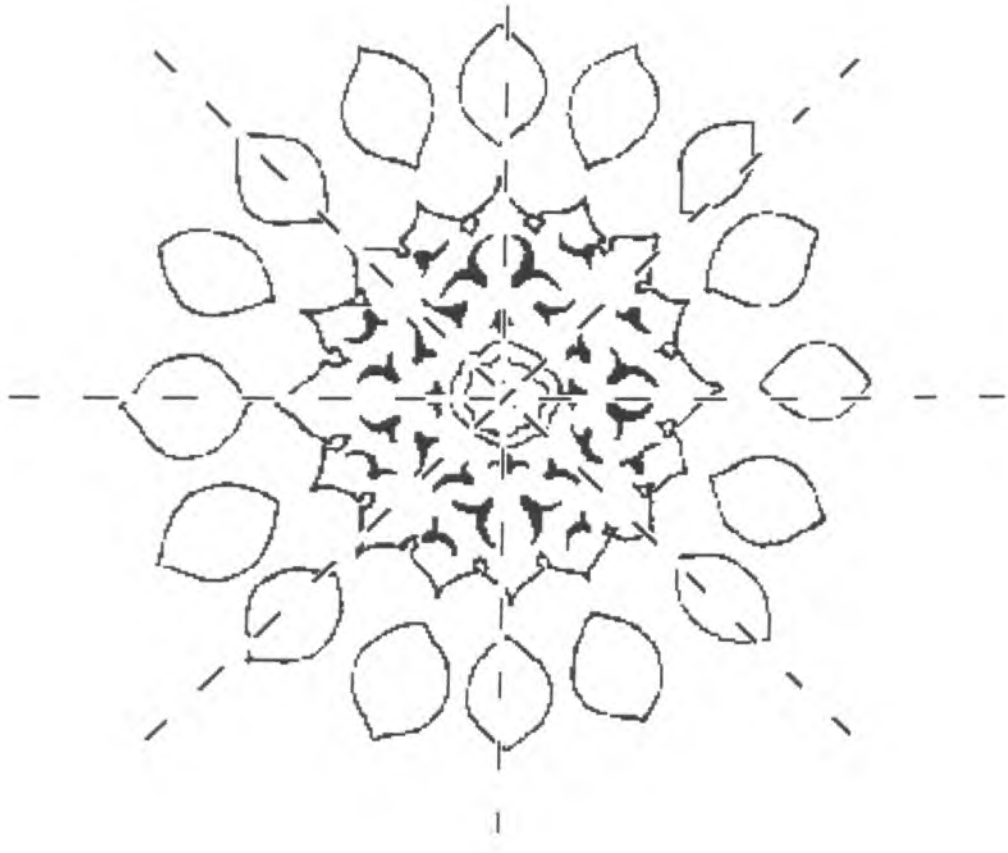
The structure of the central field is comprised of twenty-four boxes containing the crosses arranged into a four column by six row arrangement. The whole central section exhibits vertical and horizontal reflection, but due to the nature of the layout can be classified as being *p2mm*. The central section has the same visual appearance from whatever angle it is viewed.

7.3.2 Central field of the Ardabil carpet

The central ground of the Ardabil carpet is composed of a field of curling flower buds and tendrils, with a central feature of a medallion and two suspended mosque lamps. These features and their symbolism were discussed and described further in Sections 6.3 and 6.4. The Ardabil carpet is characterised and made famous by the inscription cartouche at the top of the central field. For the purpose of this section, the

cartouche will be ignored and omitted from the analysis, due to the fact that the inscription would create an overall symmetry of *p1*, due to the lettering in the cartouche having no reflection axis or rotation centres.

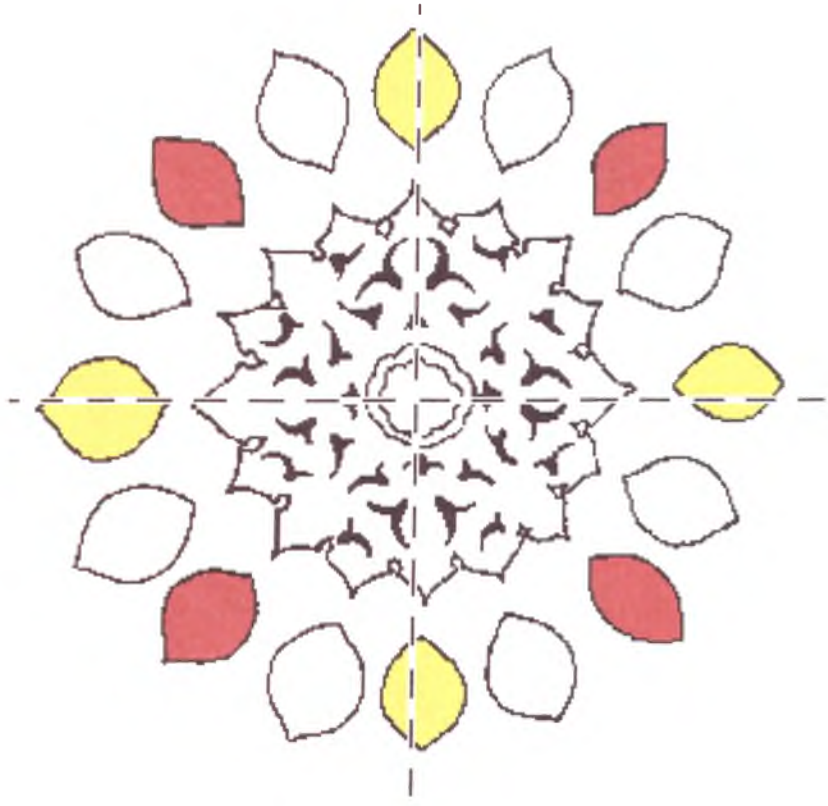
Figure 7.11 Central medallion of the Ardabil carpet and *d8* classification



The first feature studied within the central field is the medallion. Medallions are typical design features of Persian carpets, as noted by Wearden, when she stated that, "Large, sixteen-pointed medallions were a feature of many Persian carpets in the sixteenth century..." [Wearden, 1995, p.IX]. For the first part of this section only the medallion, and the sixteen radiating petals (also referred to as pendants [Wearden, 1995, p.61], or ogees [Stead, 1974]), will be considered and the two mosque lamps omitted. The central medallion can be seen by referring to Figure 7.11. By first

examining simply the shape and design of the medallion, it is apparent that it exhibits only reflectional and rotational properties, and can therefore be classified as a dn finite motif. The medallion exhibits eight-fold rotation, and therefore is classified as a *d8* finite design (Figure 7.11).

Figure 7.12 Central medallion of the Ardabil carpet and *d4* classification



By further examining the central medallion, it can be seen that the radiating sixteen petals differ in colour; either yellow, white or red. By taking this feature into account, the medallion is actually classified as a *d4* finite motif, as shown in Figure 7.12.

Within the central medallion and radiating petals, three colours are used. It becomes apparent that the white remains static, and therefore can be classified as a

background colour, with only two colours actively participating in the colour counterchange. In this case the red and yellow are the active colours undergoing colour-counterchange (see Figure 7.12). The two colours are interchanging with the rotation, from red to yellow, and back to red,...etc. Therefore the central medallion is classified as having *d8'* colour-counterchange classification.

In the four corners of the V&A Ardabil carpet's central field, four quadrants reflecting the design of the central medallion are present. These lower quadrants at one end of the carpet are missing in the LACMA carpet. It is believed that one end of the carpet was amputated from the LACMA carpet to repair the V&A carpet, as noted by Ittig, "It is generally believed that much of the restoration of the London 'Ardabil', particularly of its borders, was accomplished with sections taken from the LACMA piece, which is significantly reduced in length." [Ittig, 1993, p.81]

The central field is composed of a ground of swirling tendrils and flower buds. Wearden commented:

> "The ground is a mass of swirling stems of which it has been written that 'every attempt at an analysis seems to fail before the opulence of this vine work and yet all is laid down here...according to a simple and essentially transparent system.' Indeed it is- one pattern of thick stems bearing both blossoms and leaves overlies a pattern of thinner stems bearing only blossoms. These can be traced out and separated and then it can be seen that the left and right hand sides of the carpet are symmetrical along the vertical axis only and that two different spaces were deliberately provided for the lamps." [Wearden, 1995, p.62]

From Wearden's observations, and simple visual examination, the carpet has a vertical axis of reflection only. From initial views of the Ardabil carpet, it appears that the carpet is constructed of four identical quadrants reflected across the horizontal and vertical axis. However upon closer examination it is obvious that the two mosque lamps differ, both in size and decor, Wearden recognised this feature, when she stated that, "...the two lamps are of unequal size: one appears to be short and fat and one longer and thinner." [Wearden, 1995, p.62]

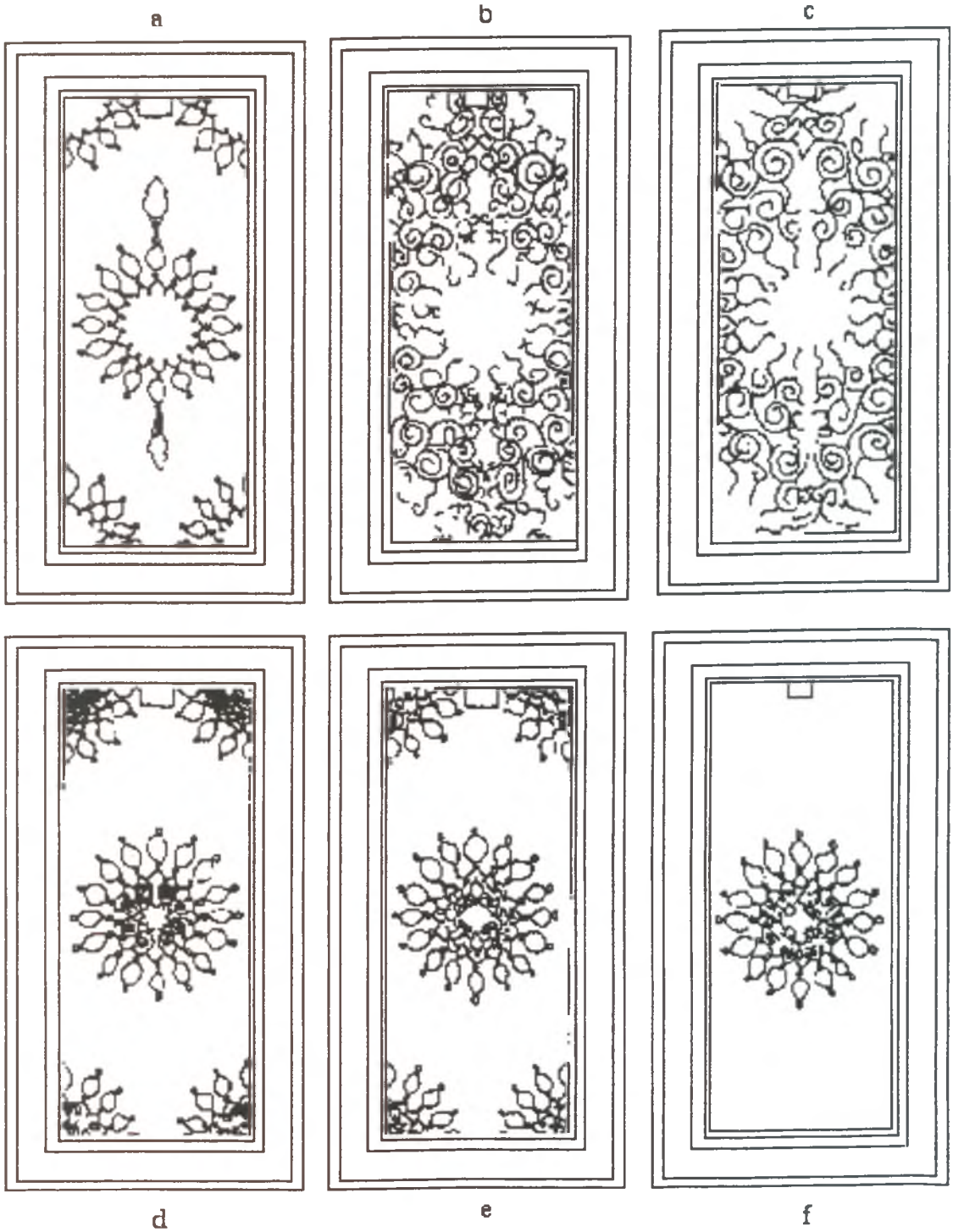
The actual tightly packed design structure of the central field of the Ardabil carpet was closely examined by Wearden. She segregated the carpet into six constituent layers, to enable an accurate study of the construction to be undertaken. The reader is directed to the work of Wearden for more extensive explanation [Wearden, Hali 80, pp.103-107].

By referring to Figure 7.13, the separation of the different layers contained within the Ardabil carpet is shown. When each separate layer of the carpet's construction is considered, each layer is still classified as a *pm* class. Wearden commented on the layered structure of the Ardabil carpet:

> "...the designer first traced out a swirling pattern of tightly coiled, leafy stems. These bear a mixture of naturalistic and composite blossoms based on the Chinese lotus flower. The blossoms are of varying size and maturity, some buds and some fully opened. On top of this was placed a second pattern of swirling leafy stems. Drawn on a slightly larger scale, these stems are thicker, less densely packed and bear only palmette-like blossoms, based on the lotus leaf...This attempt to impart depth and dimension to a design was a common practice among painters and artists, but is seldom met in carpets..." [Wearden, Hali 80, p.103]

Wearden believed that the layered structure of the carpet's design was intended to impart depth to the overall illusion of the carpet, further reinforcing the view that these carpets (V&A and LACMA carpets) were examples of opulence and luxury, and highly regarded pieces of design.

Figure 7.13 Seperation of layer structure of Ardabil carpet



recreated from : [Wearden, Hali S0, pp.103-107]

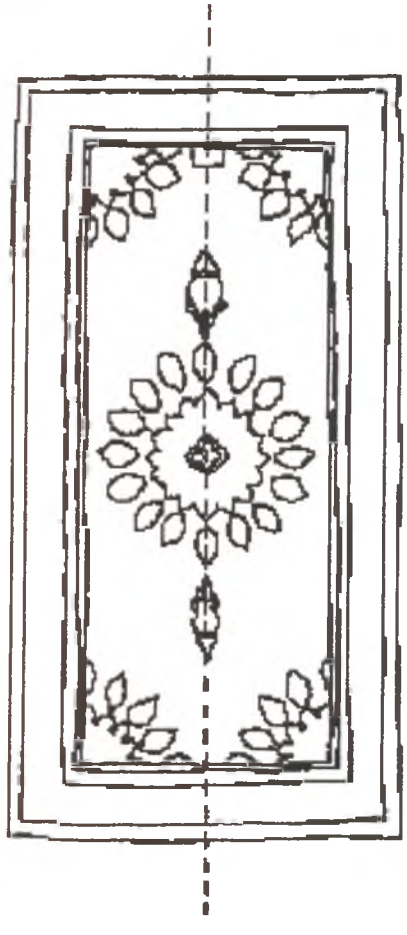
Key for Figure 7.13 (Previous page)

Figure 7.13 Separation of the layer structure of the Ardabil carpet

a...the central and corner medallions and two lamps
b...the underlying pattern of thin flower-bearing stems
c...the overlaid pattern of thick stems with leaves
d...floral scrolls contained within the medallions
e...pattern of lines and split leaves in the medallions
f...cloud bands in the central medallion

Due to the differing sizes of the mosque lamps, in general there is no rotational properties contained within the central ground, the only symmetry acting upon this area is that of an axis of vertical reflection. Therefore the central field of the Ardabil carpet can be classified as a *pm* design exhibiting only vertical reflection, as seen by referring to Figure 7.14.

Figure 7.14 General symmetry characteristics of the Ardabil carpet



7.3.3 Comparison of the central fields of the two carpets

Following on from the analysis of the two carpets, a comparison of the two central fields of the carpets is presented below.

The Pazyryk and Ardabil carpets did generate different classification groups, *p2mm* and *pm* respectively. The only similarity between the two carpets was the presence of a vertical reflection axis. The Pazyryk carpet also exhibited rotation and horizontal reflection axes; however these were absent in the design structure of the Ardabil carpet.

The Pazyryk carpet had a classification of *p2mm*, exhibiting two-fold rotation, vertical and horizontal reflection, characteristics evident in 27.1% of the central-field patterns examined in the general survey of Persian carpets, and 24.8% of the Turkish carpets presented in Chapter 4 (sub-section 4.3.3). In fact class *pmm* (*p2mm*) was the most popularly represented class in the survey of Persian carpets, and the second most popular group within the classifications of the central fields of the Turkish carpets.

The Ardabil carpet has a central field with a classification of *pm*, exhibiting only vertical reflection. When compared to the survey, this particular group accounted for 15.9% of the total population of the Persian survey, and 39.6% of the Turkish sample. This higher figure within the Turkish sample is characteristic, and generated by the high number of prayer rugs within the Turkish sample. The prayer rugs are characterised by a mihrab, or archway which naturally generates a vertical axis of reflection only, and therefore a *pm* classification, as present within a large number of carpets within the sample.

Both of these groups (ie. *p2mm* and *pm*) represented by both the Ardabil and Pazyryk carpets, were examples of the most frequently utilised pattern structures within the survey of 500 Persian and 500 Turkish carpets, making them characteristic

in design structure of Persian and Anatolian origin carpets.

7.4 General classification of the overall symmetry exhibited by the two carpets

The overall symmetry is the general symmetry that is generated by the carpet as a whole, without particular importance being placed on any one constituent of the design. Instead the carpet is viewed as a whole, with all of the design constituents playing an equal part. The overall symmetry of each of the two carpets is examined below.

7.4.1 Overall symmetry exhibited by the Pazyryk carpet

Looking at the overall symmetry of the Pazyryk carpet, there is two-fold rotation present. When the image is rotated, the images lie on top of their opposing images, although a slight error does occur. This error may be due firstly to the error created by the weaving process, and secondly due to dimensional change and instability caused by environmental conditions and the passage of time, which will undoubtedly have had some effect upon the piece. There is no vertical, horizontal, or diagonal axis of reflection, no glide-reflection or colour-counterchange present. Therefore the carpet can be categorised as having a symmetry classification of *p2*.

7.4.2 Overall symmetry exhibited by the Ardabil carpet

If the inscription cartouche is taken into account the carpet may be classified simply as *p1*. The Ardabil carpet does not exhibit any rotational properties, due to the fact that the cartouche is present at the upper end of the central ground, and also that the

two mosque lamps differ in size and decor. These features also prevent the presence of horizontal reflection, therefore the only symmetry operation present is that of vertical reflection. With this in mind the the Ardabil carpet may be classified as exhibiting *pm* symmetry. It has only one line of reflection, that of the vertical axis, with the two sides mirroring each other.

7.4.3 A comparison of the overall symmetry of the two carpets

By comparing the two carpets, it can be seen that both present different symmetry characteristics. The Pazyryk carpet is classified as being *p2*, with only 2-fold rotation present. The Ardabil carpet is classified as being *pm*, exhibiting only vertical reflection, and no rotation centres or horizontal reflection axis.

7.5 Summary

This chapter examines the symmetry and design structure of the Ardabil carpet and the Pazyryk carpet. The findings presented previously in Chapter 4 aided the comparison between the two carpets.

In general it was found that the design structures and symmetries contained within the two carpets were significantly different. The number of borders contained within each carpet was different. The Ardabil carpet had four borders, which compared to 14% of the sample of Persian carpets, and 10% of the sample of Turkish carpets (discussed in Chapter 4). The Pazyryk carpet had eleven borders, although only five of these were classified as significant borders. The Pazyryk carpet was classified within a minority group of carpets, with only 1.8% of the sample of Persian carpets, and 0.2% of the Turkish carpets accounting for this group.

The only symmetry class that was present in both carpets was found within

the borders, this was the *pmm2* symmetry class. This class accounted for 11.6% of the Persian carpet sample, and 15.9% of the Turkish carpet sample, a frequently utilised class within both groups of carpets. The Pazyryk carpet has *p111*, and *pmm2* border classes, along with *c1* finite figures. The Ardabil carpet has *pm11*, *pmm2*, *pma2*, and *p1a1* border classes contained within its structure.

When a comparison of the central fields was undertaken, the Pazyryk carpet generated a *p2mm* class, and the Ardabil a *pm* class; these classes accounted for 27.1% and 15.9% respectively of the Persian carpet sample, and 24.8% and 39.6% respectively of the Persian carpet sample.

Finally a comparison of the general overall symmetry of each carpet was examined. The Pazyryk carpet was classified as a *p2* class, exhibiting two-fold rotation only, while the Ardabil carpet was classified as a *pm* class, exhibiting mirror reflection axes, due to the presence of the differing sized mosque lamps.

The results from the survey have more direct comparison with the Ardabil carpets than the Pazyryk carpet. Many of the carpets within the survey were produced in the same period as the Ardabil carpets, while the Pazyryk carpet is at least 2,000 years older than the carpets in the survey. Therefore any anticipated correlation may have been affected by the long time difference. Jung's "*collective unconscious*" comes to mind. Certain aspects of decoration may well have been ingrained in the culture or group, and may well have remained prevalent for many successive generations. The period that elapsed between the two time periods of production extended to around 2,000 years, and this may be too long a period to expect the "*collective unconscious*" to be retained.

Chapter 8 Discussion and conclusions

8.1 Review of general aims

This thesis examines pattern structure in Persian and Anatolian carpets, and presents case studies of the Pazyryk and Ardabil carpets. In order to enlighten the research, a review is presented of literature from a range of subject areas including archeology, anthropology, psychology and mathematics.

The fundamentals of symmetry in pattern were introduced and the concept of counterchange (of colour) was dealt with in some depth (with an original table, which aided the classification of two-colour counterchange patterns, being presented). The key starting point was the work associated with Woods [1935, 1936] who presented a series of papers which have acted as the foundation stone for many researchers since. The published work of subsequent scholars such as Washburn and Crowe [1988]. Woods [1935, 1936], and Hann and Lin [1999] was also reviewed.

A sample of 1,000 carpets (500 Turkish and 500 Persian) was selected at random from an extensive range of published sources. The geometrical structures of all patterns were classified with respect to their symmetry characteristics, and a comparison made between the two groups. The important question raised was whether pattern usage was culturally sensitive?

A case study was presented of the Pazyryk carpet, an artifact which predates all previously uncovered pile-knotted carpets. The origin/location of the Pazyryk carpet has been debated by scholars since the carpet was discovered by Sergei Ivanovich Rudenko in 1949. The case study presents a debate on the structure and possible motif symbolism inherent in the carpet's decoration, and makes suggestions on purpose and probable origin.

The second case study focused on a pair of carpets, known as the Ardabil

carpets. Again the structural characteristics of the decorative elements are debated and the history of the two pieces reviewed.

A geometrical analysis was conducted on the case study carpets, and the resultant data were compared with the data from the sample of 1,000 Anatolian and Persian carpets presented previously.

The purpose of this final chapter is to widen the debate and draw conclusions from the body of the thesis.

8.2 Discussion and conclusions

It is widely accepted that diffusion occurs within a society or group. The term refers to the spread in usage of ideas, principles, concepts, innovations, decorative styles, religions or other social practices. This thesis is primarily concerned with design and pattern usage, and classifies carpet design in term of symmetry characteristics. The process of cultural diffusion is debated below in the context of the avenues of enquiry opened in the thesis.

8.2.1 Diffusion and culture

Inherently the diffusion of ideas is entwined with the principles of culture. Culture is inherent in any population, it provides a system by which individuals live, design, and interact. In order for a culture to exist, members must transmit ideas, norms, modes, etc... Hamilton defined culture as, "...that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society." [Hamilton, 1987, p.3] Culture is concerned with group behaviour, and the interaction of individuals within these groups, or between individual groups. Culture is not a static entity, it changes and

adapts constantly to outside factors, as previously noted by Hamilton [1987, p.5], and also recognised by Boas [1938, 1940, 1948]. However Boas also stated that culture itself was a direct result of the diffusion of ideas down a group from a figure-head or leader, throughout a singular group, and also group to group. He stated that,

> "...culture is conceived not as merely static but rather as a dynamic phenomenon; it is actually perceived as a diffusional phenomenon and one which I sense may be said to have grown from top down." [Boas, 1938, p.232]

It is simply the interaction between individuals that allows for the transmission and diffusion of ideas. Reber referred to diffusion, when he noted,

> "The connotation is that something in one locale spreads and scatters through another...In sociology, the spread of culture traits from one society to another or from one distinct group to another within the same society." [Reber, 1995, p.211]

Data obtained from the classification of symmetry characteristics of the two groups of carpets (Turkish and Persian) yielded various similarities, and a preference for certain symmetry groups, or numbers of borders within the design structures. From examining the findings it was found that the two surveyed cultural groups did use similar design structures, with the use of borders and a central field, however it was also recognised that the cultures were culturally selective within the confines of certain design parameters.

8.2.2 Diffusion and the development of art forms

The Persian carpets are far more naturalistic in design while the Turkish designs are more abstract in nature. Even though the designs did differ in subject matter, there were similarities between both cultures (reflected in the pattern geometry), suggesting that the design methodology had diffused between these two cultures.

Boas believed that the presentation of abstract forms was a natural

development or diffusion from representational art. Therefore representational art is an earlier form of development than abstract art. Boas stated that geometrical art developed from representational art:

> "The development of art has been reconstructed by similar methods. Since the earliest traces of art represent animals and other objects and geometric forms follow, it has been inferred that all geometrical motives have developed from representative designs." [Boas, 1948, p.178]

Therefore by examining the results presented in Chapter 4, it can be stated that the Turkish patterns, typically more abstract that their Persian counterparts, have developed or become diffused from the more naturalistic Persian carpet forms. If this is the case, this would also support the views of other scholars such as Cecil-Edwards [1983] and Bennett [1978, 1985]. Both believed that the skill of carpet weaving developed in Persia and then diffused into other countries, such as Turkey, and the Caucasus.

Washburn also examined geometric art, believing it to be important in the transport of cultural beliefs and ideas. She believed that geometric art was used as a form of development for the carriage of information through pattern, particularly where the written word was missing; symbolism thus played a more important role [Washburn, 1999, p.554]. She lent support to the work of Boas and maintained that motifs, and the symmetrical structure on which they were formed, became characteristic images; hence diffusion generates the characteristic art forms of a cultural group. Washburn noted that, "...cultures embody cultural information in the specific symmetries they use to structure non-representative decorative pattern." [Washburn, 1999, p.,548] She further commented that,

> "...pattern structure, rather than simply being another feature amenable to analytical manipulation, actually embodies cultural concepts and thus can be a sensitive record of cultural activities...cultures have consistently and deliberately chosen particular symmetries because they metaphorically embody important cultural principles." [Washburn, 1999, p.548]

The validity of the question associated with representational and geometric art can be brought into doubt when considering such pieces as the Pazyryk carpet, where abstract figures are placed alongside representational figures. For example stylised lotus flowers are located alongside the elk and horse representations. At the time of the Pazyryk carpet's production the skill of decorative carpet weaving was already highly developed. Adopting Boas' thinking, it appears that the Pazyryk carpet's design was heavily influenced by art styles that had already diffused, proven by the inclusion of stylised figures alongside more naturalistic representations. It is highly unlikely that the design elements included in the Pazyryk carpet were wholly indigenous to their (unknown) location of production. A process of diffusion (possibly over several or more generations) was operational. This possibility is supported by the fact that Chinese mirrors and carvings were also discovered in the kurgans of the Pazyryk valley. Therefore trade must already have been well established, and wherever trade occurs, diffusion must also.

The evolutionist approach to cultural anthropology, well established before the thinking of the diffusionist school (of which Boas was a key protagonist), maintained that all societies were set on a predetermined path of civilisation, and that stages of discovery were an inherent feature (i.e. every society will independently discover fire, the wheel, the process of spinning and weaving). Whilst there may be a modicum of validity in this proposition, it does not seem remotely feasible that the production techniques used in the manufacture of the Pazyryk carpet, and its design composition and motifs used, were developed within a cultural vacuum.

Boas also stated that it is possible for the same principle, concept or technique to develop successively within two separate locations, and possibly a methodology of art with similar features may be developed in two distinct localities. Such a development can be considered to be a genetic development, rather than an

interactive development. Boas stated,

> "Whenever such traits or, better still, combinations of traits, are found in widely spread localities, no matter what the distance, we are justified in suspecting genetic relationship, though our judgment in such cases may often rest on subjective rather than objective criteria." [Boas, 1938, p.211]

This possibility calls to mind the work of Jung (1875-1961) and the consideration of the '*collective unconscious*'. Jung believed that large groups of people were influenced by the *collective unconscious*, this is where large groups of people share a common unconscious memory, including beliefs. This was based on the hypothesis that genetic beliefs ran through successive generations of groups of people, and formed the ties to a certain culture. This would appear to have a degree of validity, and that successions of major developments or innovations (maybe resultant from diffusion) would gradually transform this 'collective unconscious'. Viewed historically, it would appear that innovations are invariably sourced in settled rather than nomadic societies.

However other constraints may affect the typical art forms of a culture. For example, within Islamic countries, dependent upon the doctrine of the state religion, either Sunni or Shi'ite, affects the resulting art works. Within certain sectors of the religion, particularly with the most Orthodox Muslims, representational art is forbidden, for it was decreed that only Allah was the creator, and therefore geometric and abstract art forms became prevalent [Cammann, 1973, p.6].

8.2.3 Diffusion aided by population

Many scholars assume that Persia was the initial source for the development and diffusion of weaving. Traditionally many populations were nomadic, therefore interaction between different tribes, and cultures was widespread and diffusion

became an obvious possibility. Robinson commented:

> "Carpet-weaving, which is believed to have originated in Southern Persia about 4,000 years before the Christian era...Probably, the shepherds there spun coarse wool yarns with distaff and spindle, and dyed them using the juices of plants. Subsequently, the dyed yarns were woven on a frame into rugs, which provided the main decoration of the shepherd's tent, besides being used to sit and sleep on." [Robinson, 1972, p.2]

This interaction would aid the diffusion of motifs and geometrical structure. Gans-Ruedin recognised the importance of nomadic people in the development of pile carpet weaving, noting also that they would aid the diffusion of design. Constant migration of the nomad enabled designs and other forms of decoration to become exposed to outside cultures, and to become adopted by the indigenous populations, or vice versa. Therefore designs became widespread throughout countries and cultures, and became transported around populations. Gans-Ruedin observed that,

> "...the knotted carpet was the craft of nomads, and was an important factor in the dispersion of the technique. But one must also take into consideration the complex political upheavals, often involving large movements of population." [Gans-Ruedin, 1971, p.9]

Diffusion is a complex process, which occurs when one group interacts or simply comes into contact with another. Ideas, norms, etc., characteristic of that group are exposed to another group, and these in turn are influenced by this interaction. Boas believed that it was impossible for any culture not to be influenced by these interactions, which are the key driving force in the dissemination of ideas, principles, religion, and even art [Boas, 1938, 1940, 1948]. Boas commented:

> "There is one fundamental difference between biological and cultural data which makes it impossible to transfer methods of the one science to the other. Animal forms develop in divergent directions, and an intermingling of species that have once become distinct is negligible in the whole developmental history. It is otherwise in the domain of culture. Human thoughts, institutions, activities may spread from one social unit to another. As soon as two groups come into close contact their cultural traits will be disseminated from the one to the other." [Boas, 1940, p.251]

8.2.4 Sources of diffusion

Boardman [1994] identified three main sources of diffusion, namely:

> (1) from trade, with which we may include exchange of gifts, which may be casual or with intent;
> (2) from an active interest on the part of...craftsmen rather than merchants;
> (3) [as a consequence of]... other activities which are not primarily a matter of craft production, and in this category we deal mainly with emigration, evangelism and booty." [Boardman, 1994, p.312]

It is uncertain which of the above three sources are of relevance in the specific context of the Pazyryk carpet. What does appear to be certain is that the decoration on the carpet has a relationship in terms of context to Persian decoration of the time. The technique of pile carpet weaving almost certainly diffused from elsewhere (and probably Persia). The design composition appears to be of relevance to the Scythian context, suggesting that adaption and further development may have taken place in the area around the Pazyryk valley.

Diffusion appears to be a prerequisite for development and progression to occur. In fact, Boas believed that it was impossible for any group to remain untouched by outside influences and the diffusion of ideas. Therefore the development of all art and culture is very much dependent on such interactions. Boas commented,

> "...the dissemination of cultural values has shown that there is no people that is entirely untouched by foreign influences, but that every one of them has taken over from its neighbours and assimilated inventions and ideas. There are also cases in which the achievements of neighbours are not assimilated but taken over unaltered. In all these cases an economic and social dependence of the tribe develops." [Boas, 1948, p.198]

8.2.5 Diffusion in the context of the Pazyryk and Ardabil carpets

As well as considering diffusion of designs in the context of Persia and Anatolia, further consideration was given to both the Pazyryk and Ardabil carpets, items from distinctly different time periods (the Pazyryk carpet dates from 500B.C.E., and the Ardabil carpets are from the Safavid period (1501C.E.-1722C.E. [Canby, 1999, p.6]).

The Pazyryk carpet shows evidence of cultural borrowing, and therefore cultural diffusion. Its origin is unknown, but there is evidence to suggest a Persian or Armenian origin. The carpet was uncovered in the frozen kurgans of the Pazyryk valley in Russia, and is believed to have been a burial rites item for a Scythian tribe leader. The designs contained within it, however, are not typically Scythian, and therefore the object must have been brought to the area from elsewhere, possibly Persia. Alternatively the motifs may have been sourced from other items traded to the area. It is certainly the case that the kurgans yielded much evidence of trade with outside regions; examples include Chinese silks and carved mirrors. The discovery of such items suggests that trade routes had been established, and thus diffusion was allowed to proceed. Either way the Pazyryk carpet shows evidence of a link between the Scythians and another culture. Through emulation the diffusion of techniques, motifs and patterns may occur.

It is through diffusion that art styles become adapted, although the original symbolism behind a motif or pattern may become lost. The motifs on the Pazyryk carpet may have been very powerful images of their time, within a particular location, with heavy symbolism attached, but the importance of the symbolism has been lost with the passage of time. Although an image is diffused, it does not necessarily mean that the symbolism intended is carried with the image, for symbolism is a culturally sensitive entity peculiar to a given culture.

The thesis also focuses on another important historical carpet, the Ardabil

carpet. This item was also believed to be of Persian origin, but of an entirely different time period. Comparing this carpet to the Pazyryk carpet, similarities and differences were apparent. For example, both carpets contained certain symmetry characteristics, showing the preferential use of certain symmetry groups over a long period of time, possibly suggesting ingrained usage and that certain symmetry groups were constituents of the design methodology of Persian carpet production.

This thesis discusses diffusion, through time and geographical space; although it was not possible to reach categoric conclusions, a range of possibilities was highlighted. Boas stated that it is impossible to map diffusion accurately. It always remains to a certain degree, pure conjecture. He observed:

> "When certain traits are diffused over a limited area and absent outside of it, it seems safe to assume that their distribution is due to diffusion. In some rare cases even the direction of diffusion may be determined...In the majority of cases it would be impossible to determine with certainty the direction of diffusion. It would be an error to assume that a cultural trait had its original home in the area in which it is now most strongly developed." [Boas, 1940, p.251]

Particularly in the case of the Pazyryk carpet, the means of diffusion could be various. The kurgans contained the remnants of iron-age man [Rudenko, 1953], a culture remote in time and geographical space. With no firm evidence[25] to use as a comparison, there are too may queries (in the absence of further discovery) to enable scholars to categorically trace the routes and means of diffusion during this period.

The Ardabil carpet presents a different set of questions but includes a date in its design, and can be compared to a number of surviving carpets from the same period. But without other secondary evidence, such as shrine inventories, we cannot rule categorically even on the accuracy of the date of the Ardabil. Between the

[25] The Pazyryk carpet is the oldest known whole pile carpet. Although fragments were discovered by Sir Aurel Stein in 1929, in Lou-Lan, Chinese Turkestan, that were datable to the 5th century C.E., the majority of carpets are datable to the 14th century C.E. onwards. It was widely assumed for a long period of history that pile carpet weaving did not develop until the 16th century C.E.. Therefore no real evidence is available, which could accurately be used for comparison with the Pazyryk carpet. Also the dating of carpets is very difficult. The Ardabil carpets are very rare examples due to the inclusion of a date. The majority of the carpets from the 14th-18th centuries C.E. only have approximate dates, and therefore cannot be categorically used as firm evidence of datable styles.

Pazyryk and the Ardabil carpets there is a large gap in the history of pile-carpet weaving. A precise trace on the diffusion of the skill, and decorative forms between one and the other is not possible in the absence of further evidence.

Although the methods of symmetry analysis used to classify designs within this research thesis is a useful tool, it cannot be used solely, as it forms simply another perspective to explore design and structure. Although symmetry is visible in most objects, it does not necessarily mean that the designer is consciously aware of the underlying symmetry principles. Although a design may have been created on the basis of symbolism or aesthetic merit only, a range of geometrical principles may have been used subconsciously. This range of principles may have been passed subconsciously from generation to generation

8.3 Avenues for further research

A range of possible avenues for further research and consideration has become apparent from this research thesis. Some further possibilities are discussed below.

In Chapter 4, 1,000 carpets were examined from two different carpet producing regions, namely Persia and Anatolia. It was previously observed by Bennett [1972, 1978, 1985], and Cecil-Edwards [1983], that these two cultures were close relations (Section 4.3.1), and that carpets produced in both would show close similarities in design structure, thus making valid comparison difficult. It may be worthwhile comparing the findings presented in Chapter 4 against other characteristic carpets from other carpet producing centres, such as the Caucasus or India. This would enable further testing of the hypothesis presented in Chapter 4, stating that '*pattern usage is culturally sensitive*'.

A further development arising from the research presented in Chapter 4 and 7, would be the examination of motifs, their symbolism, and their origin. This would

enable steps to be taken to map motif development and diffusion. Further examination of diffusion over time and geographical space could therefore be made. This could include motifs and patterns associated with carpet design as well as decoration from other decorative art forms. This further research would allow for the actual mapping of the diffusion of design and art through cultures.

Further consideration of the Pazyryk carpet in the context of other contemporary decorated artifacts from both the Pazyryk valley and beyond. Artifacts from similar and contrasting periods could be examined, to try and eliminate the queries associated with the carpets origin, and the location of manufacture. Further research could be enhanced through the examination of ancient art forms in general, and ancient texts, especially Herodotus and other Greek writers.

Another possible means to develop this thesis would be the mapping of carpet motifs, and designs, creating a data base of carpet designs, to facilitate in the identification, and dating of actual carpets. This would be useful not only as a academic tool, enabling the study of the geographical spread and dating of motifs, but may also be applicable commercially, in the areas of carpet and artifact trade.

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Appendix 4.1

Persian carpets : number of borders, mean and standard deviation

Number of Borders	frequency	percentage %
1	16	3.2
2	10	2
3	176	35.2
4	70	14
5	103	20.6
6	31	6.2
7	52	10.4
8	20	4
9	7	1.4
10	5	1
11	9	1.8
12	1	0.2
	∑500	

x	x^2	f	fx	fx^2
1	1	16	16	16
2	4	10	20	40
3	9	176	528	1584
4	16	70	280	1120
5	25	103	515	2575
6	36	31	186	1116
7	49	52	364	2548
8	64	20	160	1280
9	81	7	63	567
10	100	5	50	500
11	121	9	99	1089
12	144	1	12	144
		∑500	∑2293	∑1159

$$\text{Mean } (\mu) = \frac{\sum fx}{n}$$

$$\mu = \frac{2293}{500}$$

$$\mu = \mathbf{4.586}$$

$$\text{Standard deviation } (s) = \sqrt{\frac{n(\sum fx^2)-(\sum fx)^2}{n(n-1)}}$$

$$s = \sqrt{\frac{500(11579)-(2293)^2}{500(500-1)}}$$

$$s = \sqrt{\frac{531651}{249500}} = \mathbf{1.46}$$

Turkish carpets : number of borders, mean and standard deviation

Number of Borders	frequency	percentage %
0	1	0.2
1	21	4.2
2	46	9.2
3	168	33.6
4	50	10
5	67	13.4
6	43	8.6
7	58	11.6
8	23	4.6
9	7	1.4
10	4	0.8
11	1	0.2
12	3	0.6
13	2	0.4
14	3	0.6
15	0	0
16	0	0
17	2	0.4
18	1	0.2
	Σ500	

x	x^2	f	fx	fx^2
0	0	1	0	0
1	1	21	21	21
2	4	46	92	184
3	9	168	504	1512
4	16	50	200	800
5	25	67	335	1675
6	36	43	258	1548
7	49	58	406	2842
8	64	23	184	1472
9	81	7	63	567
10	100	4	40	400
11	121	1	11	121
12	144	3	36	432
13	169	2	26	338
14	196	3	42	588
15	225	0	0	0
16	256	0	0	0
17	289	2	34	578
18	324	1	18	324
		Σ500	Σ2270	Σ13402

Mean (μ) = $\frac{\Sigma fx}{n}$

$\mu = \frac{2270}{500}$

$\mu = \mathbf{4.54}$

Standard deviation (s) = $\sqrt{\frac{n(\Sigma fx^2)-(\Sigma fx)^2}{n(n-1)}}$

$s = \sqrt{\frac{500(13402)-(2270)^2}{500(500-1)}}$

$s = \sqrt{\frac{1548100}{249500}} = \mathbf{2.49}$

Appendix 4.2

Test for randomness : runs (large samples) [Freud, 1981, p.392]
Number of borders in the sample of Persian carpets

Number of Borders	frequency	cumulative frequency
1	16	16
2	10	26
3	176	202
4	70	272
5	103	375
6	31	406
7	52	458
8	20	478
9	7	485
10	5	490
11	9	499
12	1	500
	∑500	∑500

$$\text{Median} = \frac{n+1}{2} \qquad \frac{500+1}{2} = 250.5\text{th position}$$

Therefore the median falls in the '4 border' category. Therefore we disregard all 4 border groups, and classify the groups above 4 as 'a', and all those below 4, as 'b'.

Distribution of runs

abababbbabaabababbbabaaaababbbbbbbbaaaaaaabbabbaabbbbbabaaaaaaaabaaababababbbaab
baaaaabbbbbbaabaaaaabbababbbbaabbabbbbbbbbabbbaaaabbbbabbbbabaababababaaaaaab
babaababababbbaaaabbbbbabbbabbbbaababaaabaabbbabbbbbbbbbbabbbbbbbabababaabaaaaa
aaaaaabaaaaaaabaabaaaabbabaabbaaaaabababbbbbbabbaaaaaaaabaaaaaaaaaaabbbbababaa
aaabbbbbaabbbbbbbabaabababbaabaaaaaaaaabababbaabaaaabaabaaabbabbabbbabaabbbaaaaaa
aaaaabbaabaaaaaabababaaaaaababababbaabbbaaaabababbabbbaabaabbbbbb

Data generated... a = 228
b = 202
u = 184 runs

Actual test

1. Null Hypothesis : Arrangement is random
Alternative Hypothesis : Arrangement is not random

2. Level of significance : 0.05

3. Criterion : Reject the null hypothesis if $z<-1.96$ or $z>1.96$.

4. Since $n_1 = 228$
$n_2 = 202$
$u = 184$

$$\mu_u = \frac{2n_1n_2}{n_1 + n_2} + 1 = \frac{2 \times 228 \times 202}{228 + 202} + 1 \qquad \mu_u = \mathbf{215.21}$$

$$\text{Standard deviation}_u^2 = \frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1+n_2)^2(n_1+n_2-1)}$$

$$= \frac{2 \times 228 \times 202\,(2 \times 228 \times 202 - 228 - 202)}{(228 + 202)^2\,(228 + 202 - 1)}$$

$$= \frac{92112 \times 91682}{79322100}$$

$$\text{Standard deviation}_u = \sqrt{106.46} = \mathbf{10.32}$$

Therefore to calculate z... $z = \dfrac{u - \mu_u}{\text{standard deviation}_u}$

$$z = \frac{184 - 215.21}{10.32} = \mathbf{-3.02}$$

5. Since $z = -3.02$, it exceeds -1.96, the null hypothesis is rejected, therefore the alternative hypothesis is accepted, and the arrangement of the data is not random.

Appendix 4.3

Test for randomness : runs (large samples) [Freud. 1981, p.392]
Number of borders in the sample of Turkish carpets

Number of Borders	frequency	cumulative frequency
0	1	1
1	21	22
2	46	68
3	168	236
4	50	286
5	67	353
6	43	396
7	58	454
8	23	477
9	7	484
10	4	488
11	1	489
12	3	492
13	2	494
14	3	497
15	-	497
16	-	497
17	2	499
18	1	500
	Σ500	Σ500

$$\text{Median} = \frac{n+1}{2} \qquad \frac{500+1}{2} = 250.5\text{th position}$$

Therefore the median falls in the '4 border' category. Therefore we disregard all 4 border groups, and classify the groups above 4 as 'a', and all those below 4, as 'b'.

Distribution of runs

baabbbaaaaaaaabababbbaabaaabaabbaaaaaaabbabbaabbbbbbabbbbbabbbbbbbabbbbb
bbbbbabbbbbbbaaabbbbaaaaaaaaaaaaabababaabbabaabbbabbbbabaabbabbbaaba
aaaabbabaaabaabaaabbabaaaaaaaabbbbaaabaabbbbbbabbbbbaaaaaabbabbbbbbbbbbaaba
aaababbababbaabbbabaabbbbabaabababbbbabbbbbabababbaaabaabbbbbbbbabbbbbabbbbb
bbbaaaaaaaaabbbbbaaababaaaaabbbaaaabbbbbabaaaabaabbbbbabbbaabaabbababaaabaa
abababbaaaaabbbaabbababbbbabaaabaaaaaaaaaabababbaaabbbaabbbbbbbbabbbaabbabaaab
aaaaaaaab

Data generated... a = 214
b = 236
u = 180 runs

Actual test

1. Null Hypothesis : Arrangement is random
   Alternative Hypothesis : Arrangement is not random

2. Level of significance : 0.05

3. Criterion : Reject the null hypothesis if $z<-1.96$ or $z>1.96$.

4. Since $n_1 = 214$
   $n_2 = 236$
   $u = 180$

$$\mu_u = \frac{2n_1n_2}{n_1 + n_2} + 1 = \frac{2 \times 214 \times 236}{214 + 236} + 1 \qquad \mu_u = \mathbf{225.46}$$

$$\text{Standard deviation}_u^2 = \frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1+n_2)^2(n_1+n_2-1)}$$

$$= \frac{2 \times 214 \times 236\,(2 \times 214 \times 236 - 214 - 236)}{(214 + 236)^2\,(214 + 236 - 1)}$$

$$= \frac{101008 \times 100558}{90922500}$$

$$\text{Standard deviation}_u = \sqrt{111.71} = \mathbf{10.57}$$

Therefore to calculate z... $z = \dfrac{u - \mu_u}{\text{standard deviation}_u}$

$$z = \frac{180 - 225.46}{10.57} = \mathbf{-4.3}$$

5. Since $z = -4.3$, it exceeds -1.96, the null hypothesis is rejected, therefore the alternative hypothesis is accepted, and the arrangement of the data is not random.

Appendix 4.4

Chi-squared (x^2) test for non-randomness
Persian carpet sample (all-over)

Chi-squared test (x^2-test) = $\sum \frac{(O - E)^2}{E}$

O = observed frequency
E = expected frequency
œ (level of significance) = 0.05

E = 501
17 = 29.47

classification	Oi	Ei	Oi - Ei	(Oi - Ei)^2	(Oi - Ei)^2 / Ei
cm	31	29.47	1.53	2.3409	0.08
pm	80	29.47	50.53	2553.2809	860.64
pg	18	29.47	-11.47	131.5609	4.46
p1	45	29.47	15.53	241.1809	8.18
pmm	136	29.47	106.53	11348.6409	385.09
cmm	12	29.47	-17.47	305.2009	10.36
pmg	20	29.47	-9.47	89.6809	3.04
pgg	1	29.47	-28.47	810.5409	27.5
p2	4	29.47	-25.47	648.7209	22.01
p4m	102	29.47	72.53	5260.6009	178.51
p4g	41	29.47	11.53	132.9409	4.51
p4	11	29.47	-18.47	341.1409	11.58
p3m1	0	29.47	-29.47	868.4809	29.47
p31m	0	29.47	-29.47	848.4809	29.47
p3	0	29.47	-29.47	868.4809	29.47
p6m	0	29.47	-29.47	868.4809	29.47
p6	0	29.47	-29.47	868.4809	29.47
Σ	501	501			918.78

k (degrees of freedom) = number of classes - 1 - number of calc. parameters = 17 - 1 - 0 = 16
$œ(0.05)_{16} = 26.296$

H_0 : distribution is random
H_1 : distribution is non-random, therefore reject H_0

918.78>26.296 therefore reject H_0, accept H_1.

Appendix 4.5

Chi-squared (x^2) test for non-randomness
Turkish carpet sample (all-over)

Chi-squared test (x^2-test) = $\sum \frac{(O - E)^2}{E}$

O = observed frequency
E = expected frequency
œ (level of significance) = 0.05

E = 500/17 = 29.41

classification	Oi	Ei	Oi - Ei	(Oi - Ei)^2	(Oi - Ei)^2 / Ei
cm	5	29.41	-24.41	595.8481	20.26
pm	198	29.41	168.59	28422.5881	966.43
pg	1	29.41	-28.41	807.1281	27.44
p1	29	29.41	-0.41	0.1681	0.006
pmm	124	29.41	94.59	8947.2681	304.23
cmm	2	29.41	-27.41	751.3081	25.55
pmg	2	29.41	-27.41	751.3081	25.55
pgg	0	29.41	-29.41	864.9481	2.96
p2	2	29.41	-27.41	751.3081	25.55
p4m	83	29.41	53.59	2871.8881	97.65
p4g	52	29.41	22.59	510.3081	17.35
p4	2	29.41	-27.41	751.3081	25.55
p3m1	0	29.41	-29.41	864.9481	2.96
p31m	0	29.41	-29.41	864.9481	2.96
p3	0	29.41	-29.41	864.9481	2.96
p6m	0	29.41	-29.41	864.9481	2.96
p6	0	29.41	-29.41	864.9481	2.96
Σ	500	500			1553.326

k (degrees of freedom) = number of classes - 1 - number of calc. parameters = 17 - 1 - 0 = 16
$œ(0.05)_{16} = 26.296$

H_0 : distribution is random
H_1 : distribution is non-random, therefore reject H_0

1553.326>26.296 therefore reject H_0, accept H_1.