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Defining the Mechanisms of a Cooperative Computer System Based on Theories of Cooperation

By

Yoon Ping Chui

A Doctoral Thesis submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of the Loughborough University of Technology.

August 1994

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ABSTRACT

There is a growing interest in the development of computer systems that are actively involved in the tasks of the users and serve to augment the users' creativity. Cooperative computing is a major contribution to this research field. A survey of current developments in knowledge based systems led to the conclusion that there has hitherto been an absence of a formal definition of the mechanisms of cooperative computer systems based on theories of cooperation. The work in this thesis seeks to provide a full definition of cooperation derived from the behaviours of living cooperative systems.

Studies on human cooperation and cooperation in the animal kingdom, established that cooperation is a dynamic behaviour; in that the interaction processes between the cooperative partners serve to facilitate the achievement of a common goal, or a set of goals that are mutually desired by the partners. Partners in cooperation are interdependent: one member's actions are contingent on another. Therefore, the underlying processes which induce and maintain cooperation were identified. These are: communication between the partners; emergence of norms and roles governing the behaviour of the cooperating members; resolution of conflicts; distributed and coordinated activities. These factors were further elucidated within the context of small problem solving groups. A model of cooperation which encapsulated these factors was produced. From the discussions of the advantages of cooperation within different contexts, the potential for synergy was found to be the main benefit of cooperation. The potential for achieving this synergy between a human and a computer is the main motivation for the work undertaken in this research.

From the theoretical analysis of cooperation, the underlying mechanisms of a cooperative computer were successfully defined. A conceptual model of human-computer cooperation was presented. It was established that the quality of cooperation is closely associated with the nature of the task. Therefore, it is not practicable to produce a general purpose cooperative system. A specific task must be used. Creative tasks of a problem identifying and solving nature, were found to be more suitable to cooperative behaviour than others. Typical of these, and the one selected, was computer screen design. Current screen design practice was analysed, and the functional requirements and knowledge base needs of the systems were established.

The underlying mechanisms of cooperation were formalised and successfully implemented within a software exemplar, named COSY. COSY exhibits the behavioural characteristics of cooperation, and utilises the knowledge of screen design to support users in the task of formatting computer screens. COSY successfully demonstrated the synergistic relationship in its cooperation with the users.

It is concluded that the approach undertaken in this thesis has lead to a successful definition and implementation of the formal mechanisms of cooperation in a computer system, one which potentially enhances the innovative and creative aspects of design work.
To mum and dad, with all my love,

and,

To the CHUI family.
"Two are better than one,
because they have a good return for their work:
If one falls down, his friend can help him up.
But pity the man who falls and have no one to help him up!
Also, if two lie down together, they will keep warm.
But how can one keep warm alone?
Though one may be overpowered,
two can defend themselves.
A cord of three strands is not quickly broken."

Ecclesiastes
Chapter 4 vv 9-12
ACKNOWLEDGEMENTS

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Being so far from home, many friends have given me a lot of love and concern. Thanks to all my brothers and sisters in the Loughborough Chinese Christian Fellowship and Holywell Church for their prayers, and to my special friends, Dong Ju, Val, Colin, Eileen, Richard, Sue, Uncle Mel and CB-ni.

My deepest gratitude goes to my family for their understanding, love and support, without whom I could never have made it.

Last but not least, I want to thank Ronnie for all his love, encouragement and support over the years.
CERTIFICATE OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in acknowledgements or in footnotes, and that neither the thesis nor the original work contained therein has been submitted to this or any other institution for a higher degree.

Yoon Ping Chui
1994
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>i</td>
</tr>
<tr>
<td>Dedication</td>
<td>ii</td>
</tr>
<tr>
<td>Text</td>
<td>iii</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>iv</td>
</tr>
<tr>
<td>Certificate of Originality</td>
<td>v</td>
</tr>
<tr>
<td>List of Figures and Tables</td>
<td>xiii</td>
</tr>
<tr>
<td><strong>Chapter 1: Introduction</strong></td>
<td></td>
</tr>
<tr>
<td>1.1 Beyond computable numbers</td>
<td>1</td>
</tr>
<tr>
<td>1.2 The birth of cooperative computing</td>
<td>4</td>
</tr>
<tr>
<td>1.3 Aim of research</td>
<td>7</td>
</tr>
<tr>
<td>1.4 Organisation of thesis</td>
<td>8</td>
</tr>
<tr>
<td><strong>Chapter 2: Current Developments in Knowledge Based and</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cooperative Computing Systems</strong></td>
<td></td>
</tr>
<tr>
<td>2.1 Introduction</td>
<td>11</td>
</tr>
<tr>
<td>2.2 Classification of computer systems</td>
<td>12</td>
</tr>
<tr>
<td>2.3 Knowledge based expert systems</td>
<td>14</td>
</tr>
<tr>
<td>2.3.1 Components of expert systems</td>
<td>14</td>
</tr>
<tr>
<td>2.3.2 Advantages of expert systems</td>
<td>16</td>
</tr>
<tr>
<td>2.3.3 Limitations of experts systems</td>
<td>19</td>
</tr>
<tr>
<td>2.4 Expert critiquing systems</td>
<td>20</td>
</tr>
<tr>
<td>2.4.1 Model of the critiquing process (What it does)</td>
<td>21</td>
</tr>
<tr>
<td>2.4.2 How critiquing works</td>
<td>23</td>
</tr>
<tr>
<td>2.4.3 The Colorado Critics</td>
<td>24</td>
</tr>
</tbody>
</table>

vi
2.4.4 The Colorado Critics: Conclusions 28
2.5 The Human-Computer Cooperation Project (HCC) 28
2.6 The present work 31

Chapter 3: Theories of cooperation

3.1 Introduction 32
3.2 What is cooperation? 33
3.3 The origin of cooperation 35
3.4 Cooperation and other phenomena 37
   3.4.1 Cooperation and helping behaviour 37
   3.4.2 Cooperation and reciprocal altruism 40
   3.4.3 Cooperation and kin selection 44
   3.4.4 Cooperation and competition 44
   3.4.5 Cooperation and Tit-For-Tat 46
   3.4.6 Cooperation and coalition 47
   3.4.7 Cooperation and other phenomena: Summary 47
3.5 Helping and cooperation in animals 48
3.6 Summary and Conclusions 57

Chapter 4: Experimental Studies on Cooperation

4.1 Introduction 59
4.2 Mixed-motive games 60
   4.2.1 Prisoner's Dilemma Game 61
   4.2.2 Maximising Difference and Chicken Game 64
   4.2.3 Advantages and disadvantages of mixed-motive games 65
4.3 Nature of rewards 69
   4.3.1 Nature of rewards: Discussion and Conclusions 71
4.4 Payoff values within the matrix 74
4.5 Responses to programmed strategies 76
   4.5.1 Non-contingent strategies 77
   4.5.2 Contingent strategies 78
      4.5.2.1 Contingent strategy: Tit-For-Tat 79
Chapter 6: Cooperation in Small Groups: The Underlying Processes of Cooperation

6.1 Introduction 138
6.2 Tasks suitable for cooperation 139
6.3 Goals 144
   6.3.1 Group goals 144
   6.3.2 Personal goals 146
   6.3.3 Formation of group goals 146
   6.3.4 Acceptance of group goals 149
   6.3.5 Goals and mutual trust in cooperation 150
   6.3.6 Success or failure in attainment of goal 150
   6.3.7 Summary of Goals 151
6.4 Communication 152
   6.4.1 Definition of communication 152
   6.4.2 Model of communication 153
   6.4.3 Communication in cooperation 153
   6.4.4 Cooperation in communication 156
   6.4.5 Factors affecting communication 160
   6.4.6 Summary of Communication 160
6.5 Norms 161
   6.5.1 Definition of norms 161
   6.5.2 Importance of norms 161
   6.5.3 Emergence of norms 162
   6.5.4 Types of norms 163
   6.5.5 Conformity and deviance from group norms 166
   6.5.6 Summary of Norms 168
6.6 Roles 169
   6.6.1 Classification of Roles 170
   6.6.2 Emergence of Roles 172
   6.6.3 Roles stabilisation 174
   6.6.4 Role conflict 174
   6.6.5 Summary of Roles 175
6.7 Conflict
   6.7.1 Advantages and disadvantages of conflict
   6.7.2 Management of conflict
   6.7.3 Summary of Conflict

6.8 Distribution and Coordination of responses

6.9 Summary and Discussion

6.10 Concluding remarks

Chapter 7: Experimental Investigation of Cooperation in Screen Design

7.1 Introduction

7.2 Why screen design?

7.3 Objectives of the experimental investigation

7.4 Rationale for adopted procedures

7.5 Experimental Programme 1: Preliminary interview
   7.5.1 Subjects
   7.5.2 Procedure
   7.5.3 Questions for preliminary interview
   7.5.4 Results
   7.5.5 Discussion and Conclusions

7.6 Experimental Programme 2: Screen design exercise
   7.6.1 Aims
   7.6.2 Subjects
   7.6.3 Materials
   7.6.4 Tasks
   7.6.5 Procedures and instructions
   7.6.6 Post-experimental questionnaire
   7.6.7 Results: Protocol and design sketches analysis
   7.6.8 Results: Post-experimental questionnaire
   7.6.9 Post-experimental questionnaire: Discussion and Conclusions

7.7 Summary and Conclusions
Chapter 8: Formalism of the Mechanism of a Cooperative Screen Design Computer System (COSY)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 Introduction</td>
<td>241</td>
</tr>
<tr>
<td>8.2 Requirements of a cooperative computer system</td>
<td>242</td>
</tr>
<tr>
<td>8.2.1 Goal directed work</td>
<td>242</td>
</tr>
<tr>
<td>8.2.2 Roles</td>
<td>246</td>
</tr>
<tr>
<td>8.2.3 Communication requirements</td>
<td>247</td>
</tr>
<tr>
<td>8.2.4 Conflict resolution</td>
<td>251</td>
</tr>
<tr>
<td>8.2.5 Distribution and Coordination of activities</td>
<td>253</td>
</tr>
<tr>
<td>8.2.6 Norms</td>
<td>254</td>
</tr>
<tr>
<td>8.3 COSY: A cooperative screen design system</td>
<td>256</td>
</tr>
<tr>
<td>8.3.1 Introduction</td>
<td>256</td>
</tr>
<tr>
<td>8.3.2 Interface of COSY</td>
<td>256</td>
</tr>
<tr>
<td>8.3.3 Cooperation between user and COSY</td>
<td>258</td>
</tr>
<tr>
<td>8.4 Evaluation of COSY</td>
<td>266</td>
</tr>
<tr>
<td>8.4.1 Introduction</td>
<td>266</td>
</tr>
<tr>
<td>8.4.2 Subjects</td>
<td>270</td>
</tr>
<tr>
<td>8.4.3 Screen redesign task</td>
<td>270</td>
</tr>
<tr>
<td>8.4.4 Procedure</td>
<td>271</td>
</tr>
<tr>
<td>8.4.5 Results</td>
<td>271</td>
</tr>
<tr>
<td>8.4.6 Discussion</td>
<td>280</td>
</tr>
<tr>
<td>8.5 Conclusions</td>
<td>282</td>
</tr>
</tbody>
</table>

Chapter 9: Conclusions and Further Research

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1 Conclusions</td>
<td>284</td>
</tr>
<tr>
<td>9.2 Further Research</td>
<td>287</td>
</tr>
</tbody>
</table>

References 293
Appendices:

A. Preliminary Interview Questionnaire.


C. Documents for Screen Design Exercise: Cooperative Group.

D. Transcripts of the verbal protocol of a single designer in the screen design exercise.

E. Transcripts of the verbal protocol of a pair of designers in the screen design exercise.

F. Summary of procedures for design knowledge acquisition and analysis.

G. Documents for the evaluation of COSY.
LIST OF FIGURES AND TABLES

Figure 1.1 Framework of thesis. 10
Figure 2.1 Human-computer cooperative systems in the context of other relevant computer systems. 13
Figure 2.2 Architecture of a simple expert system. 15
Figure 2.3 Knowledge base is extended into knowledge database and domain database, with a Database Management System (DBMS). 15
Figure 2.4 Knowledge acquisition facility is added, with input from the expert. 17
Figure 2.5 Expert system is further extended to include an explanation facility. 18
Figure 2.6 Overview of the critiquing process. 22
Figure 2.7 Relationships between the three underlying mechanisms of the cooperative computer (GOW, PM, ADKB) and the user. 29
Figure 4.1 The general Prisoner's Dilemma Game (PDG) matrix. 62
Figure 4.2 The Prisoner's Dilemma Game (PDG) matrix. 62
Figure 4.3 Matrix for Maximising Difference Game (MDG). 63
Figure 4.4 Matrix for the Chicken Game. 63
Figure 4.5 Payoff matrix for real-life cooperative and non-cooperative choices. 76
Figure 6.1 The group task circumplex. 142
Figure 6.2 Construction of common goal through participation. 147
Figure 6.3 Model of human communication. 154
Figure 6.4 Communication in cooperation. 157
Figure 6.5 Norms governing behaviour in cooperation. 165
Figure 6.6 Task and/or maintenance roles assumed by partners for effective cooperation. 173
Figure 6.7 Cooperation as a system. 183
Figure 7.1 Rated level of experience. 198
Figure 7.2 Medium used by subjects. 207
Figure 8.1 Model of human-computer cooperation. 243
Figure 8.2 A model of cooperation between user and COSY. 259
Figure 8.3 Cooperation between COSY and the user in the layout of a screen title. 261
Figure 8.4  Cooperation between COSY and the user in the layout of screen captions and entry fields.  262
Figure 8.5  Conceptual model of the roles of COSY.  265
Figure 8.6  Hypothetical model of cooperation in a screen design task between a user and COSY.  268

Table 2.1  Evolution of the Colorado critiquing systems.  27
Table 3.1  Differences between Reciprocal Altruism (RA) and Cooperation.  42
Table 3.2  Summary of the key differences between Reciprocal Altruism (RA) and Cooperation.  43
Table 4.1  Experimental surveys on gender differences in cooperative behaviour.  93
Table 4.2  Results of experiments comparing cooperativeness between different cultures.  96
Table 4.3  Cooperative societies.  97
Table 4.4  Competitive societies.  99
Table 4.5  Individualistic societies.  100
Table 4.6  Appropriate assignments of tasks.  139
Table 4.7  Quadrants, task types, and key concepts of the Task Circumplex.  143
Table 7.1  Summary of procedures of experiment work.  195
Table 7.2  Issues considered by designers in a data entry screen.  223
Table 8.1  Rules of screen design represented by COSY.  260
Table 9.1  Summary of the features of human cooperation, requirements of cooperative systems, and the main characteristics of COSY.  289

xiv
Chapter 1:

Introduction

1.1 Beyond computable numbers

The main impetus behind the development of computers, both in terms of hardware and software, has been the need for fast and efficient computation of numbers. Other uses were few. Computers were initially built by scientists for scientists. However, these scientists eventually began to wonder how intelligent computers could become. Turing, a mathematician at Cambridge in the 1930s was well ahead of his time when he talked about learning and thinking machines. Turing (cited by Hodges, 1987) stated:

"... the intention in constructing these machines in the first instance is to treat them as slaves, giving them only jobs which have been thought out in detail, jobs such
that the user of the machine fully understands in principle what is going on all the
time. Up till the present, machines have only been used in this way. But is it
necessary that they should always be used such manner?"

In describing his plans for the Automatic Computing Engine (ACE) Turing (cited by Hodges, *ibid*) wrote:

"It will also be necessarily devoid of anything that could be called originality. There is, however, no reason why the machine should always be used in such manner: there is nothing in its construction which obliges us to do so. It would be quite possible for the machine to try out variations of behaviour and accept or reject them and I have been hoping to make the machine do this."

Thus, Turing (and other mathematicians at the time, such as John von Neumann and Warren McCulloch), realised that computers should and could be used to process not only numbers but also symbolic information.

Turing, in his paper "On computable numbers" proposed that a machine could carry out any mathematical procedure, providing the machine was supplied with an adequate instruction table. He described the key components of the concept of the programmable abstract interactive machine; one against which the very possibility of formally describing the logical mechanisms of behaviour could be measured (Edmonds, 1987). More than fifty years after the publication of Turing's paper, Edmonds (1987, 1993) contended that its significance is still not fully understood and
noted that "... we are just beginning to see some of his ideas being exploited." At his inaugural professorial lecture, Edmonds (1987) presented his audience with the challenge to "move beyond computable numbers." He said:

"The question is not, 'What is the potential of the concept of computable numbers?' but 'what is the potential of this extended concept, beyond computable to interactive computing machines?' If one considers the case of human operators interacting with the machine then one might be less interested in what the machine might compute than in what the human operators can construct. The question then is, 'What might the human operators do, using such systems? What might the human operator experience?"

Edmonds (ibid) further wrote:

"We now have the concept of a machine that can, in principal, cooperate with human operators on mental tasks in any way that is possible for us to conceive. Given this concept, and the demonstrations of its viability, we have the interest and the energy to explore the practical issues involved in achieving the construction of real machines that exploit some of these theoretic potentials. Human-Computer Cooperation is now a real possibility."

Edmonds closed the lecture by stating, "Let us not underrate the significance of computing machines. We view the invention of computable numbers in terms of arithmetic and mere technology at our cultural peril." (Edmonds, 1987).
1.2 The birth of cooperative computing

Cooperative computing could be said to have begun during the search for novel methods for improving interaction with machines during complex problem solving tasks. Research in this area is regarded as mainly falling within the domains of artificial intelligence and human-computer interaction.

Artificial Intelligence (AI) has been defined as "... that branch of computer science dealing with symbolic, non-algorithmic methods of problem solving," (Buchanan and Shortliffe, 1984) or "... the branch of computer science that deals with ways of representing knowledge using symbols rather than numbers and with rules-of-thumb or heuristic method for processing information" (Simon, 1984). Currently the most successful area in AI research is the application of expert systems. However, an objection to some current expert systems is that they have been known to take the initiative away from the users. Users who are engaged in creative problem solving tasks such as designing and composing, prefer to be involved in their task actively and creatively and not just be told what to do (Fischer, 1990). Therefore, it is argued that it is necessary to build systems that work together with users to support and augment creativity: computers which cooperate with the user.

Early use of computer systems tended to be restricted to scientists and mathematicians sharing a common interest in the very demanding computer technology of the time. Today, more or less anybody can have access to a computer. A phenomenon of the age is the need to categorise types of users. Eason (1979) offers the enthusiast, the servant, the malleable user, the demanding user, the habitual
user, the forgetful user, and the professional user. The growth of access is not accompanied by equal growth in success. Each type of user has specific needs and expectations of the computer which may not be met. For example, professional users may wish to spend the minimum time learning and operating the system. A system that demands a lot from these users is unlikely to be fully utilized even if it has high potential usefulness. Furthermore they will not adapt their own behaviour to accommodate inflexibilities in the system, and they demand complex service because their needs are diverse and changing. When the needs and expectations of the end users of computer systems are not taken into consideration, the systems often fall into disuse. At the core of many of these problems lies the user's difficulty in interfacing with the computer through the human-computer interface.

Consequently, computer scientists, cognitive psychologists, sociologists, engineers, graphic designers, and ergonomists had to work together in Human-Computer Interaction (HCI) research to contribute their specialized knowledge in exploring those novel machine interaction methods and paradigms. This would enable users to perform the complex activities required by the task, whilst keeping to a minimum time taken to learn the system. In the 1980s for example, a major contribution to HCI research came from cognitive psychologists, who developed and applied information-processing theories to model the mental structure and processes of human beings. They viewed the human mind as being essentially a rule-governed system, much like a computer (Sandford, 1985). They looked for generalisations in the theories of human memory, attention and processing resources,
problem solving, language and grammar. Their work has made a significant impact on the accessibility of computers, and a key component of these new interfaces includes implementation of the elements of communication.

People do not work in isolation. In any working environment, they interact with their machines, their environment and other people within that environment. HCI researchers have been quick to study the communication process between human beings to create new dialogue styles for human-computer communication. A noteworthy interaction process between people is human-human cooperation. Anyone who has worked with another person would acknowledge that it can produce high payoff in terms of the performance of the task. People test ideas on each other. In doing so, they can suddenly see a problem in a different light, and thus new ideas are created. Cooperation has been known to create new motives, attitudes, values and capabilities which have positive effects on the cooperating participants. However, the most exciting potential outcome of cooperation is the synergy effect, where the combined actions of two or more individuals produce net benefits that are more than the sum of the benefits available to a single individual. It is like listening to a piano sonata; one could avow that there are more than two hands moving across the piano, from the amount of notes heard.

A key piece of work on human-computer cooperation was performed by Clarke and Smyth (1993) in the LUTCHI Research Centre at Loughborough University. Mechanisms central to the development of a cooperative computer were identified and these were demonstrated on an exemplar using the task metaphor of spatial design. Fischer and his colleagues at the University of Colorado have also been
actively pursuing research in intelligent systems that will support cooperative problem solving processes between humans and computers to augment human intellect. However, research on cooperative computing systems is still in its infancy.

Cooperative computing has great promise. It is timely to introduce the knowledge of theoretical aspects of cooperation into the development of such systems which will take advantage of the positive benefits of cooperation.

1.3 Aim of research

The major aim of the research project was:

To arrive at a more accurate and complete definition of a cooperative system by consideration of theories of cooperation, and current developments in cooperative systems and knowledge based systems.

This was to be achieved by:

a. Examining the principles of cooperation through consideration of human-human cooperation, and cooperation in the animal kingdom.

b. Determining the underlying mechanisms of a cooperative computer system.

c. Developing and evaluating a representative system based on the underlying mechanisms defined in (b).
1.4 Organisation of thesis

The thesis is organised as follows:

Chapter 1 provides the context in which cooperative computers fall, as well as the aims of the work described in this thesis.

Chapter 2 presents the current developments in artificial intelligence, emphasising expert systems and expert critiquing systems. This is followed by a review of the research in human-computer cooperative systems. This chapter concludes that the theoretical definitions of cooperation are poorly defined in the current development of cooperative systems.

Chapter 3 establishes the underlying principles of cooperation by examining the definitions of cooperation that have been posited over the years, assessing the differences between cooperation and other related phenomena, and studying the social behaviours in the animal kingdom.

Chapter 4 reviews experimental studies on the factors affecting cooperation. Mixed-motive games which most commonly used in these studies are described. The external variables affecting cooperation (such as the nature of rewards, strategies employed, communication, etc.) are analysed. This is followed by a brief review of the sex and age differences, ethnic, and individual differences in cooperative behaviour of individuals.

Chapter 5 looks at the advantages of cooperation in animal, educational, organisational settings, as well as the performance of small problem solving groups.
Chapter 6 describes the underlying processes identified in Chapter 3 within the context of small problem solving groups. These are: goal directed behaviour, distributed roles, establishment of norms, communication, resolution of conflict, and coordination. Chapters 3 to 6 form the theoretical basis for defining a cooperative computer system. The types of task which are befitting for cooperation are also discussed.

Chapter 7 presents the experimental work of the project. Firstly, the reasons for choosing computer screen design as the task domain in which to construct the software exemplar are presented. The acquisition of design knowledge and procedures obtained through interviews and screen design exercises are reported in this chapter.

Chapter 8 discusses the requirements of a cooperative computer system. This is followed by a description of the software exemplar (COSY) constructed to demonstrate the underlying mechanisms in cooperative systems. The results and discussion of the evaluation of COSY are given here.

Chapter 9 restates the aims of the project and discusses how they have been achieved. Here the main conclusions derived from the project are presented. Ideas for further research are also provided in this chapter.

Figure 1.1 shows the framework of the approach adopted in the work described in this thesis.
Figure 1.1: Framework of thesis.
Chapter 2:

Current Developments in Knowledge Based and Cooperative Computing Systems

2.1 Introduction

One of the most important advantages of cooperation is its synergism, where the combined efforts of the cooperating partners result in a net benefit that is more than the sum of the benefits available to the single individuals. Cooperation between humans in a problem solving task stimulates new or different thought processes. Partners pool together their unique but different expertise and information to solve problems that individually they cannot attack successfully. Alternative solutions, new ideas and perspectives are generated and evaluated. This may result in a better quality solution. It is argued that similar benefits can be reaped from the cooperation between a human and a computer engaged in joint problem solving tasks.
Computer systems, designed with the above in mind are collectively referred to as human-computer cooperative systems. This chapter provides an overview of research in knowledge based system which led to the development of expert critiquing systems.

2.2 Classification of computer systems

Broadly classified, there are three types of computer systems as shown in Figure 2.1. Human-computer systems refer to systems where a human interacts with a computer to achieve a certain task. Two related fields are computer supported cooperative work (CSCW) and distributed artificial intelligence (AI). CSCW is concerned with cooperation between humans mediated by a computer and distributed AI refers to cooperation between computer systems.

Under human-computer systems, three sub-types can be identified, namely: expert systems, critic systems and human-computer cooperative systems. Expert systems use knowledge of facts captured from experts to reason and solve problems. Critic systems use expert knowledge to critique generated solutions to improve the human-computer interaction. A definition and survey of these systems has been provided by Silverman (1992a) and will be briefly mentioned. Work in the area of cooperative problem solving systems is somewhat scarce, and the most prominent works conducted in this specific field are by Fischer and his colleagues in the USA, and the Alvey Human-Computer Cooperation project by Clarke and his colleagues in the UK. In this thesis, cooperative systems refer to systems that support cooperation between a human and a computer.
Computer Systems

Distributed Artificial Intelligence (Two or more Computers)
Human-Computer Systems (Human plus Computer)
Computer Supported Cooperative Working (Two or more humans, computer supported)

(Expertise, Expert or Partner in System)

Expert Systems (e.g. MYCIN) Critic Systems (e.g. LISP-CRITIC) Human-Computer Cooperative Systems (e.g. COSY)

Figure 2.1: Human-Computer Cooperative Systems in the Context of other Relevant Computer Systems
2.3 Knowledge based expert systems

Expert systems are computer-based systems which use knowledge, facts and reasoning techniques to solve problems that normally require the abilities of human experts. Of all the different areas of research in AI, expert systems have thrived due to their practical application and commercial potential. It is the first AI technology to have a widespread impact on business and industry.

2.3.1 Components of expert systems

The simplest expert system typically comprises the following components (Figure 2.2):

**User interface:** This allows the user to communicate with the system. Through this, the user can enter facts about a specific situation that are relevant to the system’s subject domain, and can ask the expert system questions within the system’s subject area. The user interface also provides the expert system with the necessary facilities to offer responses.

**Knowledge base:** This contains the knowledge of a human expert on a particular subject in a codified form. (In slightly more sophisticated expert systems, Figure 2.3, the knowledge base is expanded into a knowledge database and a domain database, and these two databases are managed by a database management system.)
Figure 2.2: Architecture of a Simple Expert System (After Martin and Ovman, 1988)

Figure 2.3: Knowledge base is extended into knowledge database and a Domain Database with a Database Management System (DBMS) (After Martin and Ovman, 1988)
The database contains facts about the expert system's domain, whereas the knowledge base holds the special heuristics or rules that direct the use of knowledge (data) to solve problems in a particular domain.

**Inference engine:** The inference engine, sometimes referred to as the control structure, or rule interpreter, in effect "runs" the expert system; determining which rules to invoke, accessing the appropriate rules in the knowledge base, executing the rules, and determining when an acceptable solution has been found.

More complex expert systems are likely to have two further modules. Figure 2.4 shows an expert system with a knowledge acquisition facility. This component provides a dialogue with the human expert for the purpose of acquiring new knowledge in the form of rules and facts to update and expand the expert system. It then places the rules in the knowledge database and the facts in the domain database.

Most expert systems have an explanation facility to justify their answers or advice (Figure 2.5). This facility keeps track of the advice and consultations provided as well as the reasoning paths the inference engine used to produce the advice. At any time during an interactive session with the expert system, the user can ask the system how it arrived at a given conclusion and the explanation facility will provide the necessary responses.

### 2.3.2 Advantages of expert systems

Expert systems offer many advantages over traditional computer systems. They increase output by freeing the time of the human expert and enable him to concentrate
Figure 2.4: Knowledge Acquisition Facility is added, with input from the expert. 
(After Martin and Oxman, 1988)
Figure 2.5  Expert System is Further Extended to include an Explanation Facility.  
(After Martin and Oxman, 1988)
on other more creative activities. They capture scarce expertise and have also been used for training inexperienced workers. Expert systems also have the advantage of being able to deal with incomplete and uncertain information (Turban, 1988). Expert systems enhance problem solving by increasing users' understanding through the explanation component. This component explains to users how a particular conclusion was reached, and why requested information is needed during consultation. This has the advantage of giving users a chance to access and understand the system's reasoning ability, thereby improving user's confidence in the system.

2.3.3 Limitations of expert systems

Traditional or first generation expert systems (FGES) have many shortcomings. The user interfaces of FGES are system oriented and constrained to a large extent. The user-system dialogues are usually long, exhausting and limited (Devedzic and Velasevic, 1990). Most of them ask the user for input, make all decisions and then return an answer. Fischer (1990) argued that the assumption behind such an interaction paradigm is based on the unfounded assumption that users approach these systems with a precisely described task. But in reality, the articulation of a precise task is the most difficult problem. Users cannot ask questions about knowledge that they do not know exists, and they may not be able to articulate their questions without the help of the expert (Fischer, ibid).

FGES explain their reasoning in a rigid and mechanistic fashion. Explanation is usually done by displaying the trace of rules used during the inference process (Devedzic and Velasevic, ibid). Such explanations are not convincing enough and often do not provide the users with the information that they want.
Second generation expert systems (SGES) are emerging to overcome the shortcomings and limitations of FGES. For example, explanations are not just based on logical proof only, but also on knowledge of user expectations, causal relations and deep, context dependent knowledge of the application domain. SGES interfaces are more user oriented, providing flexible dialogues with a number of options, and more possibilities for communication to occur in a natural way. Devedzic and Velasevic *(ibid)* presented a comprehensive comparative study of FGES and SGES features covering aspects of user interface, knowledge representation, reasoning, explanation facilities, knowledge acquisition and learning, shells and real-time operations.

### 2.4 Expert critiquing systems

Expert critiquing systems, simply known as "critics," is an area of AI research that has been gaining wider interest. Based on expert system technology, they incorporate knowledge from the psychology of judgement, decision making, and human error in forming a "support-the-expert paradigm" *(Silverman, 1992b)*.

Critics are computer programs that critique human-generated solutions. They typically have the form of a narrowly focussed program that uses a knowledge base to help it recognise what types of human error occur, and what kinds of criticism strategies could help the user prevent or eliminate these errors. The goal of developing expert critiquing systems is to assist humans in achieving their potential by giving them support where they are weakest. To borrow Silverman's phrase, "the goal is not machine deduction of how to perform the task, but machine assisted human induction or deduction." Many of these critics have been implemented successfully in applications such as decision making, engineering design, word processing, knowledge base acquisition and software engineering *(Silverman, 1992a)*.
2.4.1 Model of the critiquing process (What it does)

Figure 2.6, adapted from Silverman (1992b), shows how the critiquing process functions. The user interacts with task support software, such as a word processor, or a computer-aided design package, providing two sets of input to the software. Firstly, the problem description (e.g. document to be created) and secondly, the proposed solution to the problem (e.g. a finished document). According to Silverman, this second input is what distinguishes an expert critic from either an expert system or an expert advisory system. Both these systems compute and offer their own solutions to the user as output. For a critic, the solution is part of the input. The critic is independent though it resides within the same environment as the task support software. It analyses the user's solution and offers feedback, criticism or explanation to the user, according to what the user did wrong. For a critic, the output is the criticism.

The architecture of the embedded critic includes a differential analyser and a dialogue generator. The differential analyser infers the user's goal and compares the user's task result to that produced by an expert module which is often a knowledge base or rules that an expert would run to perform the task. A file of errors is created when the differences beyond an acceptance threshold occur. The dialogue generator receives this file of errors from the differential analyser, parses it in to a user presentable form and displays it on the screen. In some critics, a user model is incorporated, which provides different displays to the users depending on the users' personal characteristics.
Figure 2.6: Overview of the Critiquing Process
(After Silverman, 1992)
2.4.2 How critiquing works

The goal of expert critiquing systems is to criticised the credibility of knowledge, rather than to prove the correctness of the user’s task result. It subjects the knowledge to four tests:

Clarity Test: Test for vagueness and ambiguity.

Coherence Test: Test for completeness and consistency.
Test whether the result omits knowledge about the problem at hand.

Correspondence Test: Test for the agreement of knowledge to reality.
Test to find out if a body of knowledge omits situations, experience, and/or empirical information that an expert would know to be relevant for practical problems of the real world.

Workability Test: Test to see if the body of knowledge leads to prescriptions that are workable.

Silverman (1992b) argued that any kind of knowledge can be criticised in terms of its clarity, coherence, correspondence, and workability but one must be aware of the fact that effective critiquing requires a process, not an event. It involves a two-way communication between the expert human and the expert critic. Through mutual exchange of viewpoints, both the originator and recipient of the initial criticism can grow from the interaction. To achieve this, the critic needs interactive skills and a dialogue in which both parties can benefit. Silverman (1992a) provided a survey of the developments to date in the critiquing systems field. Many of these systems are technology centred in that they are concerned with extending and
improving on the components which make up the architecture of the critic. Fischer and his colleagues, on the other hand look at the role critics could play in making difficult work situations more comprehensible to humans. The next section describes some of the work that they have done.

2.4.3 The Colorado Critics

The term ‘Colorado critics’ has been used by Silverman (1992a) as a catch-all for the work of Gerhard Fischer and his colleagues at the University of Colorado in the USA. Fischer used the critiquing approach to build cooperative problem solving systems which support incremental learning. Several prototypical systems that instantiate the critiquing conceptual paradigm or that illustrate an aspect of it have been developed. The key features of these evolving critiquing systems are described briefly below, and summarised in Table 2.1.

A. ACTIVIST

ACTIVIST is a critic in the form of an active help system for a text editor. ACTIVIST was developed on the basis that humans are not able to pose questions about something that they are not aware of. Therefore ACTIVIST looks over the shoulder of the user and infers user goals from observed actions. The system then matches the user’s actions to plans in its knowledge base that accomplish the same goals. It volunteers information at appropriate times based on a user model. After three suboptimal executions of a task, say, it informs the user of a better procedure for the task. ACTIVIST ceases to critique actions when the user ignores its suggestions.
B. LISP-CRITIC

LISP-CRITIC is a system which suggests how to improve Lisp codes (Fischer, 1987). The code can be improved by making it more cognitively efficient (e.g. more readable and concise) or more machine efficient (e.g. smaller and faster).

LISP-CRITIC is developed with the goal of supporting incremental learning. Fischer (ibid) argued that online help systems implemented on most systems usually do not do much more than present the same information found in the printed documentation. The existence of this support information does not guarantee that people know how to use it, or that they read it or understand it. He asserted that LISP-CRITIC is developed on the critiquing model which allows users to pursue their own goals and the program interrupts only if the behaviour of the user is judged to be significantly inferior to what the program would have done.

The system is thus used by intermediate users who want to learn how to produce better Lisp code, as well as experienced users who want to have their code improved upon (straightened out). The criticism provided by the system is supplemented by a visualization tool which illustrates the functioning and validity of certain rules. The system has been expanded and applied to other computing environments (Fischer and Mastaglio, 1989).

C. FRAMER

FRAMER is a knowledge-based design environment for the design of program frameworks (Lemke and Fischer, 1990). Program frameworks are high level building blocks for window-based user interfaces. FRAMER was built by incrementally adding simple components such as critics and checklists to simple tool kits to form sophisticated design environments. FRAMER represents design knowledge in formal, machine-interpretable knowledge sources (i.e. critics and dynamic
specification sheets) and in semi-formal knowledge sources such as a palette of user interface building blocks and a checklist. These external knowledge sources aim to help less experienced designers achieve better results. FRAMER is also a cooperative problem solving system that supports user interface designers via the various components.

D. JANUS

JANUS is a design environment based on the critiquing approach that allows designers to construct residential kitchens (Fischer et al, 1989; Fischer, 1990). The system comprises two integrated subsystems: JANUS-construction and JANUS-argumentation.

JANUS-construction provides a set of domain-specific building blocks for construction of artifacts from scratch and a catalogue of many previously designed kitchens for modification. The knowledge based critiquing mechanism in JANUS bridges the gap between construction and argumentation. It contains knowledge about building codes, safety standards and functional preferences. This critiquing component "watches over the shoulders" of the designers while they are constructing and critiques their work, displaying their criticism in the "Messages" pane if design principles are violated. This criticism provides entry point into the argumentation component of JANUS, which is supported by a hypertext system containing information about general principles of design.

E. MODIFIER

MODIFIER extends JANUS with knowledge-based components that support the following type of modifications: (1) introducing new appliances into the palette, (2)
adding new critic rules to the system, (3) adding definitions of new relationships, and (4) creating composite objects. For a detailed description of MODIFIER, please refer to Fischer and Gergensohn (1990).

### TABLE 2.1: Evolution of the Colorado Critiquing Systems.

<table>
<thead>
<tr>
<th>NAME OF SYSTEM</th>
<th>YEAR</th>
<th>FEATURES</th>
</tr>
</thead>
</table>
| ACTIVIST       | 1985  | Active help systems.  
|                |       | System volunteers information. |
| LISP-CRITIC    | 1987  | Style rules define standard ways of designing artifacts.  
|                |       | Visual explanations.  
|                |       | Minimalist explanations. |
| FRAMER         | 1989/1990 | Extending construction kits to design environment.  
|                |       | Making the situation talk back.  
|                |       | Signaling breakdowns.  
|                |       | Checklists. |
| JANUS          | 1989  | Integrating construction and argumentation to support reflection-in-action.  
|                |       | Relevancy to the task at hand.  
|                |       | Multiple critics with different points of view. |
| MODIFIER       | 1990  | Competent practitioners know more than they can say (impossibility for completely articulating background assumptions).  
|                |       | Tacit knowledge is triggered by situations, by breakdowns.  
|                |       | Critiquing knowledge is judgemental, unstable, and never complete. |
2.4.4 The Colorado Critics: Conclusions

In the development of each system, Fischer and his colleagues addressed the role of the critic in supporting the limitations of users and to aid learning. Evaluation of their systems have lead them to conclude that critics are an important step toward the creation of more useful and more usable computer systems for the future.

2.5 The Human-Computer Cooperation Project (HCC)

A key piece of work on cooperative computers was performed by researchers in the late 1980's in the LUTCHI Research Centre at Loughborough University. The primary objective of the project was to identify the mechanisms central to the development of a cooperative computer, and to exemplify these mechanisms in software. Like Fischer, Clarke and his colleagues observed that cooperation brings a synergy that can realise particular benefits, and hypothesised that the interaction between a user and a cooperative computer may yield such benefits. Key factors which characterise, induce and maintain productive cooperative behaviour between human partners during problem solving tasks were first identified. Clarke and Smyth (1993, and Smyth and Clarke, 1990) specified three main factors that reflected the underlying processes of cooperative behaviour. Firstly, for any cooperative dyad to succeed, there must exist a formally stated goal, which the partners must agree on and work towards. The process or mechanism which represented this in the machine was called the Goal Oriented Working (GOW) mechanism. Secondly, the ability to generate alternative solutions within a problem solving task is an important strand in the complex processes exhibited during cooperative behaviour (Smyth and Clarke, *ibid*). This is represented by the Partner Model (PM) which contained knowledge about the specific task domain, and would thereby represent the knowledge of the
computer partner. The ability of partners to communicate was also regarded as central to cooperative behaviour. Communication was represented firstly by a language common to both partners, containing commonly held definitions, and secondly, access to, and use of the language by both partners. This mechanism was referred to as the Agreed Definition Knowledge Base (ADKB). Figure 2.7 shows the relationships between the three mechanisms and the user of the system.

Figure 2.7: Relationships between the three underlying mechanisms of the Cooperative Computer (GOW, PM, and ADKB) and the User. (After Clarke and Smyth, 1993)

A software exemplar was constructed using the task metaphor of room layout design which is an instance of spatial design problems. (For a full description of the software, please refer to Smyth and Clarke, *ibid*; Clarke and Smyth, *ibid*.) Several important issues felt to be central to the development of cooperative computer systems were highlighted by the project:
The degree of cooperation achieved by the machine is a result of interaction between the underlying mechanisms, and not just a result of their individual actions. Thus, the quantity and quality of machine cooperation perceived by the user depends upon the interaction of the software mechanisms and the way in which the machine's resulting behaviour manifests itself to the user.

A complete definition of a task metaphor is a pre-requisite for the development of software for a cooperative machine. The depth of knowledge required to support cooperative working indicated that the technique is domain specific. What constitutes cooperation varies between tasks. The authors noted that the interface software requirements only became fully definable when the room design metaphor had been adopted.

Cooperation is most fruitful when the partners have similar, but not identical, capabilities, and are capable of learning from the cooperative machines. The authors contended that if the partner model simply mimics the user, then there is a risk that if the user is unable to solve a problem, then neither will be able to solve the problem. On the other hand, if the knowledge or expertise of the partners are too disparate, there will be little or no communication.

These issues are pertinent to the work described in this thesis, and will be further discussed in later chapters.
2.6 The present work

Unlike Fischer, Clarke's work was based on the principles of human cooperation. The aims of Clarke's work are shared by this present thesis: to define the underlying mechanisms central to cooperative computer systems, based on theoretical considerations of cooperation. However, a review of current developments in cooperative computer systems has highlighted the fact that the theoretical basis of this work is still poorly defined. The author believes that a more comprehensive review of the literature on the social psychology of human cooperation, a study of the dynamics of cooperation, and an examination of social behaviour in the animal kingdom would provide a more thorough understanding of cooperation. This would extend the basis on which to further establish and develop the mechanisms underlying cooperative computers.
Chapter 3:

Theories of cooperation

3.1 Introduction

Cooperation is a widely observed phenomenon and it has acquired a variety of meanings, depending on the context in which it operates. Holland and Danielsen (1989) pointed out, "One may be too easily caught in the trap where one believes that everyone agrees on what cooperation is." Bogardus (1959) and Holland & Danielsen (ibid) emphasised the need to spell out the "semantic background" or the "perspective" under which the term cooperation is described. According to the latter, the words that we use and the description that we make of the phenomenon will affect the questions which may be raised, the answers that might be given, and also create the conditions for the study of the phenomenon.
This chapter aims to provide a clearer understanding of the term "cooperation." This is achieved firstly, by presenting a review on the different meanings and perspectives on cooperation. Cooperation is often discussed together with other phenomena, such as helping behaviour, reciprocal altruism, etc. The differences between these other phenomena and cooperation are discussed. In the last section of the chapter, some examples of animal cooperation are presented.

3.2 What is cooperation?

Cooperation has been defined as a form of behaviour (May and Doob, 1937), or an outcome (Parsons, 1951; Homans, 1961), but the most common understanding of cooperation is simply "working together." The dictionary definition of cooperation, "the act of working together for a shared purpose" (Longman Dict., 1984), or "working together to produce an effect," (Oxford Illust. Dict., 1980) implies a goal directed act. Marwell and Schmitt (1975) defined cooperation as "... joint behaviour that is directed towards a goal in which the participants have a common interest." Deutsch's (1949a; 1949b; 1960) definition of a cooperative social situation is one in which the goals of the individuals are promotively interdependent, in that "... the movement of one member towards the goal will to some extent facilitate the movement of other members towards the same goal." This indicates that cooperation is not static; the cooperative process progresses toward some goals. It also suggests interdependence between cooperating partners. Argyle (1991) argued that the shared group goals theory provides only a partial account of one kind of cooperation. He stated that cooperation is needed not only for performing tasks, but also to sustain the basic social relationships needed for life. He therefore proposed a revised definition of cooperation as "... acting together, in a coordinated way at work, leisure, or in social
relationships, in the pursuit of shared goals, the enjoyment of the joint activity, or simply furthering the relationship. Argyle's definition shows that cooperation could occur for different purposes.

Marwell and Schmitt (ibid) viewed cooperation as a set of relations among behaviours and their consequences, rather than just a simple behaviour. They identified five specific elements which define the content of cooperative relations. These are goal directed behaviour, rewards for each participant, distributed responses, coordination, and social coordination. According to Marwell and Schmitt (ibid), the choice of elements determine the type of situation defined as cooperation and also specify the effects of other variables on cooperation. For example, the five elements can clearly be seen in the tightly knit cooperative working of a small group such as a surgical team; whereas in a cooperative investment enterprise, only goal seeking behaviour and rewards can be seen manifested (Clarke and Smyth, 1993). This view on cooperation indicates that there are certain mechanisms or processes underlying cooperation.

Cooperation is sometimes incorrectly used in the context of compulsion to mean obedience. For example, under the Communist regime in China, people are asked to "cooperate" with the authorities. Likewise, members of hierarchically organised groups who obey orders promptly are praised for being so cooperative. Conversely, a member who questions the validity of a command is challenged for being "uncooperative." However, a cooperation under compulsion, no matter who or what is the compelling force, is not true cooperation (Bogardus, ibid).

Cooperation has also been used by socio-biologists to describe an unconscious process of behaving together, as in the case of one-celled organisms, and of ants and
bees (Borgardus, *ibid*; Allee, 1951). It is arguable whether this type of reflective and non-purposive conglomeration of organisms can be considered as a form of cooperation.

Clearly the definitions of cooperation made over the years are wide ranging. However, some of the more important points within the definitions presented above which are pertinent to the purpose of this thesis can be isolated. These are:

1. Cooperation is a form of behaviour, usually involving more than one organism.
2. Cooperation is dynamic. It is a goal directed act.
3. Cooperation involves a common goal or set of goals (which are not necessarily explicit).
4. Cooperating partners or members are interdependent; one person's actions affect another, and vice versa.
5. Cooperation involves certain underlying processes, one of which is coordination.
6. Cooperation occurs for different purposes, e.g. to achieve a task, or simply for the enjoyment of the cooperating partners.

### 3.3 The origin of cooperation

Theories of kin selection, reciprocal altruism, and group selection have been put forward as the origins of helping behaviour, and cooperation (Argyle, *ibid*; Huntingford, 1982; Axelrod, 1984). These theories are rooted in the classical theory of evolution by natural selection, which states that, "... any inherited characteristics
which causes its bearer to leave more offspring will increase in frequency, because in subsequent generations there will be more individuals which have inherited the gene controlling its development" (Huntingford, ibid).

Kin selection describes the help or cooperation among relatives to increase inclusive fitness. For example, male turkeys join together in groups to fight with other such groups, but only a single animal gets all the matings. The key to this puzzle lies in the fact that the members of a group are all brothers. Although the chance of a subordinate animal mating is small, the likelihood that copies of his genes will be passed on to the next generation in the offspring of his dominant brother is quite high (Huntingford, ibid). Kin selection theory supposes that animals are in some sense able to estimate the degree of relatedness of other animals. Animals may be able to recognise relatives through similarity of appearance, knowing siblings (e.g. in the nest), or on the basis of smell (Argyle, ibid).

Reciprocal altruism describes the situation where an animal puts itself at risk in order to benefit another only if the act is likely to be reciprocated in the future. An example of reciprocal altruism is shown in vampire bats regurgitating blood to one another on a reciprocal basis when the other has failed to feed and is very hungry (Wilkinson, 1988).

Group selection suggests that groups (as opposed to individuals in natural selection, or relatives in kin selection) which help each other will be more likely to survive and proliferate because of the biological advantages of the helping or cooperative behaviour (Argyle, ibid). Allee (ibid) argued that the struggle for existence and the necessity for cooperation are not always in direct opposition to each other. He asserted that there is ample evidence that the two types of social or subsocial interactions exist among animals: the self-centred, egoistic drives, which
lead to personal advancement and self-preservation; and the group-centered, more or less altruistic drives, which lead to the preservation of the groups, or of some members of it, perhaps at the sacrifice of many others.

Each of these theories has its problems in posing as the genetic basis of cooperation. Argyle (ibid) argues that although cooperation in animals is almost entirely unlearnt, it does not follow that human cooperation has the same origin. Cooperation in humans is innate, as well as learnt through socialisation. Argyle (ibid) wrote, "... human beings are born more open, less complete than animals, and with a far greater capacity to learn." He suggested that cooperation can become a social norm, a value which is taught by parents, educators or even religious and moral leaders, and subsequently accepted and internalised.

3.4 Cooperation and other phenomena

Cooperation is usually discussed and contrasted with other phenomena, such as helping behaviour, reciprocal altruism, etc. In this section, the differences between cooperation and these other phenomena will be discussed for an enhanced understanding of cooperation.

3.4.1 Cooperation and helping behaviour

Both cooperation and helping behaviour fall under the category of positive social behaviour, and both types of behaviour increase other person's outcomes. Argyle (ibid) wrote, "... helping is not the same as cooperation, though cooperation usually involves help." According to Grzelak and Derlega (1982) the dissimilarities
between cooperation and helping behaviour that have been traditionally emphasised are a) structure of independence in the social situation and b) the choice of a situational versus personality-oriented approach to research and theory construction.

The authors gave scenarios where cooperation and helping behaviour are shown. Firstly, people of a residential area were asked to conserve energy by the Utility companies who have to meet the heightened energy demand for air conditioning during a heat wave. Secondly, a man who felt some personal responsibility to help a foreign couple at a railway station. In the first case, the action taken by one individual affects others’ interests and, at the same time, others’ actions influence the individual. Hence, this situation involves social interdependence, or mutual control over outcomes. Therefore, Grzelak and Derlega (ibid) defined cooperative behaviour as one which maximises both the individual’s and others’ interests. In the second scenario, the foreign couple did not expect the young man’s help and did not reward him for his behaviour. Their interests and his interests were not inter-related in any apparent way. His help represented a single act with no expectation of future reward. According to Grzelak and Derlega (ibid), this situation exemplifies unilateral control, in that the person’s actions affect outcomes both for him and for others, but others’ actions do not affect the person.

Thus, the "helping relationship" has been characterised as involving the unilateral dependence of people in need on others perceived as being able to help, whereas cooperation has been defined as a relationship of mutual dependence among participants.

Helping is also often conceived as a situation where the reward is experienced by the "helpee" (person who has been helped) alone, and the cost by the helper alone. In the helping example given above, the helper is seen as active and in control of
outcomes, and the helpee as the passive, dependent recipient of outcomes. Schwartz and Howard (1982) argued that this conception of helping is incomplete. They proposed that both parties gain rewards and both experience costs, but their rewards and costs differ. The helper acts to gain psychological, social and/or material rewards, and the helpee gains material rewards. The helper typically incurs material or social costs, while the helpee incurs social and psychological costs. But the costs and rewards of each person in a helping situation are at least partly dependent on the actions of the other, which is to say that they are mutually dependent. For example, the young man who helped the foreign couple is dependent on the foreign couple not to victimise him, and the foreign couple is dependent on the man not to trick them. Thus, Schwartz and Howard (ibid) viewed both cooperation and helping as characterized by mutual dependence, where the costs and benefits of all parties to a relationship are determined by their joint behaviour. They argued that the difference between cooperation and helping is the nature of the jointly determined costs and benefits, rather than the nature of the dependence relation. In a cooperative situation, all the participants incur psychological, social, and/or material costs, and gain psychological, social and/or material rewards. However, in the study of cooperation, material costs and rewards are often emphasised, as discussed next.

To summarise, Grzelak and Derlega (ibid) believe that the difference between cooperation and helping lies in the nature of the dependence relation, but Schwartz and Howard (ibid) emphasized that it is the nature of the cost and reward distribution that distinguishes helping from cooperation.

Grzelak and Derlega (ibid) noted that the approach to research on helping behaviour and cooperation also differs. The analysis of motivational sources of cooperation focus more on the external, situational structure of people's interest, e.g.
monetary rewards, rather than on the internal cognitive and emotional processes that underlie choice behaviour. Those who study helping behaviour, on the other hand, generally focus on the internal, motivational structure of personal interest or take the "personally oriented" approach. Grzelak and Derlega (ibid) argued that this could be due to the fact that research on cooperation has been dominated by theories of decision making, and particularly by game theory. For example, in using game theory, psychologists have inherited the underlying ideology of "economic man," assuming that people seek to maximise their interests. However these interests have usually been reduced to external, material goods. Having said that, Grzelak and Derlega stressed that the research domains of cooperation and helping behaviour are not mutually exclusive but overlap greatly.

3.4.2 Cooperation and reciprocal altruism

Reciprocal Altruism (RA), which is a specific form of helping behaviour, can be defined as a series of interactions involving five elements (Koenig, 1988):

1. one individual aids another;
2. at some fitness cost to itself;
3. in anticipation that the recipient will choose to return the favour;
4. again at some fitness cost to the actor; and,
5. benefiting the actor at some time in the future.

In other words, RA is a situation where A helps B, at a cost to himself, hoping that B will help him at a later point in time. Examples of RA are food sharing in vampire bats (Wilkinson, 1988) and coalition formation in baboons (Packer, 1988).

Ever since RA was formulated by Trivers (1971), it has received considerable debate on the features of an exchange that must be present for the behaviour to qualify
as RA. For example, is a significant time delay crucial? Must both participants make "active" responses or may the responses be "passive?" etc. (Taylor and McGuire, 1988). Taylor and McGuire (ibid) went on to argue that, if RA is narrowly defined, requiring a time delay before the repayment, then RA appears to be rare. If it is broadly interpreted e.g. repayment can be immediate, then nearly all forms of behaviour classified as mutualism or cooperation appear to qualify as examples of RA. The point is that, just like cooperation, RA might be very rare and restricted to a few groups, or it might be quite common and widespread, depending on how the phenomenon is defined.

Referring to Table 3.1 (Numbers 1 to 4), an important distinction between RA and cooperation is that in RA, there is a clear asymmetry between two individuals in the amount of aid each contributes and receives during an interaction, as well as a reversal of the asymmetry at a later time. As mentioned earlier, in RA, A helps B by suffering a deficit in the hope that B will help A at a later point in time. In cooperation, such asymmetry is not necessary, in that A and B help each other to ease the problem. Rothstein and Pierotti (1988) stated, "... in so much of what would be called cooperation, aid cannot be identified because individuals work together to produce mutual benefits." This is in agreement with Grzelak and Derlega (ibid) distinction between helping behaviour and cooperation based on structure of independence in the social situation.

Another difference between RA and cooperation is that successful cheating (i.e. not repaying the aid or withholding services without being caught) is beneficial to B in RA, but is not profitable to both partners in cooperation (Table 3.1, Number 5). Also, two or more occurrences of events are required in RA, but such a requirement is unnecessary in cooperation (Point 6). In cooperation, even if the event does not occur
**TABLE 3.1: Differences between Reciprocal Altruism (RA) and Cooperation. (After Rothstein and Pierotti, 1988.)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Reciprocal Altruism (RA)</th>
<th>Cooperation (CO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Only B faces a problem or a need. A incurs cost to help B; later B incurs cost to help A.</td>
<td>A &amp; B both face problems; only combined action is likely to ease the problem.</td>
</tr>
<tr>
<td>2.</td>
<td>A suffers a deficit by helping.</td>
<td>A &amp; B usually both suffer deficits (or reduced benefits) by not cooperating.</td>
</tr>
<tr>
<td>3.</td>
<td>Only one individual benefits directly from each event.</td>
<td>Both individuals benefit as a result of each event and the combined payoff must be more than twice the payoff with one individual.</td>
</tr>
<tr>
<td>4.</td>
<td>Payoffs form one event contingent mostly on the behaviour of the potential helper (A).</td>
<td>Payoffs form one event contingent on the behaviour of both individuals.</td>
</tr>
<tr>
<td>5.</td>
<td>Successful cheating (i.e. not getting caught) benefits B.</td>
<td>Successful cheating by one individual is costly to both.</td>
</tr>
<tr>
<td>6.</td>
<td>Only B benefits if the situation never occurs again; must be a high likelihood of long range destructions.</td>
<td>Both benefit even if the situation never occurs again; long range associations not necessary.</td>
</tr>
<tr>
<td>7.</td>
<td>Must involve time lag.</td>
<td>Implies simultaneous action but phrase &quot;to act together&quot; could include acts at different times.</td>
</tr>
</tbody>
</table>
again, both A and B have benefited from each other. Here it shows that for successful reciprocation and cooperation, mutual trust must exist between the individuals. However, the risk that this trust will be violated is greater in RA than in cooperation. A summary of the key differences between RA and CO is shown in Table 3.2.

<table>
<thead>
<tr>
<th></th>
<th>Reciprocal Altruism (RA)</th>
<th>Cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who has a problem?</td>
<td>B</td>
<td>A and B</td>
</tr>
<tr>
<td>Who is providing help?</td>
<td>A</td>
<td>A and B</td>
</tr>
<tr>
<td>Who benefits from the event?</td>
<td>B, and later A when B reciprocates</td>
<td>A and B</td>
</tr>
<tr>
<td>Who benefits from successful cheating?</td>
<td>B</td>
<td>None</td>
</tr>
<tr>
<td>Who benefits if the situation never occurs again?</td>
<td>B</td>
<td>A and B</td>
</tr>
</tbody>
</table>

The above discussion clearly points to the fact that in cooperation, partners are interdependent in that their coordinated actions and combined effort are necessary to realise the net benefits that could be more than twice the benefits available to a single individual. However, for this to occur, mutual trust has to exist. Deutsch (1962) wrote, "... the initiation of cooperation requires trust whenever the individual, by his choice to cooperate, places his fate partly in the hands of others." Deutsch (ibid) also
found that cooperation among individuals fosters an environment where the development of mutual trust is likely to occur. In other words, mutual trust is necessary for successful cooperation, and successful cooperation leads to mutual trust.

### 3.4.3 Cooperation and kin selection

Kin selection (KS) and cooperation are similar in that both can produce benefits to each participant. The main difference between them is that cooperation involves participants that are not necessarily genetically related. In fact it is more difficult to distinguish between RA and KS because, in both cases, A incurs a cost to help B, and only one individual benefits directly from each event, whereas in cooperation, both partners benefit from the event. An example of KS would be an individual coming to the aid of a drowning person. According to Trivers (ibid), such aid would represent RA if the helper and the drowning victim are unrelated, and if the costs of aid incurred by the original helper (time and energy plus the risk of drowning himself) are less than the future benefits the helper will receive when the original recipient reciprocates with beneficence. If the drowning victim is closely enough related that the indirect benefits to inclusive fitness received are greater than the cost of the aid, this aid would represent KS. Although KS and cooperation are very different concepts, KS has been put forward as a theory of how cooperative behaviour in humans came into existence (refer to Section 3.3).

### 3.4.4 Cooperation and competition

Studies on cooperation are interrelated, and constantly contrasted with concepts of competition. Developmental psychologists examined the growth of cooperative and competitive behaviour in children, and the cognitive and affective outcomes of cooperative, competitive, or individualistic goal structures adopted in classrooms.
Anthropologists grouped primitive societies according to their cooperative, competitive, or individualistic cultures. Experimental games, such as the Prisoner’s Dilemma Game, were devised to explore factors influencing cooperative and competitive choices of individuals.

Competition is regarded as the opposite of cooperation. Whilst cooperation is defined as working together to a mutually desired goal, competition is the pursuit of a goal also desired by another person, but which only one person could attain. In cooperation, one member’s movement towards the goal will facilitate other members towards achievement of the same goal. In competition, a person achieving the goal will hinder or wipe out the chances of another person attaining that goal. For example, in a game of chess, there is only one winner. However, in many situations, cooperation and competition could occur hand in hand. For example, in football, players cooperate with each other to compete against another team. The two competing teams cooperate to play a "fair" game, and players within a team may compete against each other to be the "star" of the team.

In competitive conditions, task interdependence is less strong, and sometimes interaction is not required. For example, students working independently on a similar task, may be quietly trying to outdo each other to get to the top of the class. Pepitone (1980) suggested that a strong contribution to competitive behaviour is social comparison. Social comparison is particularly potent when individuals of similar attributes and performance level are given identical tasks.

Often in competitive situations, interaction is aimed to put down, weaken, overcome, eliminate, or otherwise work against the competitor(s) (Pepitone, *ibid*).
For example, in a debate, verbal communication is used to counteract arguments. In competitive sports, information seeking is not so much for task accomplishment, but to find out the strengths and weaknesses of one's opponent, in order to beat him.

Interdependence and coordination are also evident in competition, especially in direct-contact sports. For example, in chess or badminton, each move by A must be responded to by B, and vice versa. However, every move aims to block and retard each other's from reaching the goal desired by both parties.

In summary, competition, like cooperation involves a mutually desired goal. However in competition, this goal is only attainable by one person (or one party). Thus, any form of interaction among competing individuals is used to hinder each other from achieving the goal. This is in sharp contrast to cooperation, where members communicate and coordinate their actions to facilitate each other towards the attainment of the mutually desired goal.

3.4.5 Cooperation and Tit-For-Tat

Another issue often discussed in the studies of cooperation is the Tit-For-Tat (TFT) strategy. Axelrod and Hamilton (1981) described TFT as, "... a strategy that can be employed in game theory to elicit stable cooperation." It is a strategy based on the other person's action. If in the last move, the other has acted in a cooperative way, then one responds with cooperation. If the other has acted last in a competitive way, then one responds in kind. In other words, it is simply doing whatever the other person or player did on the preceding move (Axelrod and Hamilton, ibid). In experimental studies, the party using the TFT strategy usually makes his first move a cooperative one to get reciprocal cooperation started. Patchen (1987) gave a special condition for TFT, which stated that, "... neither side has to be rational, both merely
repeat behaviour that has been rewarded, and change behaviour that has been punished." TFT is known to be the best strategy in eliciting and maintaining cooperation in mixed-motive situations. TFT has also been regarded by evolutionists to be the basis of cooperation.

3.4.6 Cooperation and coalition

Coalition is the joining of forces of two or more parties during a conflict of interest with other parties (DeWaal and Harcourt, 1992). It is essentially cooperation in an aggressive or competitive context, in that social units cooperate in order to obtain any kind of advantages over other individuals or unit. It is this well-coordinated "us" against "them" character that sets coalition formation apart from other cooperative interaction among individuals. However, competition may also occur within the coalition itself in that coalition members do not automatically share the advantages of their joint efforts equally. The individual identity of coalition partners within the group is not replaced by group identity, nor is the individual commitment replaced by a uniform set of rights and obligations. In coalition the interests of the coalition parties can be served at the expense of the interest of a third party.

3.4.7 Cooperation and other phenomena: Summary

The differences between cooperation and other phenomena were discussed. Firstly, cooperation and helping behaviour are both positive social behaviour, differed by the nature of the dependence relation. Helping behaviour is characterised as involving the unilateral dependence of people in need of help on others perceived as being able to help. Cooperation is identified by mutual dependence among the cooperative partners. Research on theories on helping behaviour focuses on the
internal motivational processes, but research on cooperation tends to emphasise the external factors that motivate people's interests. Reciprocal altruism involves help on a reciprocal basis, where cheating is beneficial to the person receiving the aid. In both helping and reciprocal altruism, there is a clear difference in who is incurring the cost, and who is receiving the benefit. In cooperation, the partners incurs cost to help each other reap the benefits. Therefore mutual trust plays an important role in cooperation. Kin selection refers to help given to someone who is closely related to oneself; there is no such requirement for cooperation to occur. Competition, like cooperation, involves a mutually desired goal. However, in competition this goal is only attainable by a single individual or party. Therefore, competitive partners use all forms of interaction to undermine their opponents' efforts in achieving the goal. Tit-For-Tat is often mentioned in the literature as a strategy that will elicit cooperative behaviour from another player in mixed motive games. TFT, like kin selection, and reciprocal altruism are regarded as the basis for the origin of cooperation in an "otherwise selfish" society. Lastly cooperation is contrasted to coalition, where members form subunits to compete against a third party. Therefore, it can be said that coalition involves cooperation in a competitive context.

3.5 Helping and cooperation in animals

Hebb and Thompson (1974) identified three levels of animal cooperation, namely:

1. Reflective, or non-purposive.
2. Purposive, but one sided.
3. Two sided, or team work.
The first level is similar to what Allee (ibid) regarded as proto-cooperation which is entirely non-conscious. This form of cooperation can be seen in the crowding of animals and the social aggregates in which they live. Small fishes such as minnows live in dense groups or schools with highly ordered structures. They swim at fixed distances and bearings from their neighbours and move about in a highly coordinated manner. Nectar feeding bats forage in flocks. They circle around the flowers on which they feed, each waiting for their turn to swoop in for a quick feed. Huntingford (ibid) argued that these animals are acting cooperatively by constraining their actions according to what others are doing. Many animals live in large groups to protect each other from predators. Herring congregate in immense shoals, half a mile across, containing many millions of individuals. If a barracuda approaches, those on the outer margin of the shoal dart inwards, taking refuge among the silvery bodies of their companions so that the whole shoal bunches. If the barracuda charges, the herring flee away on every side, creating a clear tunnel through the shoal. If the barracuda presses its attack, then once again the great number of bodies darting in all directions make selecting a target difficult (Attenborough, 1990). Coordination of movements for protection is also demonstrated in puffins. Puffins nest in holes on steep grassy cliffs. Their main predators are gulls. Puffins are especially vulnerable when getting from the cliffs to the sea to fish. "The puffins' defence is to gather in a huge aerial wheel, half a mile across, that circles in front of the cliffs throughout the day. Puffins leaving their homes join it immediately and travel round within it until they reach the seaward side and relative safety. Those coming in from the sea do the same thing in reverse, leaving the wheel with a sideways dive when they are within a few yards of their nest-hole. Though the gulls occasionally try to catch puffins flying within the wheel, they seldom succeed. The
number and density of flying bodies make it almost impossible for them to select and catch a particular individual. Most of their victims are stragglers who, for one reason or another, fail to gain the safety of the wheel." (Attenborough, ibid: pp 86.)

The second level of cooperation is described by Hebb and Thompson (ibid), as a situation in which A helps B, but B does not simultaneously help A. This is perhaps better described as altruism since it is entirely one-way. Birds and squirrels give a warning call to alert their neighbours of the danger of an approaching predator, sometimes at some risk to themselves (Huntingford, ibid; Argyle, ibid). One sided help to kin (kin selection) and reciprocal help (reciprocal altruism) described in Sections 3.4.3 and 3.4.2 respectively are clearly demonstrated in vampire bats:

"A vampire bat feeds on blood and nothing else. It needs to drink at least half its body-weight every night. Collecting that is not easy. The bat has to land on a mammal, usually a horse or a cow, detect with its heat-sensitive nose just where there are blood vessels close to the surface and then shave away the skin with its triangular incisor teeth. Its saliva contains an anti-coagulant that ensures that the wound will remain open long enough for the bat to complete its meal as well as an anaesthetic that reduces the likelihood of its victim being irritated by its attentions and shaking it off. It needs to be able to drink for about twenty minutes if it is to fill its stomach. To do all this takes luck as well as skill and a third of the immature bats in a colony may fail to feed at all on any one night. Even 7% of experienced adults will be unsuccessful. Yet if an individual does not get blood for two nights in succession, it will die.

Female bats live in small groups of about a dozen. For most of the year they have a young pup with them. They not only provide it with milk but when they return from a successful night’s raid, they regurgitate blood for it. But a bat with a full
stomach will also give blood to another adult in the roost who has failed to feed. The recipient may be a relative: a sister, a daughter or a mother. ... But careful investigations using genetic fingerprinting techniques have shown that often those being fed are not closely related at all. ... It would be to the bat’s benefit to give blood to a starving companion, if she could be sure that when she herself had bad luck and failed to feed, the recipient could be relied upon to behave in the same way. And that proves to be exactly what happens. ... A cheat who solicited blood and took it but did not repay the debt when required would soon be detected." (Attenborough, ibid: pp 219.)

Some animals help each other for mutual benefits. Wrasse, a slim fish with blue and white stripes, provide a valet service to big grouper, or parrot fish, trimming off pieces of dead skin, and snipping away infestations of fungus and fish lice. Giant tortoises in the Galapagos are cleaned by finches, and oxpeckers provide the same kind of service to eland, buffalo, warthog, and rhino in Africa (Attenborough, ibid). Without the services of the birds, these animals are unable rid themselves off maggots at the base of their tails, or ticks from their ears. And the service providers get a good meal out of it.

The third level of cooperation is "two-sided" or team-work. Hebb and Thompson (ibid) stated that when A and B cooperate fully, very complex mental processes are required. At each stage of action, A must anticipate not only his own next act, and its effect, but also those of B. The authors asserted that as far as one can tell from the available evidence, the last seems to occur only in man. However, this higher level of cooperation or team work has clearly been demonstrated in chimpanzees (Attenborough, ibid; Boesch, 1990). Chimpanzees in the Kenyan savannahs hunt for colobus regularly, and do so in teams within which there are
specialised roles, habitually taken by particular individuals. Four different roles are taken. Firstly, there is the driver who is responsible for getting the troop of colobus moving through the canopy. He does not chase the monkeys, but only keeps them from settling. The blockers take up conspicuous positions in the branches on either side of the drive, so preventing the monkeys from breaking out. The chasers in turn, join in the hunt once the monkeys are on the move. They must spring up the trees as the monkeys are driven into them and they are the ones that usually make the kill. And finally, there is the most skilled job of all that requires the most experience and judgement, the ambusher. He is usually an old male who can anticipate which way the colobus will go and climbs a tree well ahead of them, so completing their encirclement. A description of the hunt demonstrates the coordination, communication and team effort that are engaged in the hunt:

"Before a hunt, the team assembles gradually. It may be that the drummings by the males have served to communicate not only where each one of them is, but what mood they are in. At any rate, the males leave their parties and come together in a posse. The change in their behaviour is dramatic. There is no more calling and hooting, no picking up of fruit or plucking of leaves. They pace together through the forest in silence, scanning the canopy intently, sometimes stopping and listening for the calls of colobus. It may take only twenty minutes or as long as two hours before they find the monkeys and are sufficiently close to them to launch an attack.

Suddenly, the driver runs up a tree, climbing swiftly, hand over hand. He will, if he can, isolate one or two monkeys from the main troop. Most of the chimpanzees stay on the ground as spectators. The adult females bob and dance with excitement, standing upright, craning their heads back and forth to see just what is going on. If
one monkey is separated, the blockers dash up into the trees ahead to take up their positions, crashing through the branches in a way that is quite unlike their normal movements.

"Now all is action. The ambusher sprints ahead to find the place where he will hide in the leaves, while the chasers move in front of the driver and run along the branches trying to grab the monkey and chasing it towards the place where the ambusher sits hidden. The colobus, driven forward between the blockers, is deceived into thinking that an avenue of escape lies ahead until suddenly the ambusher reveals himself. The monkey hesitates, turns back and is grabbed by the catchers. As they do so, they scream with excitement. Their calls are immediately taken up by the whole team and the spectators on the ground so that the forest rings with wild and terrifying shrieks." (Attenborough, ibid: pp 105.)

Clear division of labour and coordination as in an assembly line in a factory plant can also be seen in the leaf-cutter ant of South America. These leaf-cutter ants cultivate a fungus to digest the cellulose which forms a large part of plant tissues. Soldiers leave their encampment and set off to hunt, with scouts at the head of the trail. They rub the ground with their bodies, laying down a trail of scent that others behind will be able to follow. If the path leads over a steep bark or log, workers will cling to one another to form a living ladder up which the rest of the column clammers. If they traverse a patch of sunshine, the soldiers link legs and form a roof over the path so that the workers, who are less well armoured are protected from the damaging heat. They work on a tree, cutting segments of leaf and carrying them back to the nest. They drop them on the floor of a chamber inside the nest, and hurry back to the cropping site, following the scent of trail laid down. A different caste of workers of smaller size then lick the leaf segments to remove any spores or bacteria that may
contaminate the cultures within the nest, and cut them up still further. A caste of even smaller workers takes over, champing the fragments into a moist pulp and adding little droplets of anal fluid to break down the leaf tissues chemically. These are then carried into a special garden chamber, where the garden fungus is. Here, the tiniest and most numerous workers take over, crawling inside the spongy fungus garden to pluck tufts of fungal thread and plant them on the macerated leaf surface. The harvest is then taken away and fed to the grubs that are kept in the nursery chambers.

Perhaps the most interesting cooperation is that between animal and man. Honey-guide, a lark-sized bird that lives in east Africa, enlists the help of man in getting to the grubs of honey bees which build their nests in hollow trees or clefts in rocks. The semi-nomadic Boran tribe in northern Kenya specialises in collecting honey. Again it can be seen that cooperation between the partners involves not only coordination of behaviour and a division of labour, but also unique and constant communication:

"... he begins by walking into the bush and whistling in a very penetrating way, blowing across a snail shell, a seed with a hole in it, or just using his clasped fists. If he is within the territory of a honey-guide, the bird will appear within minutes, singing a special chattering call that it makes on no other occasion. As soon as the two have registered one another's presence, the bird flies off with a peculiar low swooping flight, spreading its tail widely as it goes so that the white feather on either side of it are clearly displayed. The man follows, whistling and shouting to reassure the bird that he understands its summons and is following.

The bird may now disappear for several minutes. When it comes back, it perches high some distance away, calling loudly and waiting for the man to catch up with it. As the two travel together through the bush, the bird stops and calls more
frequently and takes lower and lower perches until, after maybe a quarter of an hour, its song changes into one that is low and less agitated. Having repeated this two or three times, it falls silent and flutters to a perch where it stays. Beside it will be the entrance to a bees’ nest.

It is now up to the man to take the initiative. If the day is hot, a stream of bees may be buzzing in and out of the entrance. Something has got to be done to pacify them if the man and the bird are not both to get badly stung. The man lights a fire close to the nest, and if possible, pushes burning sticks into holes beneath it so that smoke swirls up around the nest itself. With the bees partially stupefied, he now opens up the tree with his bush knife or pokes out the nest from a rock cleft with a stick and extracts the combs, dripping with rich deep-brown honey. ... The honey-guide can now get its share. It flies to the remains of the wrecked nest and pulls out the fat white bee-grubs from the cells of the combs." (Attenborough, ibid: pp 229-230.)

Before the cooperation process begins, the bird visits every bee colony, and has precise knowledge of its location. When the bird starts guiding the man, it does not wander about at random but leads him directly to the nearest nest. It leaves the man for a short period to check on the nest that it has in mind. This ensures that successful cooperation ensues.

In summary, three levels of "cooperation" have been described. The first is reflective, or non-purposive, and is demonstrated in animals living together in large groups, maintaining a spatial structure between them. To call this cooperation would be using the term loosely. Human beings walking down a shopping mall without knocking into each other can hardly be said to be cooperating. In the event of an
out-break of fire, people who move in an orderly manner to avoid stampede are said to be acting cooperatively. Coordination of movements for protection as demonstrated in the actions of herrings and puffins were also described.

The second level of cooperation is better described as altruism as it is mainly one way. Warning calls given at risk to one’s life is a good example of altruism. Vampire bats regurgitating blood to another conspecific who is not related to itself, whereupon the act is later reciprocated, is noted as an example of reciprocal altruism. Animals also help in grooming each other, providing benefits to both parties.

The third level, and perhaps the closest to the description of goal directed cooperation, is exemplified by a team of chimpanzees hunting for colobus, and to a lesser extent, by leaf-cutter ants cultivating fungus for food. Lastly, a unique man-animal cooperation between that of a honey-guide bird and its honey collector human counterpart is described.

The examples discussed in this section were not intended to support evolutionary theories of the origin of cooperation. These examples served to demonstrate that animals do behave altruistically towards each other and also cooperate with each other. Sociobiologists constantly debate whether these social behaviour constitute altruism, kin selection, reciprocal altruism or cooperation (Chase, 1980; Koenig, ibid; Ligon, 1983; Packer, ibid; Rothstein and Pierotti, ibid; Taylor and McGuire, ibid; Wilkinson, ibid). For the purpose of the work described in this thesis, it is sufficient to draw the following conclusions with regard to animal cooperation:

1. Cooperation in animals is difficult to detect as the intentions may not be so obvious, except perhaps in cooperative hunting.
2. Coordination alone does not necessarily qualify for cooperation, although cooperation involves coordination.

3. Cooperation produces joint reward for the cooperative team, as exemplified in group hunting.

4. Cooperation is demonstrated by the following processes, although in some cases, not all the processes exist: communication among the cooperative partners; coordination of actions; division of labour; division of roles; goal (reward) directed actions.

3.6 Summary and Conclusions

This chapter aims to provide a clearer understanding of the term cooperation, and establishes the underlying mechanisms of the phenomena. A review of the different definitions and perspectives of cooperation was firstly presented, followed by a discussion of its origin. Cooperation was also contrasted with other interrelated phenomena, namely helping behaviour, reciprocal altruism, kin selection, competition, tit-for-tat and coalition.

Cooperation is a form of behaviour involving more than one organism. It is dynamic; interaction processes among the cooperative partners serve to facilitate each other towards achieving a common goal or a set of goals that are mutually agreed and desired by all the members. Thus, members are interdependent; one member's actions are contingent on another, and their combined actions are necessary to realise the net benefits that could be more than the sum of their combined effort. Cooperation requires trust among the cooperating members. Trust can be defined as the confidence in each member having the intention and ability to achieve the mutual goals. Cost and reward of cooperation can be tangible or intangible. In Chapter 5, the
rewards associated with cooperation are discussed.

Cooperation takes place for different purposes. In this thesis, interest lies in cooperation over a task, rather than cooperation in social activities for the enjoyment of the partners. There are many processes underlying cooperation: coordination of actions, communication among partners, division of labour and roles, and goal directed behaviour. These processes are evident in animals’ behaviour. The type of task influences how these processes operate in cooperation. Chapter 6 is dedicated to examining these processes in small problem solving groups.

As mentioned above, cooperating partners are interdependent. Each person’s choice of behaviour influences the other. There have been many experiments on cooperation, exploring the conditions and factors which influence the cooperative behaviour of adults, as well as children. Many of these experiments used mixed-motive games. In the next chapter, the rationale of some of these games are reviewed, followed by discussions of the results of these experiments.
Chapter 4:

Experimental Studies on Cooperation

4.1 Introduction

There have been many experiments conducted for the study of cooperation. Many of these experiments used empirical "games" which were designed to model the underlying processes involved in cooperation (Argyle, 1991). Many of these experiments were carried out in the early 1960s to the late 1970s. These experiments studied the conditions under which cooperation is most likely to occur, and the factors that will affect cooperation, such as the nature of rewards, or the comprehensiveness of instructions, etc. In this chapter, a brief review of the determinants of cooperation using experimental games is presented.
The purpose of this chapter is to draw conclusions from these experimental studies in order to:

a. verify some of the theories and postulates of cooperation presented in Chapter 3 and,
b. provide a validated basis for the subsequent work discussed in the following chapters.

In the next section, the most common paradigm used in these experimental studies, mixed motive games, are described followed by a discussion of the validity of these models.

4.2 Mixed-motive games

Mixed-motives games have been developed within mathematical game theory and used in social psychology for the study of social conflicts in groups and analysis of interdependent decision making. In any mixed-motive games:

a. there are two or more decision makers, called players;
b. each faces a choice between two or more courses of action, called strategies;
c. the strategy choices of the players will affect the outcome of the interaction; and,
d. each player has preferences among the possible outcomes, so that a set of payoffs reflecting these preferences can be assigned to every outcome.

The goal of these games is to discover the strategies that the players will choose in order to maximise their individual payoffs, that is, to produce the best outcomes for themselves.
Mixed-motive games are sometimes referred to as non-zero sum games. In a strictly competitive game or zero-sum game, the players' preferences are diametrically opposed, in that an outcome that is good for one player is correspondingly bad for the other and vice versa. At the opposite extreme is a pure coordination game, in which the players' preferences among the possible outcomes are identical. However, in mixed-motive games, the players' preferences are neither strictly opposed nor coincident, hence possess both competitive and cooperative features. The players in a mixed-motive game are motivated partly to cooperate and partly to compete, and have therefore to contend with an intra-personal conflict arising from clash of motives, in addition to the interpersonal conflict that is built into the game (Colman, 1982).

4.2.1 Prisoner's Dilemma Game

Prisoner's Dilemma Game or PDG is one of a family of mixed-motive games, and is the most widely used experimental model for the study of cooperation. The game gets its name from an anecdote about a district attorney who lacks sufficient evidence for conviction, separates two suspects and informs each that they have two alternatives: to confess to the crime the police are sure the pair has committed, or not to confess. If neither confess, the prisoners are informed that they will receive minor punishment. If both confess, a sentence less than the most severe one will be recommended for both. If one confesses and the other does not, the one who confesses will get off almost "scot-free," but the other will receive the most severe sentence possible. This dilemma is displayed in Figure 4.1 and can be represented by a pay-off matrix, as shown in Figure 4.2. In a laboratory experiment, two players A and B are allocated to different rooms, where they are asked to choose either to cooperate (C) or defect (D), by pressing the corresponding buttons on each trial,
Prisoner A's choices

<table>
<thead>
<tr>
<th></th>
<th>Stand firm (C)</th>
<th>Confess (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prisoner B's choices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stand firm (Cooperate)</strong></td>
<td>A and B get minor punishment</td>
<td>A gets most severe punishment.</td>
</tr>
<tr>
<td></td>
<td>R,R</td>
<td>B gets off almost scot free.</td>
</tr>
<tr>
<td><strong>Confess (Defect)</strong></td>
<td>A gets off almost scot free.</td>
<td>A and B get less than most severe punishment.</td>
</tr>
<tr>
<td></td>
<td>B gets most severe punishment.</td>
<td>P,P</td>
</tr>
<tr>
<td></td>
<td>T,S</td>
<td></td>
</tr>
</tbody>
</table>

\[ R = \text{reward} \]
\[ T = \text{temptation} \]
\[ S = \text{sucker's payoff} \]
\[ P = \text{punishment} \]

Figure 4.1: The General PDG Matrix

Player B

<table>
<thead>
<tr>
<th>Player A</th>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperate</td>
<td>3,3</td>
<td>1,4</td>
</tr>
<tr>
<td></td>
<td>R,R</td>
<td>S,T</td>
</tr>
<tr>
<td>Defect</td>
<td>4,1</td>
<td>2,2</td>
</tr>
<tr>
<td></td>
<td>T,S</td>
<td>P,P</td>
</tr>
</tbody>
</table>

For PDG: \( T > R > P > S \)

Figure 4.2: The PDG Matrix
Player B

<table>
<thead>
<tr>
<th></th>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
</table>
| Cooperate | 3,3  
R,R       | 1,2  
S,T |
| Defect | 2,1  
T,S       | 1,1  
P,P       |

For MDG:  \( R > T > S = P \)

Figure 4.3: Matrix for Maximising Difference Game (MDG).

Player B

<table>
<thead>
<tr>
<th></th>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
</table>
| Cooperate | 4,4  
R,R       | 2,5  
S,T |
| Defect | 5,2  
T,S       | 1,1  
P,P       |

For Chicken Matrix:  \( T > R > S > P \)

Figure 4.4: Matrix for Chicken Game.
without knowing what the other person will do. A matrix similar to that shown in Figure 4.2 is presented to the players to inform them of their payoffs akin to each choice. If both choose D, they both do equally badly ([P]unishment for joint defection), while if both choose C, each gets a favourable and equal payoff ([R]eward for joint cooperation). However, a C choice involves risk, since the other might choose D. The player who chose D gets a highly favourable payoff ([T]emptation to defect) and the one who chose C gets a very negative payoff ([S]ucker’s payoff).

Hence, referring to Figure 4.2, for the PDG matrix, T>R>P>S. The goal of the game is to win as many points as possible. As widely as it has been used, PDG has also been criticised, mainly on the grounds of the highly abstract and artificial nature of the task that subjects are confronted with. A fuller discussion on the usefulness and problems of mixed-motive games will be given in Section 4.2.3.

4.2.2 Maximising Difference and Chicken Game

Two other mixed-motive games are Maximising Difference Game (MDG) and Chicken. MDG can be defined by the inequality R>T>S=P, as shown in the matrix in Figure 4.3. C is the most rational choice to maximise the players’ individual payoffs as well as their joint payoff. The most intelligible motive for a D choice in this game is spite, that is, a competitive desire to do better than one’s partner at the expense of a worse payoff for oneself. Empirical studies have revealed surprisingly high levels of competitive spitefulness in subjects playing the MDG (Colman, *ibid*).

The Chicken game is named after a gruesome pastime which originated among Californian teenagers in the 1930s, where the contestants drive towards each other at high speeds in motor cars. Each contestant has to choose between swerving to avoid a head-on collision and thus showing himself to be chicken (C) and driving straight
ahead (D). If both players choose C the result is a draw, and if both choose D, they may both be killed; but if one chooses C and the other D, then the first loses face but remains alive, and the other receives the highest payoff in the form of a large ego-boost (Colman, *ibid*). Hence, as shown in Figure 4.4, T>R>S>P, although a further technical restriction 2R>S+T is sometimes imposed on the Chicken game. Chicken is a dangerous game because a player cannot go for the highest payoff without risking the worst possible payoff for both players.

While PDG has dominated the research in the study of cooperative and competitive behaviour, other experimental paradigms have been employed. For example, the Deutsch’s trucking game (sometimes called the Acme-Bolt trucking game) and models of social traps such as the Mintz experiment (Argyle, *ibid*). The Marble pull, Madsen board and the Circle matrix are games devised by Madsen (1971) for studying cooperative and competitive behaviour of children. A full description of the games is provided by Bethlehem (1982).

4.2.3 Advantages and disadvantages of mixed-motive games

Although mixed-motive games (especially the PDG) have been widely used for the study of cooperation and competition, only some researchers are in favour of the usefulness of mixed-motive games for studying cooperation (and competition) behaviour.

According to Colman (*ibid*), the enduring popularity of experimental games is due to, "... the ease and flexibility with which subjects can be placed in precisely specified states of interdependence, corresponding at a formal level to any imaginable social situation." He claimed that experimental games provide a natural and convenient method of investigating the many interesting phenomena associated with
social interaction (including cooperation and competition) that are difficult or impossible to understand without the conceptual framework of game theory.

Likewise, Gallo and McClintock (1972) credited the popularity of PDG to the fact that, "... it answers the long felt need in social psychology for a well-controlled interaction situation with an easily quantitative and unambiguous dependent variable, namely the number of cooperative responses made by the subject." They argued that these games provide a means of investigating fierce competition without the ethical problems usually associated with the study of potentially antisocial forms of behaviour. Gallo and McClintock (ibid) also claimed that the games required subjects to make decisions that are very similar to decisions that are made in real-life bargaining and conflict situation. Researchers have found them to be economical and easy to perform, especially compared to field studies, and they generate objective and quantitative data.

Ironically, the main criticisms of experimental games have also focussed on the simplistic and artificial nature of the tasks that confront the subjects. Argyle (ibid) argued that PDG is not a good model of cooperation in real life and questioned the usefulness of PDG. He stated, "... most of these experimental games have very low external validity, in the sense that they are very different from most real-life occasions for cooperation, though sometimes real-life parallels can be found." Similarly, Grzelak and Derlega (1982) noted that critics are highly sceptical of the value of game theory especially of its psychological interpretation. PDG, like most laboratory experiments use concocted instead of natural groups. For the sake of experimental control, subjects are restricted in the ways they should response. Restrictions are also imposed on the interaction patterns among subjects and in some cases, communication is totally forbidden, as in the "minimal social situation" experiments conducted by Marwell and Schmitt (1975) and Kelley et al (1962). Moreover, these
experimental games are not easy to play. Often subjects do not understand the instructions given, nor the implications of their choices. The extent of pre-game instructions significantly influence the degree of cooperation in PDG (Wrightsman et al, 1972). Knox and Douglas (1972) commented, "The PDG probably isn't a reliable measure of anything unless ... instructions are extensive."

Pruitt (1967) and Argyle (ibid) listed several discrepancies between laboratory findings with the PDG and what is commonly known about real life:

1. Simultaneous play; ignorance of other’s move; risk if other fails to cooperate; according to Argyle (ibid), these are all key features of PDG but very rarely apply in real life.
2. There is usually no communication.
3. The game is too abstract.
4. Players are usually strangers, and invisible to one another.
5. Absence of social norms.
6. No opportunity to try out decisions tentatively and then reverse them if the rules are unfavourable.
7. Use of unrealistic payoffs.
8. Assumption that people maximise their own gains in interdependence situations (Grzelak and Derlega, ibid).

Wrightsman et al (1972) stated, "The next step in research is to measure the similarity in conditions between laboratory and the real world. Until such similarities are demonstrated, we are not convinced that the findings reported can be very specifically applied to real-world conflicts."

Page 67
In defence of these criticisms, Colman (ibid) argued that "... these criticisms stem from a misunderstanding of the fundamental purpose of a formal model, which is to reduce reality to its essentials by deliberately excluding unnecessary details. Simplified models have proved their usefulness in other fields of investigation ...." Euclidian geometry was cited as an example.

McGrath (1984) pointed out that methods are simply tools; the instruments, techniques, procedures, by which science gains and interprets information. Like tools in other domains, different methods do different things. Each method should be regarded as offering potential opportunities not available by other means, but also as having inherent limitations. For example, field studies gain realism at the price of low generalisability and lack of precision. Surveys have high generalisability but get it by giving up much realism and precision. Laboratory experiments maximise precision of measurement and control of variable, at the price of lack of realism and low generalisability. If only one method is used, there is no way of separating out the part that is the "true" measure of the concept in question from the part that reflects mainly the method itself (McGrath, ibid). One solution suggested by McGrath (ibid) is for researchers to bring more than one approach, more than one method, to bear on each aspect of a problem. "Researchers need to take advantage of multiple approaches, not so much within a single study, which usually must use a single strategy as a practical matter, but over several studies of the same problem." If consistent outcomes across studies using different strategies are obtained, one can be more confident that those outcomes have to do with the phenomena that is being studied, not just with the methods. In a nutshell, McGrath's (ibid) contentions are that:
- methods enable but also limit evidence,
- all methods are flawed, but all are valuable,
- different flaws of various methods can be offset by simultaneous or successive use of multiple methods, and,
- such multiple methods should be chosen to have patterned diversity, so that the strengths of some offset weaknesses of others.

Therefore, although experimental games (such as the PDG) have very little face validity and is a very flawed test-bed for studying cooperation, nevertheless, they have yielded interesting results that can be used to substantiate some of the postulates of cooperation mentioned in the previous chapter.

The next section briefly review studies in which experimenters manipulated certain factors, such as nature of rewards, strategies used, etc. to determine their respective effects on cooperative or competitive choices of the subjects. Although a literature search of studies on cooperation was performed up to 1992, it was found that the majority of the experimental studies were reported between 1965 and 1975. Wrightsman's et al (ibid) review on studies evaluating the determinants of cooperation and competition in PDG are discussed together with other recent studies.

4.3 Nature of rewards

Studies have been conducted to test the effect of real (playing for money) versus imaginary (playing for points) rewards on the frequency of cooperative choices made by the players, with varying results.

Using PDG, Stahelski and Kelley (1969), Gallo and Sheposh (1970), and Radlow et al (1968) had all found that subjects who were told that they were playing
for real money tended to be more cooperative than subjects who were told that they
were merely playing for points. Stahelski and Kelley (ibid) found that this effect was
more evident among subjects who had expressed an intention to compete prior to the
game. Gallo (1966) obtained the same results using Deutsch’s trucking game.

However, just as many experiments have shown that there is no significant
differences between real and imaginary rewards on the level of cooperation; these
were studies performed by Wrightsman (1966), Evans (1964), and Willis and Joseph
(1959) using PDG. Sermat (1967) came to the same conclusion with the Chicken
matrix, and likewise Vinacke (1969), using a board game for studying coalition
formation.

The effect of high versus low payoff values had also interested researchers.
Oskamp and Perlman (1965), using PDG, discovered that higher average payoff
produced greater cooperation, and concluded that "monetary gain is more potent in
stimulating cooperation than is the threat of monetary loss." Whitworth and Lucker
(1970) found a significantly greater number of cooperative responses when subjects
were playing for high payoff matrix than when they were playing for low. Gallo and
McClintock (ibid) blamed the low levels of cooperation found in PDG to the low
amount of reward given in most of the experiments. They urged all experimenters to
offer larger, more meaningful rewards, and more attractive and desirable prizes.

On the other hand, studies by Gallo (ibid), Christie et al (1970) and Knox and
Douglas (ibid) found no significant effect of higher rewards on cooperation, and
commented that players playing the Trucking game are more likely to cooperate in the
production of high personal and aggregate wealth when the rewards for cooperation
are initially small and then gradually increased.
4.3.1 Nature of rewards: Discussion and Conclusions

From the experimental results cited above, no definite conclusion could be drawn regarding the effect of the nature of rewards upon cooperation. However, to a certain extent, the results do support the contention that the level of cooperative choices made by subjects are higher when real and higher payoffs are given.

Wrightsman et al (ibid) concluded that real rewards do make a difference depending on the type of games in which the subjects are involved, with MDG and other non-PD games leading to more cooperation under real rewards. Gallo (ibid) suggested that the reason why some studies showed no effect from tangible reward was because the payoff for cooperation is too close to the average payoff per trial. In those experiments, by cooperating 50% of the time, subjects will earn approximately 80% of the total amount of money that they could have earned by being completely (100%) cooperative. Gallo (ibid) argued that in effect, these studies have not really put any of the subjects in conflict. "There is virtually no pressure on him to solve the conflict by cooperation, since he seems to get paid no matter what he does" (Gallo, ibid). In fact, subjects complained of boredom from constantly making cooperative choices. Gallo and McClintock (ibid) pointed out that when rewards have no real value for a subject, it would be far more interesting for the subject to invent a new game in which the object is to maximise the difference between his own payoffs and those of his opponent. In effect, the subject changes the game from a non-zero-sum game to a zero-sum game. Hence, Gallo (ibid) recommended that tangible payoffs should be increased such that a real conflict exists and contended that under those circumstances, the cooperation level should increase. Shaw and Thorslund (1975) explored this "boredom" hypothesis through a study in which the relationship between the reward size and boredom was examined, and an attempt was made to vary
boredom directly by introducing a novel element into the game setting. The results of the experiment lead them to conclude that "... the decrease of boredom can be instrumental in producing cooperative game behaviour so long as concomitant side effects do not counter this process."

Subjects often do not make choices based solely on how much money or points they can win. Many other factors affect the decision to cooperate or to defect. For example, Whitworth and Lucker (ibid) found that not only how much reward a subject can win, but also his perception of how much his opponent is winning is a vital factor in cooperation.

Gallo (ibid) argued that in every conflict situation, there are two classes of payoff at stake. These are, firstly, tangible rewards which consist of material benefits which could be in terms of money, fringe benefits and so on. Secondly, symbolic payoffs which are related to the needs of the conflicting parties for maintaining face, self-respect, prestige, honour or status. Subjects could resolve conflict by arriving at a solution where tangible payoffs are shared. However, symbolic payoffs are not divisible. Hence, although the conflict over the division of the resources may be a non-zero-sum game, the conflict over status and prestige, for example, is a zero-sum game. It is difficult to measure the effects of symbolic payoffs on the subjects in deciding whether to cooperate or to defect. In some cases, using large amounts of real money increased the value of the tangible payoffs to a point at which they became more important to the subjects than the symbolic values of saving face or of increasing their status. Roos (1966) discussed non-zero sum game in the framework of Atkinson's model of motivation which places emphasis on three major variables: incentive, expectancy and motive, as determinants of drive strength. Roos (ibid)
stated that an increase in the values in the payoff matrix increases the incentives, which in turn leads to a rise in the economic drive. This enhanced the probability of cooperative responses.

In other cases, symbolic values may override even high tangible payoffs. Gallo (ibid) described an experiment where subjects played a modified version of the trucking game for real money. In the first half of the experiment, the subjects were exploited by the other subject, who was a confederate of the experimenter. An imaginary audience provided feedback to these subjects, indicating that they had looked weak and foolish, or that they had played fair in the face of a greedy opponent. In the second half of the experiment, subjects who had felt that they had been humiliated were significantly more likely to retaliate, even at a great cost to themselves. Gallo (ibid) pointed out that in this study it is clear that the value of maintaining face before the audience and before their opponent overrode the value of the tangible rewards.

Schwartz and Howard (1982) wrote, "Much research on cooperation has emphasised material payoffs. To understand the undermining of cooperation by perceived inequity, however, we must attend to psychological, moral, and social costs and benefits. Participants in a relationship may refrain from cooperation even when a calculation of absolute material benefits would dictate cooperative behaviour. Anticipated group sanctions for violating equity norms, moral self-deprecation for perpetuating an unjust distribution of resources, and psychological discomfort for allowing oneself to be exploited may all militate against cooperation."

In conclusion, real and meaningful rewards may have a positive effect on the cooperative choices of subjects in mixed-motive games but this is dependent on the type of game employed, and can be overridden by other factors such as boredom and
a subject’s perception of the symbolic payoffs associated with his choices. As mentioned in Chapter 3 (Section 3.4.1) the analysis of motivational sources of cooperation often focus on the external, situational structure of people’s interest (e.g. monetary rewards), rather than on the internal motivational structure of personal interest. Results of the experiment conducted by Gallo (ibid) have confirmed the postulation of Schwartz and Howard (ibid) cited in Chapter 3 that in cooperation, not only material cost and rewards are involve, but also psychological and social cost and rewards.

4.4 Payoff values within the matrix

It is thought that the payoff values, R(eward), S(ucker’s Payoff), T(emptation to defect) and P(unishments) affect the ways in which subjects behave (Refer to Figure 4.1). Most experimental studies manipulated these values while maintaining the restrictions or rules for the same type of game matrix.

Lave (1965) hypothesized that:

a. the smaller S is with respect to R, the more difficult it will be for subjects to decide to attempt cooperation,

b. the larger T is with respect to R, the greater will be the pull away from cooperation, and the less likely it will be that a pair will settle on stable cooperation, and,

c. the smaller P is with respect to R, the more likely it would be that subjects will attempt to achieve cooperation. Lave (ibid) suggested that R-P measures the incentive to establish cooperation.
Results from twelve series of experiments conducted by Lave (ibid) supported each of these hypotheses. He concluded that the size of the temptation to defect (i.e. value T), in comparison to other payoffs, is a variable that influences cooperation and exploitation.

Ells and Sermat (ibid), Komorita and Mechling (1967), Aranoff and Tedeschi (1968), Terhune (1968) and Fisher and Smith (1969) had also found that increasing the difference between T and S leads to lesser cooperative choices. In other words, when the temptation to defect (T) is increased relative to the sucker's payoff (S), cooperation decreases. But cooperative choices increase when the reward for joint cooperation (R) is increased to the punishment for joint competition (P). Rapoport and Chammah (1965) defined the cooperation index as:

\[
\text{Cooperation Index} = \frac{R - P}{T - S}
\]

Terhune (ibid) calculated the cooperation index for each of the three matrices that he used, using the formula proposed by Rapoport and Chammah (ibid). He found that as the cooperation index increases, subjects increase the number of joint C-C or mutually-cooperative choices. This was particularly true among subjects whose predominant motive was affiliation. For achievement-oriented and power-oriented subjects, the trend was similar but less extreme. Rapoport and Chammah asserted that the cooperation index is a reliable predictor of cooperation across the PDG matrix (Colman, ibid).

In summary, the payoff values within the experimental matrices have an effect on the amount of cooperative choices made by the subjects. However, Argyle (ibid) argued that a great majority of two-person cooperation, the payoff matrix for
cooperative and uncooperative choices looks more like that shown in Figure 4.5. When people choose to work together, both will be rewarded. There is no payoff for either party when cooperation does not take place. As mentioned in Table 3.1 (see Chapter 3), in cooperation the combined effort of the cooperating individuals are necessary to ease the problems faced by the partners, and that the combined payoff is contingent on the behaviour of both the partners.

\[
\begin{array}{c|cc}
\text{Player B} & \text{Cooperate} & \text{Defect} \\
\hline
\text{Cooperate} & 10,10 & 0,0 \\
& R,R & S,T \\
\text{Player A} & 0,0 & 0,0 \\
\hline
\text{Defect} & T,S & P,P
\end{array}
\]

Figure 4.5: Payoff matrix for real-life cooperative and un-cooperative choices. (After Argyle, 1991)

4.5 Responses to programmed strategies

Responses to programmed strategies has been one of the most extensively examined topics in studies of conflict and bargaining in games. In these studies, subjects play against human opponents (who are usually confederates of the experimenter) or computers whose sequence of choices have been programmed in
advance. The subjects are usually led to believe that their opponents are genuine. From the results, conclusions can be drawn regarding the ways in which people respond to various patterns of behaviour on the part of their opponents.

Oskamp (1972) conducted an exhaustive literature review of games studies which investigated the strategy of the other player as it affects a subject’s level of cooperation, focussing especially on PDG. Patchen (1987) argued that due to the artificial nature of experimental studies, it is also important to look at inter-nation studies in order to draw conclusions about the most effective strategies for eliciting cooperation. He examined possible convergence of the results from experimental studies, computer simulation and inter-nation studies. Here, a summary of these works and other recent studies is presented.

4.5.1 Non-contingent strategies

Non-contingent strategies are those in which the "other player" follows a preset series of moves (e.g. 100%C or O%C, where C denotes cooperation) on every trial.

Substantially greater concurrent cooperation were produced by strategies in which a cooperative choice is made on every trial (100%C) than by the unconditionally competitive (0%C) strategy. However, while most subjects reciprocated the cooperation of the 100%C program in the PDG, a significant proportion of subjects seized the opportunity of exploiting their opponents.

Patchen (ibid) explained that a consistent competitive strategy (0%C) can result in a struggle with an adversary that could bring low payoffs to both parties. A person may compete out of the belief that their persistence and willingness to sustain a temporary loss will lead the other side to give in first. If the other side proceeds on
the same assumption, this costly contest may continue and intensify. This results in a "lock-in" on a mutually destructive struggle. Results from inter-nation studies by Patchen (ibid) lead him to conclude that overall neither unconditional cooperation nor unconditional competitiveness appear to be very effective ways of getting another to cooperate, and thus of getting good outcomes for one's own side.

In summary, it was found that consistent cooperation or unconditional cooperation tends to bring exploitation by an adversary, whereas a policy of consistent competition tends to lead to a fight.

4.5.2 Contingent strategies

Contingent strategy is one in which an actor (e.g. the confederate of the experimenter) adjusts his action in some consistent way to the actions of the other side, rather than following preset moves. There are two main types of contingent strategies. The first chooses between cooperative (conciliatory) and competitive (coercive) moves, according to how successful each type of move has been in eliciting compliance from the other side. There have not been many investigations into this type of strategy. However Patchen (ibid) reported that the limited evidence available suggests these "trial and error" strategies can be effective in promoting mutual cooperation.

In the second type of conciliatory strategy, one chooses one's own action according to the last action of the other side, usually reciprocating the other's actions (Patchen, ibid). Tit-for-tat (TFT) and Graduated and Reciprocal Initiatives in Tension-reduction (GRIT) are two strategies in this category and will be discussed in the next section.
Both experimental studies (Oskamp, ibid) and studies of strategies followed by national leaders (Leng and Wheeler, 1979) indicated that contingent strategies are more effective than non-contingent ones in securing the cooperation of an adversary. It is also likely to be of greatest relevance to real world conflicts, because national leaders/real players are likely to adjust their actions to the cooperativeness or belligerence of an adversary (Patchen, ibid).

4.5.2.1 Contingent strategy: Tit-For-Tat

Tit-For-Tat (TFT) is the policy of cooperating on the first move and then doing whatever the other player did on the previous move. If in the last move, the other player has acted in a cooperative way, then one responds with cooperation, and if the other player has acted last in a competitive way, then one responds in kind.

In his review Oskamp (ibid) found

a. TFT strategy produces significantly higher levels of cooperation than a non-contingent strategy having the same level of cooperation.

b. In a sequential-play situation (where the second player is informed of the first player's response before he made his own choice) a contingent TFT strategy has very powerful effects, producing much greater concurrent cooperation than strategies of 100%C or 0%C or various levels of randomized cooperation. By contrast, in a simultaneous-play situation (where both players make their choice simultaneously and independently) a contingent TFT strategy produces significantly more concurrent cooperation than a 0%C, but not more than a 100%C.
c. A contingent TFT strategy usually produces significantly more concurrent cooperation than does a free-play situation (where there is no programmed strategy).

Axelrod (1984) conducted a computer tournament in which experts in conflict submitted strategies for playing the PDG. Two-hundred trials were played by computer simulation between rival strategies. The winner was the TFT strategy, which defeated other more complex strategies in producing favourable outcomes.

Patchen (ibid) believed that TFT would be just as effective in the Chicken situation. He stated, "In fact, one might expect it to be even more effective because an adversary suffers his worst outcome when his competitive move is reciprocated in Chicken, as compared to suffering his next-to-worst outcome when this occurs in PDG." He cited Sermat's (1967) work where 58% to 70% cooperative responses from an adversary was elicited by TFT strategy in a Chicken situation.

Whitworth and Lucker (ibid) found that a matching strategy leads to much higher cooperation levels because any attempt at unilateral defection by subjects resulted in a non-committant competing response by the "other person." Like Oskamp, Whitworth and Lucker (ibid) found that 100%C is less effective than TFT because in the former case, people can defect and win more money without fear of retaliation. They concluded that, "... simply cooperating with a person all the time does not insure his cooperation. The way to insure his cooperation that appears to be most effective is the matching strategy in which a cooperative response is matched with a cooperative response and competition is matched with competition."

Leng and Wheeler (ibid) studied the use of TFT strategy in serious disputes between nations. They found that a reciprocating (TFT) strategy was generally
effective when used by national leaders in disputes with nations following a variety of strategies. The outcomes obtained were better than the outcomes following the use of a bullying (consistently coercive) strategy or an appeasing (consistently rewarding) strategy. Against a bullying opponent, it was the only strategy generally effective. Leng and Wheeler (ibid) concluded that "... the findings support the central hypothesis that a reciprocating strategy is the most effective means of avoiding a diplomatic defeat without going to war, especially when it is employed against a bullying opponent."

According to Patchen (ibid), there are a few assumptions underlying the TFT strategy:

1. Neither side has to be rational; it merely has to repeat behaviour that has been rewarded and change behaviour that has been punished (or perhaps follow a norm of reciprocity).
2. Altruism is not needed and neither is trust, because defection is unproductive.
3. The players do not have to exchange messages or commitments; deeds speak for themselves.
4. No central authority is needed; cooperation based on reciprocity can be self-policing.

For TFT to be effective, it is essential that the payoffs for each side are greater when they cooperate than when they both compete. If there is greater advantage in mutual competition than in mutual cooperation, then adopting a TFT strategy will not be effective in eliciting cooperation. Also, it is important that both parties place sufficient importance on cooperation in the future to induce them to resist from competing in the present.
Although TFT has been found to be an effective strategy in eliciting cooperation, it is sometimes hard to get reciprocal cooperation started. In experimental studies, the party using the TFT strategy will make his first move a cooperative one. Patchen (ibid) argued that in real world cases where a new strategy is being considered, the interaction is on-going. If the other side has just taken a competitive action, the TFT rule would be to reciprocate with a competitive action. This will lead to both sides getting "locked-in" on mutual competition. For TFT strategy to do well, the other player must be willing to break out of a "lock-in" on mutual competition and follow a "more generous" strategy. A strategy that is intended to overcome the major problem of TFT, that is, the difficulty of breaking out of a "lock-in" on mutual competition, is the Graduated and Reciprocal Initiatives in Tension-reduction (GRIT) strategy.

4.5.2.2 Contingent strategy: Graduated and Reciprocal Initiatives in Tension-reduction strategy

GRIT strategy combines elements of reciprocity with conciliatory initiatives taken independently of the other's actions. The basic aim of the GRIT strategy is to encourage an eventual pattern of mutual cooperation, by lowering the level of mutual mistrust and hostility to a point where further cooperation could be made.

The features of GRIT can be simplified to the following (Lindskold and Han, 1988):

a. A general announcement recognising interdependence and stating intent to begin a program of conciliatory steps;

b. Open announcement of each step; and,

c. Retaliation to exploitation, followed by renewed unconditional conciliation.
The possible effectiveness of the GRIT strategy had been investigated in several experimental studies (Lindskold and Collins, 1978; Lindskold et al, 1983). When applied to PDG, the GRIT strategy was found to be more effective than TFT strategy in eliciting more or earlier cooperation from the other player. It was also found to be more successful than 100%C, 50%C and free play. The GRIT strategy was as effective for groups as for individuals. It was also as successful for generally competitive subjects as for those who were generally cooperative.

Lindskold and Han (ibid) believed that GRIT fosters interpersonal trust and provides experience in coordination that produces jointly rewarding outcomes. This in turn creates high aspirations for future interactions. "GRIT favourably influences opening aspirations, the nature of communication, speed in reaching agreement, and the frequency of reaching optimal agreement" (Lindskold and Han, ibid). Patchen (ibid) established that successful strategies in inter-nation disputes are consistent with the GRIT program.

However, there are some limitations to the conciliatory GRIT strategy. Under certain conditions, the adversary whom one is attempting to influence may try to exploit one's willingness to take conciliatory initiatives (Patchen, ibid). The adversary may continually lag behind in reciprocation, and in this way attempts to do better than its partner. More seriously, he may attempt to get the conciliatory side to surrender completely to his demands (Pilisuk and Skolnick, 1968).

Brams (1985) suggested that when faced with an opponent who may be tempted to exploit one's conciliatory move, it is important to make clear also one's resolve to reciprocate competitive moves. Experimental evidences have also indicated that conciliation is most likely to be effective in eliciting cooperation when the conciliator is perceived by his adversary as being strong and as having made the concession.
willingly, rather than as having been compelled to do so (Patchen, *ibid*). An opponent is also more likely to cooperate in response to a strategy of conciliation when the initiator of conciliation is equal in power to, or stronger than, the other side (Lindskold and Aranoff, 1980; Chertkoff and Esser, 1976).

Patchen (*ibid*) concluded by stating, "Though the limits of its application need to be recognised, a conciliatory strategy like GRIT appears to be a very promising way to use the basic strengths of a reciprocating strategy without getting 'locked-in' on mutual competition. It appears to offer a feasible way to reverse a spiral of mutual competition, and to turn it into a pattern of mutual cooperation."

Pilisuk and Skolnick (*ibid*) suggested a possible way in which the GRIT strategy can be combined with the TFT strategy. A conciliatory (GRIT) strategy may be most useful for inducing movement toward cooperation, but once the advantages of mutual cooperation have grown apparent, a TFT strategy may be best to push it all the way to full mutual cooperation.

4.5.3 Responses to programmed strategies:

**Summary and Conclusions**

Many experimental studies have been conducted to investigate the effects of programmed strategies on the subject's level of cooperation. Inter-nation studies have also been performed to examine the best strategy to elicit cooperation from an opponent. Taken together, these studies suggest that a strategy of unconditional cooperation (100% C) generates more cooperation than a policy of consistent competition (0% C). Unfortunately, this strategy also tends to encourage exploitation. Moving from a strategy of low level to a high level of cooperation is also more
effective than shifting from being cooperative to competitive. When confronted with a competitive opponent, an exhibition of firmness and a demonstration of one’s willingness to use coercion before a conciliatory move will deter exploitation.

The more successful strategies are the contingent strategies where one adjusts one’s own behaviour to the actions of the other side. The trial-and-error strategy where the successful actions are repeated and unsuccessful ones are discarded is often successful in gaining cooperation from an opponent. However, when confronted with a bullying contender, the Tit-for-tat (TFT) strategy is found to be more effective in evoking cooperation than the trial-and-error strategy. TFT is effective because the opponent learns quickly that exploitation is quickly followed by retaliation. However, players can easily get "locked-in" on mutual competition, once a single competitive move is made. To overcome this major problem of TFT, the Graduated and Reciprocal Initiatives in Tension-reduction (GRIT) strategy is introduced. This strategy combines unilateral conciliatory initiatives with a general policy of reciprocity, to encourage trust and further cooperation. It has been suggested that GRIT and TFT strategies be combined to cultivate and maintain a high level of cooperation.

The results of these studies clearly show that the choices of the other player have an important effect upon the subject’s degree of cooperation. As proposed in Chapter 3, cooperating members are interdependent: one member’s actions affect another. Therefore it is not surprising that the situation in which a person finds himself and his perception of how he is being treated determine his level of cooperation.
4.6 Communication

Colman (1972) expressed, "Common sense suggests that communication should facilitate cooperation in mixed-motive games." However, in most experimental games, the subjects are often forbidden to communicate. Both Nemeth (1972) and Wrightsman et al (ibid) argued that the absence of any possibility of communication between subjects in these games may be a significant cause of the low level of cooperation that are characteristic of most PD and other experimental games. Several studies have sought to verify this.

Instead of looking at the direct effects of communication on cooperation, most of these studies examined the effect of communication on some factor which is known to enhance cooperation. In the study by Loomis (1959), this factor is "perceived mutual trust," defined as the perception of a cooperative intention and expectation. He believed that the establishment of a cooperative relationship depends on the individual's response to the other person's expectation and intention. If the individual perceives mutual trust, he will cooperate, and if the individual does not perceive mutual trust, he will not cooperate. And unless the individual has already learned what to expect from the other person, he will have to depend for this awareness on communication between himself and the other person. Results from the experiment using PDG showed that two thirds of the communicating subjects, as against one-tenth of the non-communicating subjects, perceived trust. Secondly, the percentage of perceived trust increases as communication increases from a minimal kind of note stating only the writer's expectancy (Level 1) to a note which contained the complete statement of the game relationship (Level 5). Loomis (ibid) concluded that communication clearly establishes mutual trust, which in turn promotes cooperation.
More recently, Dawes et al (1988) studied the importance of group identity in eliciting cooperation in dilemma situations, and used discussion to create group identity. They held that group identity could enhance cooperation even in the absence of any expectation of future reciprocity, or current reward or punishment, or even reputational consequences among other group members. Results from a series of experiments conducted indicated that with no discussion, egoistic motives explain the presence of cooperation. However, with discussion, group identity (alone or in interaction with verbal promises) gave rise to its dramatic increase in cooperation.

Nevertheless, there are a few experimenters who have concluded that communication may, but does not necessarily, ameliorate the conflict present in the experimental games. Terhune (1968) noted that communication may provide greater opportunity for cooperation, but that opportunity may either not be used, ineptly used, or used for deceit and vituperation. In their study of communication, group loyalty and trust (again using PDG), Wallace and Rothaus (1969) wrote, "We might have found, happily, that the presence of communication reduced conflict or competition under the intergroup condition. Instead, communication seemed more to serve the end of conflict and warfare than to function in the service of conflict resolution. Peaceful overtures were mere deception."

Wichman (1972) argued that one factor that contributes to the lack of ability to generalise the results of communication across experiments is that communication has been defined differently in nearly every study. In some experiments, subjects wrote notes to each other. In others, subjects communicated through bulky headphones where voices were slightly distorted by a filter circuit that served to disguise the speaker. Wichman (ibid) expressed, "Speaking into strange apparatus, passing 'canned notes', writing spontaneously, and talking to each other before making a
decision have all been lumped together under the common rubric ‘communication’, while the many important nonverbal forms of communication have been largely ignored. Some messages were incomplete; sometimes a message was transmitted from one partner to another with no opportunity for reply. What is more, since most of the studies used restricted numbers of trials from only one to thirty, the communication opportunities that did exist were often not fully developed."

Wichman’s experiment attempted to test the effect of communication on cooperation by dividing communication into its verbal and nonverbal components. The results supported the hypothesis that subjects who can see each other when playing a PDG are more cooperative than subjects who cannot see each other.

Wichman (ibid) discussed why seeing each other might allow subjects to be more cooperative. He stated that considerable evidence can be found in literature that points to the fact that much important communication is nonverbal. "Many animal, social psychology and communication studies suggest that the behaviour of the organisms is significantly influenced by other very subtle cues ... the communication of emotional meaning, which plays a large part in social control, is often carried out nonverbally by such expressions as frowns and smiles." In the typical isolated PDG situation, all feedback of this sort is cut out of the loop. Thus, even though there is some tacit communication of information as a consequence of the payoff matrix and the choices made, most processes of social control are not introduced. If a player does not feel he has any way of influencing the other player, then the minimax strategy (playing competitively in the PDG) is the compelling choice, for it minimises losses. Since influence over another’s actions is almost directly a function of communication, the typical PDG experiment made it quite likely that subjects will be
highly uncooperative. Wrightsman et al \textit{(ibid)} stated, "Wichman's results are clear-cut; they force us to recognise that the absence of communication in the typical PDG may limit the applicability of its results to real-life encounters."

Not only is communication during the running of the game important, pre-play communication had also been found to play an important role in enhancing cooperation (Bornstein and Rapoport, 1988; Stockard et al, 1988; Oskamp and Perlman, \textit{ibid}). Preplay group discussion provides the opportunity for the players to coordinate their individual strategies and to work together to enhance their benefits (Bornstein and Rapoport, \textit{ibid}). McClintock et al \textit{(ibid)} also found that communication between subjects prior to playing the PDG increases the level of mutual trust, and as a consequence leads to cooperative behaviour reflecting either or both the motives to maximise own gain or joint gain through such behaviour.

In summary, when subjects are allowed to communicate either during or before the experiments, cooperation between the subjects increases. It has also been established in the previous chapter that communication is an essential process underlying cooperation. However, some experiments have shown that communication does not necessarily improve cooperation; others have shown that communication had been used to stifle cooperation. The difficulty in generalising results of communication across experiments could be due to the fact that the term "communication" has been loosely applied. It has also been established that cooperation is greatly improved when both verbal and non-verbal communication were allowed to manifest in the interaction between the cooperating partners. Communication had been found to improve perceived mutual trust, and group
identity. Any favourable effects of communication may be negated if the previous interactions between players have been such as to instil a spirit of distrust (McClintock et al, *ibid*).

### 4.7 Past experiences and information of other player

Buckley et al (1974) commented that, "... seldom do actors interact in a social structural vacuum. The social structural context, social controls, and the existing or anticipated social relations among actors significantly influence their responses to a situation or issue and their interaction in that situation." Thus, two persons cooperating together are not only influenced by their tasks or rewards, but also among many other things, by their past interaction or by the perception of each other. Information regarding the other player's intentions, personality, or race may also influence a person's behaviour.

Experimental studies have shown that:

- **a.** Dyads in the prior-success group who played the PDG immediately after the manipulation were significantly more cooperative than those in the prior-failure and no-prior experience conditions (McClintock et al, *ibid*).

- **b.** Dyads in both the prior-success and prior-failure conditions who played the PDG after a one-week delay were significantly more cooperative than those in the no-prior experience condition (McClintock et al, *ibid*).

- **c.** Subjects in the mutually friendly condition were significantly less likely to compete in the MDG than either those in the mutually hostile condition, or those without prior experience (Harrison and McClintock, 1965).
d. Dyad members who had experienced mutual success or friendship in a laboratory or in a "real" environment tended to cooperate more than those who had experienced mutual failure or unfriendliness (McClintock and McNeel, 1967).

e. Information concerning the other player's cooperative nature led to more cooperation by the subject than did information about the other person's competitive nature (Baxter, 1972; Wrightsman et al, 1967).

f. Subject's perception of high similarity between himself and a fictitious other player caused the subject to cooperate more and to expect more cooperation from the other player (Kaufmann, 1967).

g. Subjects who anticipated further interaction with the other player were less exploitative than those who did not (Marlowe, 1966).

h. Subjects were less cooperative when playing with people of a different race (Baxter, ibid; Rice and White, 1964; Sibley et al, 1968).

Results of the studies by McClintock and his colleagues are consistent with the more general hypothesis that prior experience per se increases the likelihood that dyad members will mediate positive reinforcement for one another (i.e. cooperate) and that given prior experience, prior success or friendship is more likely to produce this effect than prior failure or non-friendship (McClintock et al, ibid). All the results also support the contention of Buckley et al (ibid) that people do not act in a structural vacuum. Often experimental games are conducted with subjects sitting in different rooms, with little or no interaction, and little or no information regarding the other player (Argyle, ibid). These results have highlighted the problem of using a non-interactive condition to study a highly interactive phenomenon.
4.8 Non-experimental factors affecting cooperation

This section reviews experimental and other studies on the differences in the cooperative nature of subjects, covering issues such as the sex, age, ethnic and personality differences.

4.8.1 Sex and age differences

Wrightsman et al (1972) reported that up until 1972, more than 90 studies had looked at sex differences in mixed-motive game behaviour. Interest in this factor still continues. These studies produced conflicting results. Some of them showed that there are no sex differences in cooperative behaviour, while quite a few revealed that males are more cooperative than females. However, a majority of these studies provided evidence that females are more cooperative than males (Table 4.1). The reasons underlying such behaviour are not clear. The strongest support seems to stem from the fact that both male and female were acting in conformance to social stereotypes imposed. Stockard et al (1988) showed in their experiments that even though females did not cooperate more than males, they justified their behaviour with ideas that conform to their views of socially defined roles. Argyle (ibid) discussed gender differences in cooperation, helping behaviour, altruism, empathy, communication, and assertiveness and leadership. He concluded that in all these areas of behaviour, the same pattern emerged. Women seek close, supportive, social relationships; are warm, considerate and trusting; and prefer intimate egalitarian relationships. They are described as cooperative in the interpersonal sphere, especially with friends and family. Men on the other hand were found to be more assertive and independent, prefer larger and hierarchical groups, and are more concerned with tasks than women are. They are less involved in interpersonal
### TABLE 4.1: Experimental surveys on gender differences in cooperative behaviour.

<table>
<thead>
<tr>
<th>Females more cooperative than males</th>
<th>Males more cooperative than females</th>
<th>No sex differences in cooperative behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parsons, 1945</td>
<td>Oskamp and Perlman, 1965</td>
<td>Lutzker, 1961</td>
</tr>
<tr>
<td>McKee and Leader, 1955</td>
<td>Rapoport and Chammah, 1965</td>
<td>Bixenstine and Wilson, 1963</td>
</tr>
<tr>
<td>Sims, 1956</td>
<td>Sampson and Kardush, 1965</td>
<td>Evans and Crumbaugh, 1966</td>
</tr>
<tr>
<td>Aranoff and Tedeschi, 1968</td>
<td>Kagen and Madsen, 1971</td>
<td>MacCoby and Jacklin, 1974</td>
</tr>
<tr>
<td>Sibley et al, 1968</td>
<td>Marwell and Schmitt, 1975</td>
<td></td>
</tr>
<tr>
<td>Jenkin and Vroegh, 1969</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shears and Behrens, 1969</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tedeschi et al, 1969</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broverman et al, 1970</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halpin and Pilisuk, 1970</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nelson, 1970</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lambert et al, 1971</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Szal, 1972</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stingle, 1973</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chodorow, 1974</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ahlgren and Johnson, 1979</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owens and Stratton, 1980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herndon and Carpenter, 1982</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cook and Sloane, 1985</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stingle and Cook, 1985</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Englehard and Monsaas, 1989</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
activities and their concern with tasks and group games is often competitive, but also cooperative, though in a non-egalitarian way (Argyle, ibid). Argyle (ibid) argued that this could have its origins in the different parental treatment of boys and girls; the difference between the male and female subcultures; and sociological factors. (Refer to Argyle [1991] for a full discussion.) Stockard et al (ibid) warned that those who speculate on gender differences in cooperative behaviour may have overstated these differences. They concluded that anyone interested in enhancing cooperative behaviour in the general population should focus on developing optimal settings for this behaviour rather than on the participant’s sex.

The contention that as a person grows older, he/she is less cooperative have received some empirical support, even though again, no clear conclusion can be drawn, especially from the small sample of literature that was looked at (McKee and Leader, 1955; McClintock and Nuttin, 1969; Sjoberg et al, 1969; Kagan and Madsen, 1972; Stingle and Cook, 1985). Older boys were generally thought to be less cooperative than older girls. This could be due to the fact that boys have been taught to conform to masculine behavioural standards (Cook and Sloane, 1985) and to place higher value on individual achievement (Kagan and Madsen, ibid). Boys have also demonstrated less cooperative behaviour due to their high level of self-confidence in their ability (Pepitone, 1980; Pepitone and Hannah, 1980). Some researchers argued that older children are more cooperative than younger children due to their ability and flexibility in adapting their social strategies to assigned goals (Schmidt et al, 1988).

The general conclusion is that differences in cooperative and non-cooperative behaviour are not sex or age dependent alone, but are part of a complex relationship between age and sex, mediated by other personal variables.
4.8.2 Ethnic and cultural differences

Table 4.2 shows the results of experimental studies comparing the cooperative behaviour of people from different cultures, cited by Bethlehem (1982). Some clear conclusions emerged from these results. Rural and traditional people, whose culture encourages cooperation, are generally more cooperative. Urban and Westernized people are more competitive. However, certain idiosyncratic cultural differences also appear (McClintock and Nuttin, *ibid*).

As many of these studies compared the cooperative behaviour of children, rather than adults, caution in interpretation of the results is recommended. Many factors beside culture may affect the degree of cooperativeness in the experiments. For example, American children frequently associate competition with games. Therefore game-theoretical research may stimulate competitive motivations that are not representative of their strength in other situations (Pepitone, *ibid*). Children's ability to cope with the complexity of the experimental rules and rationale of the games, and the extent to which the task is interesting or boring to the children, can have strong effects on the results.

Anthropologists such as Mead and Bethlehem have categorised primitive societies as cooperative, competitive and individualistic. Argyle (*ibid*) and Bethlehem (*ibid*) provided descriptions of some of these societies. These are shown in Table 4.3 (cooperative societies), Table 4.4 (competitive societies), and Table 4.5 (individualistic societies). A summary of Argyle's discussions of Utopian and the Israeli kibbutz communities are also included in Table 4.3.

In cooperative societies, cooperation is commonly employed in hunting, agricultural work, and house building. Cooperative societies exhibit strong cohesion,
### Table 4.2: Results of experiments comparing cooperativeness between different cultures.

<table>
<thead>
<tr>
<th>More Cooperative Group</th>
<th>Less Cooperative Group</th>
<th>Techniques</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural, poor Mexican children</td>
<td>Urban middle class Mexican children</td>
<td>Madsen Board</td>
<td>Madsen, 1967</td>
</tr>
<tr>
<td>Less Western-educated Kpelle people in Liberia</td>
<td>More Western-educated Kpelle</td>
<td>PDG</td>
<td>Meeker, 1970</td>
</tr>
<tr>
<td>Rural Mexican children</td>
<td>Los Angeles American White/Black American children</td>
<td>Madsen Board</td>
<td>Madsen and Shapira, 1970</td>
</tr>
<tr>
<td>Mexican-American</td>
<td>White American</td>
<td>Circle matrix board</td>
<td>Kagan and Madsen, 1971</td>
</tr>
<tr>
<td>Traditional aboriginal Australian young people</td>
<td>Westernised aboriginals</td>
<td>Madsen Board</td>
<td>Sommerlad and Bellingham, 1972</td>
</tr>
<tr>
<td>Indian University students in Delhi</td>
<td>Canadian students</td>
<td>MDG</td>
<td>Carment, 1974</td>
</tr>
<tr>
<td>Rural Tonga adults in the Gwenebe Valley in Zambia</td>
<td>Westernised Tonga adults Tonga or African students at University of Zambia</td>
<td>PDG</td>
<td>Bethlehem, 1975</td>
</tr>
<tr>
<td>Cuban-American children in Miami</td>
<td>White, native-American children</td>
<td>Madsen Board</td>
<td>Concha et al, 1975</td>
</tr>
<tr>
<td>Rural Korean children</td>
<td>Urban Korean children</td>
<td>Madsen Board</td>
<td>Madsen and Yi, 1975</td>
</tr>
<tr>
<td>Cook Island and rural Maori children</td>
<td>Urban Maori children and White New Zealand children</td>
<td>Madsen Board</td>
<td>Thomas, 1975</td>
</tr>
<tr>
<td>Israeli Kibbutz children</td>
<td>Urban Israelis Urban West German Urban American children</td>
<td>Modified Marble Pull</td>
<td>Madsen and Shapira, 1977</td>
</tr>
<tr>
<td>Semi-traditional rural Kikuyu children in Kenya</td>
<td>American white children</td>
<td>Circle matrix board</td>
<td>Munroe and Munroe, 1977</td>
</tr>
</tbody>
</table>
**TABLE 4.3: Cooperative Societies.**

<table>
<thead>
<tr>
<th>TRIBE</th>
<th>COUNTRY</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zuni Indians</td>
<td>New Mexico</td>
<td>Live by agriculture and keeping sheep in hard environment. Cooperate over working in fields, looking after sheep and building houses. Education emphasises cooperation and sobriety. Little accumulation of wealth. Some tribal quarrels occur due to inhibition of individuality and initiative, and hatred of priests.</td>
</tr>
<tr>
<td>Bathonga</td>
<td>South Africa</td>
<td>Live in larger villages of 1000 or more, controlled by hierarchy of chiefs, headmen, and fathers. High level of cooperation and sharing. Men constantly engage in games and drinking, and polygamy is practiced. Rivalry occurs in the form of sorcery and warfare, and in struggles for kingship.</td>
</tr>
<tr>
<td>Bushmen of Kalahari</td>
<td>Botswana and Namibia</td>
<td>Hunters and gatherers who live in relatively small bands. Nomadic and move around in small and fluid bands. Hunting is cooperative and food is shared. Mutual help in building huts. Regard helpfulness and sharing as the norm, and are greatly valued. High level of warmth and friendliness.</td>
</tr>
<tr>
<td>Mbuti</td>
<td>Zaire</td>
<td>Grow crops and keep cattle. Members of a household naturally cooperate, but cooperation is also widely organised. Headmen organise work parties for large enterprises. Groups of kinsmen from different homesteads and neighbours work together to help kinsman or neighbour who cannot cope with a task on his own or with members of his own household. Ambition and wealth are disapproved. Excessive ambition and accumulation of unshared wealth leads to unpopularity, and can bring upon personal accusations of witchcraft. Again, cooperation is the norm. Cooperation, sharing, respect for the rights and feelings of others, generosity, sociability, mutuality among people are valued.</td>
</tr>
<tr>
<td>Country</td>
<td>Community Type</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Miri</td>
<td>Sudan</td>
<td>Small tribe, with a strong sense of identity. Strongly committed to mutual help within each village. Work together in the fields, sharing food, drink and bed. Intense village cohesion is sustained by festivals of music and dance in which the whole community take part and share powerful emotional experience, generating strong feelings of unity.</td>
</tr>
<tr>
<td>Kibbutz</td>
<td>Israel</td>
<td>Originally farming collective, though now partly industrialised. Land and means of production belong to the state; only furniture and minor personal items belong to individuals. Most members have regular jobs, and experts keep to their expertise - working in farms and industry. Women engage in domestic work, rather than production work. Children spend most of the time in the children's house, regarding that as their home, though they return to their family at night. This results in children having less intensive attachment to their parents and siblings. Meals are taken together, and ideology is reinforced by lectures, debates, annual festivals and other community events. In recent years, younger men and women have been losing faith in the ideals of cooperation, togetherness and equality, wanting to move towards private life and self-fulfilment.</td>
</tr>
<tr>
<td>Utopian communities:</td>
<td></td>
<td>Strong ideology within the communities, usually related to religion. Cooperation is more formal. New members expected to hand over all their possessions, and in exchange are supported for life. Strong division of labour; members use whatever skills they have to service the community. Frequent group meetings, and other rituals. Domestic activities are shared. Commitment to the community is encouraged. There are usually strongly established norms and conformity to these norms is induced.</td>
</tr>
<tr>
<td>Shakers, Hutterites, Oneida.</td>
<td>USA</td>
<td></td>
</tr>
<tr>
<td>Findhorn, Beshara, Kingsway.</td>
<td>Britain</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 4.4: Competitive Societies.

<table>
<thead>
<tr>
<th>TRIBE</th>
<th>COUNTRY</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwakiutl</td>
<td>Vancouver Island</td>
<td>Life is dominated by competition, for material property, and non-material things, like names and rights. Rich people throw elaborate, ritual feasts, where there are music, dancing and expensive presents for well-to-do visitors, and everyday things for poorer ones. Children are given early training in the manipulation of property. Some cooperation over fishing and house building takes place.</td>
</tr>
<tr>
<td>Iftugao</td>
<td>Philippines</td>
<td>Household is a nuclear family group, with dependents and kinship. Members of household cooperate with each other, but competition is the general practice. Life is a constant struggle for status, and prestige, through accumulation of wealth, and by giving expensive feasts. Wealth is acquired only minimally through inheritance. Therefore the surest way to wealth is shrewdness and good management of one's paddy fields. One is not allowed to relax, or show weakness in enforcing his rights, or in coming to the aid of a near kinsman in a blood feud, for he would be taken advantage of, and would find it hard to accumulate and maintain wealth.</td>
</tr>
<tr>
<td>Kachins</td>
<td>Burma</td>
<td>The social scale is climbed by the acquisition of riches and the giving of lavish feasts. All Kachin chiefs and headmen aspire to be autocratic chieftains. A chief arrogates status and wealth to himself, emphasizing the ritual position of a chief which entitles him to material and spiritual tributes from ordinary people. When his demands become too great, social reorganisation takes place where people remove themselves from the authority of the chief. It is an unstable society.</td>
</tr>
<tr>
<td>TRIBE</td>
<td>COUNTRY</td>
<td>CHARACTERISTICS</td>
</tr>
<tr>
<td>-------------------</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Objibwa Indians</td>
<td>Ontario, Canada</td>
<td>Each male hunts on his own hunting ground. Women work alone at home. Couples are self-sufficient, and are completely isolated in the winter. Marriages are short and unstable. Property is owned separately by family members. Some cooperation and competition occur, when neighbours are invited into private land for sociability.</td>
</tr>
<tr>
<td>Eskimos</td>
<td>Greenland</td>
<td>Live in small family units during the summer hunting season, but in settlements of related families in the winter. Marriages are short and unstable. Quarrels over women, and high murder rates. There is also little care of the old. There is cooperation over jobs which require more than one person, e.g. whale hunting, reindeer drives, seal hunting, or housebuilding.</td>
</tr>
<tr>
<td>Ik</td>
<td>East Africa</td>
<td>Described as &quot;selfish and malicious, a society barely coherent, in which everyone acts almost exclusively for himself/herself.&quot; No sharing of food, even with spouses. Little love is shown for children; children at the age of three or four are pushed out of the house to fend for themselves. No trust between people. The old and sick are left to die. The numbers of Ik are decreasing due to severe food shortage, and inability to cope.</td>
</tr>
<tr>
<td>Iban and Sea Dayaks</td>
<td>Sabah, East Malaysia</td>
<td>The bilek family, essentially a nuclear family with aged parents or adopted children, forms the basic unit of social organisation. Live in longhouse, consisting of many bileks (rooms). Cooperation over clearing jungle or working in fields, but each day's labour is received only by a bilek family. All land, rights to fruit trees, etc., are owned by the bilek family which planted them. Fishing is done communally by poisoning lengths of a river, but each fish belongs to the bilek family whose member picks it from the water. Because land is in abundance, so there is little competition.</td>
</tr>
</tbody>
</table>
which are encouraged by social activities, such as games, festivals and rituals. It can also be seen that cooperative behaviour is cultivated through setting cooperation and helpfulness as the norm, backed by sanctions. Argyle (ibid) noted, "If cooperation is socially valued in a culture, cooperative rules can be enforced, both by reward of social approval, and by punishments for failing to cooperate." This "phenomenon of conformity" is shown to be a strong basis for the establishment of cooperative behaviour in societies.

Whiting and Whiting (1975) attempted to relate differences in children's social behaviours to their social roles at home and in the larger community. Children who are expected to help and are taught cooperation as the norm develop cooperative tendencies. This explains why children from a more traditional and urban culture showed more cooperative behaviour in the experimental games.

In competitive societies, competition is propelled by shortage of essential resources and fuelled by vigorous social comparison. Therefore competing over material wealth and high status are common. Even so, cooperation is needed especially for tasks which are too big for one man like house-building. Bethlehem (ibid) wrote, "... even in the most competitive or individualistic society, everyone needs some primary group, usually based on ties of kinship and marriage, that he or she can trust, share with, and cooperate with." Friendship and sociability is needed, although in competitive societies, these are often used for selfish gains.

Bethlehem (ibid) stated, "Western culture enjoins competition. Conspicuous wealth is admired and envied, and so are achievements such as winning races even when there is no reward other than victory itself. Once people get Western"
aspirations - for even more possessions, security, comfort, and so on - competition cannot be avoided, though it can be engaged in to a greater or lesser degree. ... Yet even in competitive Western culture, cooperation is never wholly absent."

In a nutshell, cooperation is necessary and evident in all societies, even in the most competitive or individualistic ones.

### 4.8.3 Individual differences

Argyle (ibid) wrote, "Some people are more cooperative than others ..." The degree of cooperativeness can be influenced by one's personality or attitude. The relationship between cooperative (or competitive behaviour) in experimental games and personality characteristics and attitudes have been widely researched. Baxter (1972) listed 17 studies which have yielded only negative results or no significant relationships, and 11 studies with inconsistent results, with the weight usually on the negative side. Only 5 studies which produced positive results between number of cooperative choices and personality dispositions and attitudes were recorded.

The lack of consistent positive findings has been attributed to the nature of experimental games. There is usually no communication or interaction between subjects in PDG and other mixed-motive games (refer to Section 4.2.3). Wrightsman (ibid) wrote, "Attitudes are more likely to be related to behaviour in a mixed-motive game in situations in which there is face-to-face interaction, opportunity for improvisation of responses, and irrelevant affect which detracts from the task at hand. Since the standard PD game situation lacks at least two of these three conditions, attitudes are not expected to contribute to behaviour in PDG to the degree that they do in interpersonal situations possessing the three conditions." Vinacke (1969, cited by Baxter, ibid) expressed the same view, "It is clear that when the game presents very
limited and formal conditions, individual difference among subjects have little scope to manifest themselves. ... we need to pay much more attention to games in which social interaction is permitted to occur - it is likely that under such conditions personality variables will emerge more sharply." It is also argued that the subject's attitude plays a greater role in a one-trial game than in a multi-trial game. The other player's choice may override the subject's attitude or personality. Baxter (ibid) wrote, "... personality characteristics of subjects are interactive with the structure of the conflict situation at first but soon are 'washed out' by the spiral of conflict. ... the logic of the conflict situation soon becomes compelling to the subjects." For example, if the other player has adopted a consistently competitive strategy, most subjects will do likewise, regardless of their attitudes or personality characteristics.

Cook and Sloane (ibid) assessed the extent to which locus of control can determine the cooperative behaviour in pairs of boys and girls. The locus of control dimension was characterised as "mediating the degree to which events are perceived as consequences of one's own behaviour." Same-sex dyads were paired homogeneously or heterogeneously on a premeasure of locus of control. There were four different locus of control groups: Internal, External, Midrange and Mixed dyads. Cook and Sloane (ibid) concluded that, "It was the dyadic locus of control variable rather than an individual locus of control variable that determined different performances over the course of the game."

Argyle (ibid) listed and described some personality traits that are related to cooperation. From his discussion, it is gathered that extraverts and people who have strong affiliation and intimacy needs are more likely to cooperate. Also, people who are socially competent, and empathic are more able to sustain successful cooperation.
4.9 Summary and Conclusions

Many experiments have been conducted for the study of cooperative and competitive behaviour. The most popular experimental paradigms adopted for these studies, mixed-motive games, were presented. Although these games are widely used, they have also received wide criticisms, especially on the artificial nature of the task, and the discrepancies between laboratory and real life situations (e.g. usually communication between the players is not allowed). However, these games have produced interesting information, and have helped to substantiate the conclusions that have been drawn in the previous chapter of this thesis. Here, the salient points of these experimental studies are highlighted.

A. Nature of Rewards and Payoff values

Real and meaningful rewards may be able to increase the cooperative choices of subjects in mixed-motive games. However, this effect is sometimes overridden by other factors, especially the subject's perception of the symbolic payoffs associated with his choice. For example if a subject think he looks foolish in cooperating, he may choose to be competitive even at a great cost to himself. Often research on cooperation emphasises on the external and tangible rewards. It should be borne in mind that cooperation also involves psychological, moral, and social costs and benefits. Argyle (ibid) noted that cooperation over external rewards alone is rare. Often cooperation leads to other emotional rewards, such as interpersonal attraction between those involved, and a sense of satisfaction and enjoyment.

The payoff values within the experimental matrices have an effect on the cooperative choices made by subjects. The Cooperation Index proposed by Rapoport and Chammah (1965) was shown to be a reliable predictor of cooperation across the
PDG matrix. However, often in cooperation, when partners choose not to cooperate, neither party will benefit. The combined effort from both partners is required in cooperation to achieve the rewards associated with the team work.

B. Strategies of other player

In PDG, a strategy of unconditional cooperation (100%C) is more effective in generating cooperation from a player than a policy of consistent competition (0%C). However, this strategy tends to induce exploitation. The more successful strategies in producing and maintaining cooperation are those in which one adjusts one's own behaviour to the actions of the other side, such as the trial-and-error strategy, the Tit-For-tat (TFT) strategy and the Graduated and Reciprocal Initiatives in Tension-reduction (GRIT) strategy. The TFT strategy could be described as "an eye for an eye" strategy. It more successful in producing cooperation if the first move is a cooperative one. Otherwise players can get locked-in to mutual competition. This is because a competitive norm has been established. Looking at the assumptions underlying TFT (Section 4.5.2.1), it is a strategy based on retaliation; trust and commitment are not prerequisites for the strategy. In Chapter 3, it was shown that mutual trust is an important factor in cooperation. This may explain why GRIT was found to be more effective than TFT in eliciting a higher level of cooperation from the other player. GRIT is a strategy that "fosters interpersonal trust and provides experience in coordination that produces jointly rewarding outcomes" (Lindskold and Han, 1988). In conclusion, studies on strategies have highlighted the fact that cooperation can only be sustained when there is trust, and the willingness of both parties to engage in the cooperative behaviour. Also, it is important to develop positive behavioural norms for elicitation and sustenance of cooperative behaviour.
C. Communication

Cooperation between the subjects increases when they are allowed to communicate either during or before the experiments. It has also been established that cooperation is greatly improved when both verbal and non-verbal communication is allowed to manifest in the interaction between the cooperating partners. Unfortunately, most of the experimental games do not allow subjects to communicate with each other. As mentioned above, this is one of the main criticisms of experimental games, and is also used to explain the low level of cooperation often found in these games. Previous consideration of cooperation and helping behaviour in animals has shown that communication is vital in establishing this social behaviour. Communication is important in that it reveals the intentions of the partners, and allows coordination of actions towards achieving the goals of the partners. Communication was found to improve perceived mutual trust, and group identity; two important factors which enhance cooperation.

D. Past experiences and information about other player

Cooperation increases when there is a positive relationship between the subjects. It has been found that subjects who are friends, and who are similar to each other (in nature or race) made more cooperative choices. Argyle (1991) argued that when there is a positive relationship, the players' motivation changes; they are no longer trying to win regardless of or at the expense of the other, but want to maximise the gains of both. Prior experience provides information about the other subject; his behaviour and probably restraint. Subjects who have worked together successfully before have developed trust, and thus are more ready to cooperate again. Cooperative norms can be developed when people have a positive relationship with each other, and care for the welfare of each other.
E. Sex and age differences

Cooperation in experimental games have shown that while women are more cooperative than men, the actual difference is smaller than gender stereotypes suggest. The argument that as a person grows older, he/she is less cooperative cannot be substantiated here by the small survey of experiments. Following Stockard (ibid), speculation on gender and age differences in cooperation may be overstating these differences. For this reason, these aspects of cooperation will not be developed further in this present work.

F. Ethnic and cultural differences

Anthropological studies have shown that cooperative behaviour can be cultivated through setting cooperation and helpfulness as the norm, backed by sanctions. Children who have been brought up in these societies have been found to be more cooperative in experimental games. Cooperation exists even among people from competitive and individualistic societies, even if it is only within the nuclear family and kin.

G. Individual differences

Some people are more cooperative than others. Experimental studies on the relationship between personality characteristics and cooperation failed to show any consistent results. This has been attributed to the nature of the experimental games. In cooperation, one person’s action has an effect on the other person. Therefore it is not surprising Cook and Sloane’s (ibid) study found that it is the personality of the dyads (both the players) rather than the personality of an individual that determined the cooperative behaviour in the games.
Personality traits have been widely researched by psychologists. It is maintained that cooperation is more successful among people who have an interest in other people, having the desire to interact and relate to them; have the capacity to be empathetic, able to see the views of others; and are socially competent, able to sustain social interactions and relationships.

Important issues that have emanated from this chapter such as, the importance of communication, norms, coordination, and trust (relating to goal congruence) in cooperation are expounded within the context of small problem solving groups in Chapter 6. Rewards associated with cooperation is discussed in the next chapter.
Chapter 5:

Advantages of Cooperation

5.1 Introduction

Cooperation at work consists of either simultaneous, sequential or parallel performance of the same, similar or complementary tasks. When a task is too big for one person, such as house-building, or lifting a piano, cooperation consists of simultaneous performance of the same task. Some tasks require the division of labour, such as in an assembly line work, where sequential performance of different tasks occur. Other tasks, such as offshore drilling, demand that experts in differing fields work in parallel with each other. In a surgical team, surgeons, doctors and nurses work simultaneously in complementary tasks towards the same goal.
Cooperation also occurs when the task can be achieved by one person, but by cooperating, the task is made easier, quicker, or leads to a better solution. Often in the dynamic processes of exchanging information, resources and specialised expertise, cooperating partners stimulate and inspire one another towards a better solution to the problem, improving overall performance.

Clarke and Smyth (1993) said, "One of the conceptually most challenging problems at present is the understanding of those hierarchical systems for which the whole system is 'more' than its constituent parts. By 'more' we usually mean the emergence of some system behaviour that is qualitatively different from the behaviour of the constituent systems. In order to obtain such a metamorphosis at a certain hierarchical system level, the subsystems of the previous stage cannot interact at random but must somehow cooperate." This "synergy" is what is claimed to be the most important consequence of cooperation. This is similar to what Rothstein and Pierotti (1988) meant when they wrote, "In cooperation the combined actions of two or more individuals is usually needed to realise net benefits that are more than twice the benefits available to a single individual." In previous chapters, it has been established that cooperation involves external, as well as internal rewards. Not only does cooperation produce high payoff in terms of the performance of some tasks, it also creates new motives, attitudes, values and capabilities which have positive effects on the cooperating participants.

In this chapter, the outcome of cooperation in the following environment is looked at:
- cooperation among animals;
- cooperation among children in the classroom;
- cooperation among workers in an organisation; and,
- cooperation among members working in a small group.

5.2 Cooperation among animals

Broadly stated, animals cooperate to survive. As described in Chapter 3, cooperation among puffins leads to protection against the main predator, gulls. Herring move together in groups to safeguard themselves against the attacks of barracuda. Birds provide warning calls of approaching predators. Vampire bats regurgitate blood for their starving companion so that they can all survive.

Boesch (1990) reported that hunting became more successful as wild chimpanzees act together and coordinate their actions in a cooperative hunt. It also causes them to share meat more consistently as a gesture of giving.

Seeley and Vischer (1988) examined the benefits of cooperation in honeybee foraging. They found that cooperation increases the quality of the food sources located by the foragers as well as the ability of the colony's foragers to compete for high quality food sources.

Ligon (1983) described many advantages from studies of birds cooperating with each other in different situations. For example, long term or life time pair bonds (monogamy) are common among many groups of birds. In such species, each member of the pair often behaves in a manner designed to promote the welfare of each other. Frequently males in particular provide aid to their mates by feeding and protecting them from predators. The personal fitness of each member of the pair is increased only by providing extensive and dependable aid to one another. In the
majority of birds, a high level of extended cooperation between mated adults usually is more profitable for individuals of each sex than any other strategy (Ligon, *ibid*). In the pukeko, cooperative polyandry (the presence of two or more males that copulate with a single female and rear young at one nest) produces more surviving offspring than pairs. In woodpeckers, this also enhances reproductive success and increases survival of individual flock members.

In summary, cooperation in animals leads to a higher probability of the survival of the cooperating members and the survival of their species.

5.3 Cooperation in the classroom

Johnson et al (1978) believed that the ability of all students to cooperate with other people was the keystone to building and maintaining stable families, career success, neighbourhood and community membership, important values and beliefs, friendships and contributions to society. They stated, "Knowledge and skills are of no use if the students cannot apply them in cooperative interaction with other people. There is no aspect of human experience more basic and important than cooperating with others. Going back to basics in education means going all the way back to the socialisation of students into the competencies needed for cooperating with other people."

There are three types of interpersonal goal structures that can be implemented in the classroom: cooperation, competition, and individualisation. In a cooperative learning situation, student goal achievement is positively correlated; when one student achieves his goal, all students with whom he is cooperatively linked achieve their goals. In a competitive learning situation, student goal achievement is negatively correlated; when one student achieves his goal, all other students with whom he is
competitively linked with fail to achieve his goal. In an individualistic learning situation, student goal achievement is independent; the goal achievement of one student is unrelated to the goal achievement of other students. These three interpersonal goal structures influence the way in which students interact with each other and with the teacher, which in turn affects students' achievement and attitudes (Johnson and Johnson, 1979). There has been a great deal of research into the effects of these three goal structures on the cognitive and affective outcomes of students. Results of these studies are discussed below.

5.3.1 Enhanced learning

Peer interaction can foster cognitive development by allowing children to acquire new skills and restructure their ideas through discussion. Azmitia (1988) set out to investigate the role of collaborative problem solving in the intellectual development in children during the elementary school years. According to the author, the two abilities necessary for collaboration are cooperation and simultaneous evaluation. He referred to Piaget's claims that preschool children's egocentrism limits students in showing these two abilities. The author argued that, "... preschool children are less egocentric than Piaget proposed, but there are still some questions about the sophistication of the children's interactive skill. Cooperation is fairly rare and although preschoolers can consider other's perspectives in some situations, they usually are unable to sustain the discussions or resolve the conflicts assumed to mediate learning during collaborative problem solving. Despite these limitations, preschoolers can solve simple problems interactively but it is still not known whether collaboration leads to greater learning than solitary work." Azmittyia set out to answer the following questions:
1. Does interactive problem solving lead to greater learning than solitary work?

2. Do the benefits accrued from interaction generalise to the children’s subsequent individual performances?

3. What are the features of interaction that promote learning?

Expertise was considered by comparing novice and expert singletons with dyads formed by two novices, two experts or an expert and a novice. (5-year-olds children were employed in the experiment.) Azmittia (ibid) suggested that children’s acquisition of strategies can be facilitated by a collaborative context because partners often bring different skills to the tasks. The contribution of observational learning was assessed and the contribution of experts’ guidance was also assessed. Results of the experiment were as follows:

1. Consistent with the hypothesis, it was found that as early as the preschool years, collaboration can lead to greater learning than independent work.

2. For novices, collaboration produced greater learning, and this has maximized when children worked with an expert partner. Children were more likely to acquire cognitive skills when they worked with an expert partner.

3. Generalisation of skills to the individual post-test only occurred for novices who worked with an expert partner.

4. Increased competence of novices was mediated by their acquisition of task strategies and the quality of their verbal interaction (task related conversation).

5. Out of the three mechanisms of facilitation that were examined, only observational learning and guidance by an expert mediated learning. Conflict, which requires children to suggest different alternatives, did not facilitate learning. The author argued that this is possibly due to the fact that preschoolers lack the skills to sustain discussions of alternatives.
6. Learning is not only mediated by experts' guidance, but also by novices' own initiatives in observing, imitating and making suggestions.

7. Interactive benefits increase over time.

Rudduck and Cowie (1988) stated, "At a time when it is widely recognised that knowledge is changing rapidly, emphasis in education is moving away from the acquisition of fixed bodies of knowledge towards procedures for advancing knowledge and for criticizing knowledge." They strongly recommended implementation of group work in classrooms, and argued that the whole point of cooperative group work, and its central feature, is the opportunity to learn through the expression and exploration of diverse ideas, and experiences in cooperative company. They listed three characteristics of groups that are working effectively:

1. Group members are, between them, putting forward more than one point of view in relation to the issue or task that confronts them.

2. Group members are at least disposed to examine and be responsive to the different points of view put forward.

3. The interaction assists with the development of group members' knowledge, understanding and/or judgement for the matter under scrutiny.

Jaques (1984) believed that learning is best when one is personally involved in the learning experience. "Knowledge of any kind has more significance when we learn it through our own initiative, insight and discovery. Learning is best when our participation is valued and when there is a supportive framework in which to learn. Cooperative group work fosters intellectual autonomy because instead of students receiving at second hand the judgements of others, it offers opportunities for active engagement with issues and problems, and first hand experience of thinking things out in dialogue with others" (Jaques, ibid).
In summary, cooperation leads to greater learning, when children are able to participate in the learning procedures, examining and responding to the different points of views put forward. However, younger children tested by Azmittia (ibid) lacking the skills to sustain discussions of alternatives, learnt through explanations and observing the demonstrations given by their partners.

5.3.2 Controversy

Johnson and Johnson (1978) stated, "An important aspect of instruction is the degree to which intellectual disagreements can be fostered which create conceptual conflict within students and thereby increase their motivation to seek out new information and reorganise what they know. Compared to a discussion lacking any contention, controversy in either a cooperative or competitive context causes an increase in motivation to seek out new information." This effect was found to be stronger in a competitive rather than a cooperative context (Tjosvold and Johnson, 1978). However, competition produced a closed mind orientation in which participants felt unwilling to make concessions to the other's viewpoint, and perceived a high level of disagreement between themselves. They felt being viewed as closed minded in listening to their opponent, and they themselves perceived their opponent as being closed minded. Overall, it was found that when controversy occurred within a competitive context, greater internal distress was experienced than when it took place within a cooperative context (Johnson and Johnson, ibid).

5.3.3 Involvement in instructional activities

Johnson et al (1978) found that cooperative learning experiences of children:

- resulted in greater liking for talking to the class about one's ideas (self expression);
- promoted greater willingness to present one's answers, and more positive feelings toward one's answers and the instructional experience; and,
- promoted more positive attitudes toward the instructional tasks and subject areas.

They also discovered that the more cooperative the students' attitudes are, the more they can see themselves as expressing their ideas and feelings in large and small classes, and as listening to the teacher; while competitive and individualistic attitudes are unrelated to indices of involvement in instructional activities.

5.3.4 Motivation

Motivation is conceptualised as "... a combination of perceived likelihood of success with the incentive for success" (Johnson and Johnson, 1978; Johnson et al, 1978). Motivation increases with the likelihood of success and the importance of succeeding. Success that is intrinsically rewarding is seen as being more desirable for learning than having students believe that only extrinsic rewards are worthwhile.

Results of experiments have shown that cooperative students:

- saw themselves more as being intrinsically motivated;
- enjoyed school work more, finding it fun and interesting;
- sustained effort to achieve even when not doing every well;
- desired clear learning goals (signifying a need for direction), and persevered in pursuit of these clearly defined goals;
- believed that it is their own efforts that determine their school success;
- wanted to be good students and get good grades;
- believed ideas, feelings and learning new ideas are important and positive; and,
- demonstrated a high probability of academic success and a continuing motivation for further learning by taking more advanced courses in the subject area studied.
5.3.5 Attitudes toward school personnel

The positiveness of students' attitudes toward school personnel affect their internalisation of values and attitudes, as well as their susceptibility to be influenced by teachers. Johnson et al (1978) claimed that the more favourable the students' attitudes toward cooperation, the more they believe that:

- teachers, teacher aids, counsellors and principals are important and positive;
- teachers care about, and want to increase students' learning;
- teachers like and accept students as individuals; and,
- teachers and principals want to be friends with students.

Johnson et al (ibid) and Tjosvold et al (1977) discovered that students who had experienced cooperative instruction liked the teacher better, and perceived the teacher as being more supportive and accepting, academically and personally, than do students who experienced competitive and individualistic instructions.

5.3.6 Attitudes toward peers

Positive interpersonal relationships among students is necessary for both effective learning and for general classroom enjoyment of instructional activities (Johnson and Johnson, 1978). Cooperative experiences, compared with competitive and individualistic ones, resulted in:

- a greater liking for peers;
- more positive interpersonal relationships characterised by mutual liking, concern, friendliness, attentiveness, feelings of obligation, and desire to win the respect of other students;
- stronger beliefs that one is liked and accepted by other students;
- caring how much each other learns, and wanting to help each other;
- wanting to listen to, help and do school work with other students;
- more positive attitudes toward heterogeneity among peers;
- liking peers who are both "smarter" and less "smart" than oneself; and,
- more positive attitudes toward member of a different ethnic group or sex, and handicapped peers.

Cooperation was found to lead to increased liking and better relations among group members at:

- elementary school level (Philips and D'Amico, 1956);
- junior high school level (Gottheil, 1955); and,
- college level (Deutsch, 1949a).

Social support is understood as the existence and availability of people whom one can rely on for assistance, support and caring. One of the most important aspects of classroom climate is the student's perception of social support. "Social support is important because it is related to performance in achievement situations (especially in problem solving situations), persistence in challenging tasks under frustrating conditions, academic and career aspirations, resilience in stressful situations, psychological health and adjustment" (Johnson et al, 1985). Teachers and peers are the two potential sources of social support. Two ways in which social support can be provided is by helping and encouragement for academic achievement, and personal liking and caring. Johnson et al (ibid) found a positive relationship between cooperative learning and social support. The more students liked to work cooperatively, and the more they perceived positive goal and resource interdependence between them and their classmates, the more they perceived their
classroom climate as being both academically and personally supportive and enhancing. The longer cooperative learning was used within the classroom, the more positive the effects on classroom social support.

5.3.7 Perspective taking

"Social perspective taking is the ability to understand how a situation appears to another person and how that person is reacting cognitively and emotionally to the situation. Perspective taking is a central process underlying almost all interpersonal and group skills" (Johnson and Johnson, 1978). It is related to the effective presentation of information, the constructive resolution of conflicts, willingness to disclose information on a personal level, effective comprehension of information, effective group problem solving, cooperativeness, positive attitudes towards others within the same situation, autonomous moral judgement, intellectual and cognitive development, and social adjustment. Cooperativeness is positively related to the ability to take the emotional perspective of others. Cooperative learning experiences were found to promote greater cognitive and emotional perspective-taking ability than either competitive or individualistic learning experiences (Bridgeman, 1977; Johnson 1975a, 1975b; Johnson et al, 1976).

5.3.8 Self-esteem

Coopersmith (1967) defined self-esteem as, "... the amount of worthiness an individual perceives in him/herself." External self-esteem is the perception of an individual of the appraisal of others, and internal self-esteem is a function of personal experiences, accomplishments and abilities. In education, these two dimensions of self-esteem develop from a child’s interpretation of the feedback from teachers and classmates as well as from his own learning experiences (Aronson et al, 1978).
Competition in a student can instil in a child the fear of failure, which can cause low self-esteem and low achievement. Aronson et al (ibid) stated, "One method to accomplish positive outcomes for students is to change from a competitive to a cooperative environment in the classroom. ... In a cooperative interaction, the emphasis is on all the participants working together to accomplish a mutual goal. The production of 'losers' is virtually eliminated in this environment; thus, it is likely that the students will experience greater success and increase in support from the classmates. Positive feedback received from group members and skills and abilities gained by members when they help teach their classmates produces an increase in self esteem."

Ames and Ames (1978) investigated how children interpret success and failure in competitive and cooperative learning environments. Some children interpret success as a consequence of their ability and effort; this makes them feel more confident of future success. Other children interpret it in terms of luck and task difficulty. They found that in the competitive learning environment, children who failed, viewed themselves as incapable and engaged in self-condemnation. This can be rather devastating to a child's self-image. Success in the competitive environment in turn leads children to devalue others. However, in the cooperative learning environment, none of these negative effects were found. The reduced need for social comparison in cooperative reward structures may have helped students gain confidence in their abilities. The cooperative learning environment produced an important mechanism for promoting interpersonal attraction by emphasizing similarities across students regardless of their different levels in performance. Low achieving students in particular have a higher advantage from being in a cooperative rather than in an individualistic environment. Cooperative structures facilitated improvement in these students' self-image. Working with others, sharing goals, and
providing some inputs (even if this is relatively little) promulgated the interpersonal evaluations of the low achievers. Ames and Ames (ibid) suggested that efforts should be directed toward reducing social comparison among students by using a more cooperative or non-competitive orientation in the classroom.

Johnson and Johnson’s (1978) correlational studies indicated that cooperativeness is related to higher self-esteem in students throughout elementary, junior, and senior high school in rural, urban, and suburban settings. Attitudes toward cooperation are associated with basic self-acceptance (belief in the intrinsic acceptability of oneself) and positive self-evaluation (one’s estimate of how one compares with one’s peers).

5.3.9 Psychological health

Emphasis on cooperative involvement with other people and on appropriate competition during socialisation may promote psychological health and well-being, while social isolation may promote psychological illness. Cooperative attitudes were found to be positively related to emotional maturity; well adjusted social relations; strong personal identity; the ability to resolve conflicts between self-perceptions and adverse information about oneself; amount of social participation; and basic trust and optimism (Johnson and Johnson, 1978).

Sherman (1986) conducted an experiment with university students where four introductory educational psychology classes were taught with either a cooperative goal structure (with or without intergroup competition) or an individually competitive goal structure. Although no differences were found in the achievement gains of the groups, affective differences were obtained between the groups, indicating more negative perceptions being associated with the competitive group as contrasted with
the cooperative groups. Individually competitive groups perceived their competitive experience as more "unpleasant," "bad," "threatening," and "unfair" compared to their counterparts in the cooperative structure group.

5.3.10 Prosocial acts

Prosocial acts can be thought of as behaviours that have positive social consequences (e.g. empathy, sharing, donating, helping etc). According to Wispe (1972), if a person behave in such a way, "... the probability would be raised that the needs, goals, self-esteem, welfare etc. of the other person(s) in the interaction would be realised." Barnett et al (1979) hypothesised that anticipation of a competitive encounter would elicit self concern from the children and thereby suppress donations; compared to children anticipating cooperative interaction wherein the needs of another individual are more salient. Results of their experiments supported the hypothesis in that cooperative children donated more to children with disabilities than did children in the competitive condition. However, competition also served to suppress generosity to others to a greater extend than cooperation served to enhance it.

Crockenberg and Bryant (1978) studied the socialisation aspect of learning environments with respect to 8-11 year old children. The cooperative learning environment was found to enhance the development of social concern in children, in that children who had experienced a cooperative learning environment verbally encouraged the self enhancement of others more than children coming from a competitive or an individualistic environment. Children who had experienced the competitive learning environment engaged in more self enhancement and social-comparison behaviour at the expense of others than did children coming from the cooperative experience.
5.3.11 Interdependent learning: The Jigsaw Method

Aronson et al (1975) devised a technique for classroom instruction that attempted to incorporate beneficial features of cooperation and peer teaching into the highly structured atmosphere of the more traditional classroom. This method, referred to as the Jigsaw technique, contains the following features:

a. Students are required to work together and teach each other so that the students must depend on each other to accomplish their goals. None of them could do well without the aid of every other person in that group.

b. Students are reinforced for helping one another; doing better than the other person has no rewards.

c. Students must utilise one another as resources rather than depend on the teacher as the sole provider of information.

d. Every student in the group has a unique and essential contribution to make.

The Jigsaw technique was found to have the following effects on students:

- an increase in liking for school;
- an increase in self-esteem;
- group members were liked significantly more;
- positive feedback, support and successful experiences of many of the students in the cooperative classes led to generalised improvement in self-esteem and feelings of competence;
- a reduction in inter-group (or ethnic) hostilities and tensions;
- an improvement in academic performance; and,
- individual members treated their partners in the same kind of ego-enhancing manner in which they treated themselves.
Aronson et al (1975) believed that the Jigsaw structure induces children not only to imitate and model skills of group dynamics and social interaction, such as listening carefully and asking good questions, but also requires them to integrate these skills cognitively in their interactions with fellow group members. The authors claimed, "The aim of the Jigsaw method is not to train young people to be so cooperative that they will be out of place in a highly competitive society, but to teach cooperation as a skill so that the individual can call on that skill under appropriate conditions - when cooperation is the most facilitative way to perform a task - even in a environment that is highly competitive. The ultimate goal is for children to begin to learn that cooperation is appropriate, functional, exciting and humanising in many more situations than they may have realised."

5.3.12 Contact hypothesis

The Contact hypothesis predicts that a favourable change in attitude will result when an individual has personal contact with members of a group he dislikes under the following conditions:

a. Circumstances define the status of the participants from the two social groups as equal in the situation in which the contact occurs.

b. The attributes of the disliked group members with whom the contact occurs are such as to disconfirm the prevailing stereotyped beliefs about them.

c. The contact situation encourages, or perhaps requires, a mutually interdependent relationship, i.e., cooperation in the achievement in the achievement of a joint goal.

d. The social norms of the contact situation favour group equality and egalitarian intergroup association.
A brief statement of the hypothesis, incorporating these qualifications, might read as follows:

"Attitude change favourable to a disliked group will result from equal status contact with stereotype-disconfirming persons from that group, provided that the contact is cooperative and of such a nature as to reveal the individual characteristics of the person contacted and that it takes place in a situation characterised by social norms favouring equality and egalitarian association among the participating groups" (Cook, 1978).

Cook (ibid) tested the contact hypothesis. Three general conclusions were derived from the results of his experiments:

1. Involuntary contact with representatives of a disliked social group under conditions of interdependence and cooperation induces friendly behaviour, and in some cases, promotes favourable changes in intergroup attitudes. Thus, a version of the contact hypothesis that stresses intergroup cooperation is supported.

2. Even in the absence of cooperative interdependence, equal status contact involving close and friendly association of long duration, in the presence of norms favouring racial equality, induces cross-racial respect and liking among those present in the contact situation.

3. In newly desegregated schools, white Anglo students cooperating in inter-racial and cross-ethnic learning groups, by comparison with those in equally heterogeneous traditional classrooms, show more respect and liking for non-Anglo classmates and more frequently choose friends from outside the
Anglo group. They do not, however, change their attitudes toward minority groups in general, at least not in the course of the limited amount and duration of cooperation experienced during the school experiment described.

5.3.13 Cooperation in the classroom: Summary and conclusions

In summary, cooperative learning environment was found to provide a psychologically and healthy learning environment for children. It motivates children to enjoy school, and be involved in the activities. Attitudes of children towards their teachers and peers improve under the cooperative learning environment. It raises social support among children in the classroom. It leads to a higher self-esteem, and promotes psychological health. Under this environment, children’s performance as well as development in social concern is enhanced. In concluding, it is best to refer to the statement by Johnson and Johnson (1978), "Cooperation should be used more frequently in the instruction situation than competitive and individualistic goal structures. Whenever it is important for students to be motivated, involved, and attending; whenever it is important to master, retain and apply knowledge and skills; and whenever positive student attitudes are derived, cooperation should be used."

5.4 Cooperation in organisations

Cooperation is a crucial issue for organisations. "Employees within the same department must coordinate to avoid duplication and compliment each other’s efforts. They must share knowledge and help each other solve problems to complete departmental tasks. In addition, people from different work groups and departments must share their experiences and expertise to capture synergy and create new services and products" (Tjosvold, 1988). Tjosvold (ibid) studied the usefulness of Deutsch’s theory of cooperation and competition (Deutsch, 1962) to examine coordination in
organisations. He proposed that goal interdependence helps in the analysis of the
dynamics and outcomes of how people work together within and between groups. The interdependence dynamics were found to affect task accomplishment and efficiency as well as relationships, feelings, and expectations of future collaboration. Tjosvold (ibid) was able to support his main hypothesis that employees who believed their goals are cooperative, compared to competitive or independent, exchanged more information and ideas, developed greater positive feelings, and became more confident that they could work effectively in the future. Cooperative dependencies were found to be related to positive and confident expectations, exchange of information and resources, effective and quality task performance, cohesion, and morale.

In another study, Tjosvold et al (1983) found that the positive experiences of working together lead employees to believe they have gained a great deal from the organisation; teamwork bound them to each other and to the organisation. Results from a questionnaire administered to companies in Singapore revealed that cooperation was related to shared vision and mission; shared values of people and productivity; and, altogether contributed to effective collaboration and commitment to organisations. "Promoting a shared vision and cooperative interaction can develop a company oriented approach both to productivity and people. Employees feel they benefit from camaraderie and support as they work cooperatively to complete organisational tasks. Cooperative work appears to provide an important way to integrate the needs of individuals with the organisation’s requirement of productivity" (Tjosvold and Tsao, 1989).
The conditions under which departmental representatives constructively discuss their opposing positions was also investigated by Tjosvold (ibid). He found that participants in the cooperative context:

- believed that they were more willing to work with the discussant in the future and that the other discussant was more willing to work with them;
- rated themselves as more open to the other and the other’s arguments than did those in the competitive condition;
- thought there was more give and take in the discussion;
- felt they understood the other participant more than did competitive participants;
- learnt more through the discussion;
- made more effort to create new solutions;
- made integrative decisions or recommendations rather than inclining to make decisions reflecting their own point of view; and,
- demonstrated openness and interests.

Overall, shared responsibility created incentives for thorough discussion but a cooperative context facilitated the interaction and exchange of ideas which promote organisational decision making. Combining the incentives of shared responsibility with the facilitating interaction associated with a cooperative context would seem most likely to result in constructive dynamics and outcomes of controversy between departmental representatives (Tjosvold, ibid).

5.5 Cooperation in small groups

Performance of individuals compared to small groups is an enduring topic of research on the dynamic of small group interaction. Individual refers to a single person functioning in an isolated condition, attempting to achieve an objective or
goal. His behaviour typically does hold immediate or direct consequences for others, and is not characterised by interaction with others. Group usually refers to a collection of individuals who share similar attitudes, beliefs, values, and norms. The interaction of members is commonly motivated by a determined goal, and each member's behaviour has consequences for the other members of the group. Therefore, group work is a cooperative venture.

In both learning and problems solving, groups when compared to individuals:

- tend to make fewer errors in recall and judgement;
- arrive earlier at a response (or learning criterion); and,
- make more correct or accurate responses (Davis, 1969; Barker, et al, 1979; Brown, 1988; Ellis and Fisher, 1994).

The superiority of group performance over individuals can be attributed to the following factors:

1. Groups have a greater variety of resources. There are more minds to contribute to the task, and more sources of information (Ellis and Fisher, *ibid*). Group is more likely to come up with a greater variety of alternatives than will a single individual. By pooling information, the group provides the potential for solving a problem that an individual may not attack successfully (Barker et al, *ibid*).

2. In the group, more than one "head" is available in which information can be stored for learning; and this "stored data" in several "memory banks" is available for the group's use for recalling information (Davis, *ibid*; Barker et al, *ibid*).
3. Ellis and Fisher (ibid) noted that even experts can become over-confident, misinterpret inconsistent evidence, and engage in reasoning fallacies. Errors are more easily detected and eliminated in a group. While groups may generate and consider a greater number of alternatives than do individuals, they also must eliminate inferior contributions (Barker et al, ibid). Often duplication of work in a group provides a check on the quality of the group's output (Davis, ibid). Members can check each other for consistency and accuracy (Barker et al, ibid).

4. Some decisions require judgment rather than expert knowledge because the nature of the task is more ambiguous or because there is no clear-cut solution to the task. One may be required to be creative in deciding possible decisions; to be sensitive to a range of new information, and to change beliefs in the face of new information; and to make decision with incomplete information. Members in a group are able to provide a more accurate judgment as they critically evaluate information and ideas presented. Group can also provide a decision of superior quality when members of differing expertise bring their knowledge into the decisions making process.

5. Questioning and debating during social interaction may stimulate new or different intra-individual thought processes that the uniform environment of the isolated individual might not provide; thus, the other persons have a cue value in provoking new task approaches (Davis, ibid). The limits of creativity and valuable interpretation of information are extended when individuals have others to stimulate them (Ellis and Fisher, ibid).
Deutsch (1960) documented an experiment where 34 hypotheses related to the effects of cooperation and competition upon group processes were investigated. These effects covered a wide range of factors such as communication, orientation, group productivity, and interpersonal relations. Deutsch (ibid) found that individuals who were exposed to the cooperative social situation demonstrated the following characteristics:

- better quality of product and discussions;
- greater productivity per unit time;
- greater amount of learning;
- more diversity in amount of contributions per member;
- better coordination of efforts;
- more subdivision of activity;
- more orientation and orderliness;
- more communication to one another;
- more common appraisals of communication;
- more mutual comprehension of communication;
- greater friendliness during discussions;
- greater attentiveness to fellow members;
- more favourable evaluation of the group and its products;
- more behaviour directed towards helping the group improve its functioning;
- higher amount of interest and involvement;
- greater feeling of being liked by fellow members; and,
- greater feeling of obligation and a desire to win the respect of other fellow members.
In a more recent experiment, Cosier and Dallon (1988) also found that:

- subjects working under cooperative conditions performed significantly better than those working under competitive conditions;
- a cooperative environment is more conducive to high performance than a competitive one; and,
- subjects not only performed better under a cooperative payoff scheme, they also reported exerting more effort under this conditions.

It had been shown repeatedly that cooperation not only improves the performance of the cooperating members and encourages learning, but it also leads to positive affect and other emotional rewards. Deutsch’s studies on cooperation (1960, 1962) provide some insight into the motivational forces behind cooperation and its effects. He proposed three consequences of cooperation (between A and B):

1. **Substitutability:** "B moved towards his goal as a consequence of A’s actions so there is no longer any necessity for B to perform any action which is similar to A."

2. **Positive cathexis:** "A’s action positively cathected by B; that is, B is likely to accept, like or regard A’s actions."

3. **Inducibility:** "If A’s actions move B towards his goals, it is expected that B will facilitate A’s actions, and will be receptive to A’s attempts to induce him to engage in behaviour which will facilitate A’s actions."

These consequences produces certain effects in the cooperation. Substitutability permits the division of labour and development of role specialisation. Role specialisation may develop from initial differences in abilities, skills, knowledge, and
inclinations among individuals in a cooperative situation. With successful actions "cathected positively," individuals will develop predispositions to perform certain roles and they come to value the opportunities and conditions which permit them to perform their roles. Deutsch (ibid) wrote, "Thus, the process of cooperative interaction is, in its idealised form, one in which cooperating individuals perform specialised but complementing activities which are motivated in part by values and expectations deriving from prior experiences in cooperative situations."

According to Deutsch (ibid), positive cathexis also contribute to the development and maintenance of organised collective effort by creating new motives for participation in the system of cooperation. When there is a development of mutual positive interest in one another, each person receives indirect pleasure from the other person's pleasure or satisfaction. Therefore even when the original goal around which cooperation developed are attained or changed, a continuing basis for cooperative relations is created. Mutual interest may arise as a consequence of cooperation, and may then provide a basis for continuing cooperation. In other words, one successful cooperation can lead to another as mutual interest are created.

Inducibility, according to Deutsch (ibid), provides the basis for normative control of individual behaviour in the cooperative situation. An individual will be receptive to the influence attempts of others to the extent that he perceives attainment of his goals as promotively linked with theirs. Normative control functions to elicit cooperative behaviour aimed at facilitating the promotive behaviour of others or obstructing the actions of others that are contrient with respect to goal attainment and to the continued existence of the system. Thus, mutual inducibility provides the psychological basis for channelling individual effort into a coordinated system of action, moving the group toward goal attainment while maintaining the viability of
the cooperative system itself. In other words, A and B mutually encourage actions that facilitate each other towards successful role performance and goal attainment, and sanctions actions that hinder goal attainment.

It would be misleading to assume that groups are always advantageous. Often groups turn out to be less superior when compared to individuals' performance in terms of time required to reach an answer or solve a problem. Groups must establish a history before it can function effective as a system. Group members express opinions, argue, summarise, question, gather information, and evaluate information; consider ideas and drop them, and reconsider them. These communication processes, are responsible for improving the quality of the decisions, but they do slow the system down (Ellis and Fisher, ibid).

Sometimes group members fail to utilise their resources in the optimum way for a given task (Brown, ibid). Also, the polarisation effect occurs, where the collective decision is more extreme than the average of individual opinions in the same direction. Problems like the groupthink phenomenon, where groups make faulty decisions due to pressure of conformity, also arise in group work.

Moreover, not all tasks are suitable for group work. Ellis and Fisher wrote, "Having looked at many conflicting results in attempting to determine if in fact 'two heads are better than one,' researchers have turned to the question 'On what kinds of tasks and in what environments will the group perform better than its individual members working separately?'' In the next chapter, the types of tasks more conducive to group work is discussed.
5.6 Summary and Conclusions

In this chapter, the positive outcomes of cooperation within the following context has been discussed:

- cooperation among animals;
- cooperation among children in the classrooms;
- cooperation among workers in an organisation; and,
- cooperation among members working in a small group.

Animals cooperate for survival. Cooperation among animals lead to protection against predators, more successful hunting, greater reproductive success and increased survival.

A cooperative learning environment have been shown to produce a psychologically and socially healthy environment for children to learn. Under such environment children are motivated to enjoy school, and be involved in the activities. Children's attitudes towards peers and teacher were found to improve, and the level of social support within the classroom increases. More importantly, under the cooperative learning environment, children's performance improves through discussions, participation, examining and responding to the different points of views, instructing one another, and observing their partners.

Cooperation in organisations was also found to promote a better working environment. Shared visions, values and responsibilities facilitated interaction and exchange of ideas, which lead to a higher quality of task performance.

Cooperation in small problem solving groups was also found to lead to better task performance, and positive social effects.
Looking at all the positive effects of cooperation on task accomplishment, whether in the classroom, in an organisation, or in small problem solving groups, the main contributing factor is the ability to exchange and criticise information. Cooperating members are able to:

- recall and exchange information, resources, expertise;
- stimulate and inspire each other towards new ideas and a greater variety of alternatives;
- criticise knowledge and proposed solutions;
- check for inconsistencies;
- eliminate inferior contributions; and,
- make group decisions of superior quality.

The potential of synergy in cooperation is the driving force behind the work described in this thesis. The ability to generate alternatives and to critically evaluate information and proposed partial solutions, is a prerequisite in representing cooperation between human-computer system.

In the next chapter, the type of task suitable for cooperative work will be described. This is followed by discussions on the processes underlying human-human cooperation that form the basis for defining the mechanisms of human-computer cooperation.
Chapter 6

Cooperation in Small Groups:
The Underlying Processes of Cooperation

6.1 Introduction

The superiority of groups over individuals is dependent on the task to be performed. Some tasks can be presented either to individuals, or to groups. Other tasks are impossible, or undefined, for individual persons apart from a group (Davis, 1969). In the next section, the types of task that are more suitable for group work are elucidated.

From the discussion so far, it has been established that cooperation is a goal directed behaviour, involving certain underlying processes, such as norms and roles, communication among the members, resolution of conflicts, and coordinated and
distributed actions. These processes which induce and maintain effective cooperation are often evident in a small group of people working on a task. In this chapter, these underlying processes and their relations to one another are expounded.

6.2 Tasks suitable for cooperation

Kowitz and Knutson (1980) offered the following table (Table 6.1) illustrating the differing approaches to tasks with different characteristics.

TABLE 6.1: Appropriate assignment of tasks.

(After Kowitz and Knutson, 1980.)

<table>
<thead>
<tr>
<th>Task Characteristics</th>
<th>Assignment</th>
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<tbody>
<tr>
<td>One correct answer.</td>
<td>Most capable person.</td>
</tr>
<tr>
<td>(E.g. solution to a mathematical equation.)</td>
<td></td>
</tr>
<tr>
<td>Routine collection of information.</td>
<td>Individuals working separately,</td>
</tr>
<tr>
<td>(E.g. preparation of a bibliography.)</td>
<td>coordinated by one person.</td>
</tr>
<tr>
<td>Open-ended task.</td>
<td>Task-oriented group.</td>
</tr>
<tr>
<td>(E.g. design task.)</td>
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</tbody>
</table>

Kowitz and Knutson (ibid) believed that tasks which are more suitable to group work should be open ended, where the outcome is not predetermined. There are several approaches to the tasks, and there are several alternatives to the solutions. Tasks suitable for deliberation in small groups encourage discussions and the
exchange of ideas. Kowitz and Knutson (ibid) also identified two other criteria for tasks that are more suitable for group work: the tasks should be complex enough to permit division of labour, and the tasks should require a range of members' backgrounds for adequate resolution. Groups consisting of members with varied backgrounds can bring more insight and perspectives to the task than members having nearly the same background. The last two demands ensure full utilisation of the physical and knowledge resources provided by group members.

Some tasks, such as crossword puzzles, can be performed either by an individual or by a group. However, according to Ellis and Fisher (1994), the social dimension of the group process (in terms of more information resources, critical analysis of information, capacity to divide labour, etc.) could add nothing to the solution of such a problem. They went on to argue that a group functions under a condition of "psychological interdependence," so that the productivity of the group is more than the sum of the contributions of the individual members. If a group were to perform a task that could be just as easily performed by an individual, the output would be merely the total of the contributions of all the individual members. It cannot surpass the efforts produced by its most competent individual member. However, in tasks that require the critical exchange of conflicting viewpoints, where no single "correct" or "best" answer exists, a group has a distinctly superior advantage (Ellis and Fisher, ibid).

McGrath (1984), drawing upon past attempts by social psychologists to classify tasks, produced a circumplex model of types of group tasks. The framework offered is shown in Figure 6.1 and listed in Table 6.2. The task circumplex is divided into four quadrants, representing four performance processes: Generate, Choose, Negotiate and Execute. Each of the processes is divided into two subtypes, as described in
Table 6.2. The circumplex is also a two-dimensional representation, with the horizontal dimension reflecting a contrast between behavioural or action tasks to the right (types 1, 8, 7 and 6) and conceptual or intellectual tasks to the left (types 2, 3, 4 and 5). Of particular interest here is the vertical dimension which reflects Laughlin’s classification of tasks being done by cooperating group from those being done by competitive and/or mixed motive group. McGrath’s circumplex shows that creativity and planning tasks favour cooperative work. Creativity and planning tasks share the same task performance process: Generate. Creativity tasks involve generating ideas or alternatives, whereas planning tasks involve generating plans, paths or actions to carry out already chosen objectives. Both types of tasks require the generation of alternatives, and the selection and/or shaping of those alternatives. Creativity tasks are also adjacent to intellective task type, and are related to tasks of that type in that they share an emphasis on cognitive aspects (McGrath, *ibid*).

In short, tasks which are most appropriate for cooperative small groups are those which are open ended, i.e. have no predetermined solutions, and which members require to:

a. generate a range of ideas; and,

b. select among the alternatives a "satisficing" solution.
Figure 6.1: The Group Task Circumplex (After McGrath, 1984)
TABLE 6.2: Quadrants, task types, and key concepts of the Task Circumplex.  
(After Mc Grath, 1984.)

<table>
<thead>
<tr>
<th>QUADRANT I: GENERATE</th>
</tr>
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<tbody>
<tr>
<td><strong>TYPE</strong></td>
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<th>QUADRANT II: CHOOSE</th>
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<td><strong>3</strong></td>
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<td>4</td>
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<tr>
<th>QUADRANT III: NEGOTIATE</th>
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<table>
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<tr>
<th>QUADRANT IV: EXECUTE</th>
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<td><strong>7</strong></td>
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<td><strong>8</strong></td>
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To develop a cooperative computer exemplar for demonstration and evaluation purposes, the screen design task was chosen based on these principles. (This will be discussed further in the next chapter.)

In the next section, the underlying processes of cooperation are discussed within the context of small groups oriented towards tasks that are described above as suitable for cooperation. Literature in group dynamics often distinguish problem solving tasks from decision making tasks. The term "small problem solving group" used here denotes groups consisting of 2 to 10 persons, working together on a task which is open ended, where members exchange information, generate ideas or partial solutions, and select from these alternatives a "satisficing" solution. Thus, decision making is part of the process within these tasks. This type of group is different from working groups, such as those in assembly lines where workers coordinate their physical activities to manufacture a product, and little oral interaction is required. Problem solving groups are also different from encounter groups which may be designed, for example, to improve an individual's interpersonal skills. The basic function of a problem solving group is to reach solutions of problems, while the function of encounter groups is to achieve deeper-insight, and thus relying more on emotional experiencing.

6.3 Goals

6.3.1 Group goals

Working towards a common goal is the crux of cooperation. Almost all of the definitions of cooperation presented in Chapter 3 (Section 3.2) pointed to the
existence of a common goal, which cooperating partners work towards. The existence of common goals is the strongest factor in the development and maintenance of cooperation.

The goals of a cooperating group are the aims or the objects towards which group members' activities are directed. They are the end results that a group seeks to achieve. Barker et al (1979) mentioned two types of group goals, namely, achievement goal and group maintenance goal. "Achievement goal" refers to the major outcome or product that the group intends to produce or seeks to achieve. (This could also be referred to as "task directed goal.") Working with other members in a group to accomplish achievement goals requires some attention towards interpersonal issues to maintain the group at a satisfactory level of operation. Barker et al (ibid) used the term group maintenance goal to refer to a goal designed to maintain, strengthen, or ensure the continued existence of the group itself. Often priority is placed on achievement goals. An ideal situation would be effective accomplishment of achievement goals with simultaneous and satisfactory achievement of group maintenance goals. However, obstacles that hinder the accomplishment of both types of goals do occur. Barker et al (ibid) recommended shifting or fluctuating the weight placed on the achievement of each kind of goal depending on the conditions of the group. When the group is moving towards its achievement goal and interpersonal relations are favourable, primary attention may be devoted to the achievement goal. However, when the group's structure is deteriorating but reasonable progress is being made toward the achievement goal, it may be necessary to shift the emphasis of the group to the attainment of group maintenance goals (Barker et al.)
6.3.2 Personal goals

Each member of the group also has personal goals, which are the objectives or end results that the individual seeks to achieve. These personal goals are based on individual needs. The pursuit of these personal goals is compelling and occupies much of one's attention and energy. The discrepancy between personal goals and group goals can be detrimental for the group. For example, if a member is more interested in being the star (satisfying personal need for recognition) than in getting the problem solved, it may cause disunity to the group. The goal of a group is initially a composite of personal goals of members of the same group (Barker et al, *ibid*). The next section discusses how group goals are formed.

6.3.3 Formation of group goals

The formation of a group goal requires that the various goals for the group held by the different members be somehow converted into a single goal capable of steering group activities (Figure 6.2). It is naive to imagine that when members start to work together, they have a well-formulated common goal and every member knows precisely what actions must be taken to achieve that. Usually members construct the group goals incrementally in a cooperative fashion. There are many ways in which this is achieved. For example, "Fairness to individuals" approach combines the preferences of every individual in the group, whereas a "group effectiveness" strategy gives more weight to the "expert" of the group in selecting the group goal, although participation by group members is advocated. Participation produces a better fit of the motives of members and the chosen group goal, and hence a greater acceptance of this goal. It also produces an understanding of group actions required for goal attainment, and a better appreciation of how the behaviour of individuals contributes
Figure 6.2: Construction of common goal through participation

$G_A = \text{Goal of Partner A}$

$G_B = \text{Goal of Partner B}$

$G_{AB} = \text{Common Goal of Partner A and Partner B}$
to the required group action. Cartwright and Zander (1968) wrote, "If the group goal is not accepted by a significant portion of the group, we should expect to find relatively poor coordination of efforts and a relatively high incidence of self-oriented rather than group-task oriented behaviour. Also those members with a clear picture of the group goal and the path to the goal have a closer involvement with the group goal, more empathy with group emotions, and a greater readiness to accept influence from the group than those who are unclear about the goals and paths to their goal. Members who have a correct understanding of the group actions required for goal attainment, and of how their own behaviours contribute to group actions, perform effectively."

The formation of a group goal involves both cognitive and motivational aspects. Cognitive processes are evident in the search for agreement about the facts relevant to the decision. This involves an exchange of information and opinions. The quality of group decision depends in part on an accurate assessment of facts, and reflects intelligent problem-solving. However, even if members could solve their cognitive problems effectively, they may still disagree as to what the group goal should be. If members have conflicting interests, the selection of a group goal will be difficult. The members are likely to bargain, manoeuvre for power and form coalitions in which some part of the larger group acts in concert to determine the outcome. The relative emphasis on cognitive and on motivational processes in decision-making may vary from one group to another and within the same group at different times. Members who are "task-oriented" and "group-oriented" and who see that their basic relationships are promotively interdependent, place greater emphasis on the cognitive aspects compared to the "self-oriented" members (Cartwright and Zander, ibid).
6.3.4 Acceptance of group goals

A member's acceptance of the group goal is dependent on several factors. Firstly, the nature of the member's person-oriented and group-oriented motives. A person-oriented motive means a more-or-less enduring interest that exists whether or not the person is a member of the group under consideration. A group-oriented motive refers to a disposition to be satisfied by group outcomes favourable to the group as a unit. The nature of these two types of motive may be exemplified by considering how they motivate achievement behaviour. A person who is concerned with the quality of his own performance and is satisfied by his personal success has a person-oriented motive for personal achievement. But a person who is concerned about the group's performance and is gratified by his group's success has a group-oriented motive for group achievement. It is right to suggest that a person who has a strong person-oriented motive has a stronger disposition towards achieving his personal goal than one who is influenced by a group-oriented motive. Usually both motives are present in any group goal setting, but if the person-oriented motive is dominant, then the person is less likely to accept or work towards achieving the group goals. Studies of 72 decision-making conferences in business and government led to the finding that groups with high scores on self-oriented need behaviour completed fewer items on the agenda but held longer meetings. They were also less satisfied with the meeting in general, with the decisions reached, with the way in which the groups reached their decision, and with the chairing of the meeting (Cartwright and Zander, ibid).

Secondly, the attractiveness for any given member of a particular goal for the group is also influenced by his judgment of the costs and rewards involved for him,
and the risk of getting involved with the group in pursuit of the group’s goals.
Thirdly, a person is also influenced by his subjective estimate of the possibility that
the group will attain this goal.

6.3.5 Goals and mutual trust in cooperation

It has been established that the initiation of cooperation requires mutual trust. Deutsch (1962) wrote, "... cooperation will not develop unless at least one person initiates it through actions which are clearly recognisable as contributing to the attainment of the mutually interdependent goals. Taking the initiative, however, may involve a cost which the individual would not be willing to bear unless he felt that the others were sufficiently trustworthy to reciprocate with further cooperative actions." In other words, Partner A will only work together with Partner B towards a mutual goal, if he knows for sure that Partner B is also willing to work with him towards the same goal. However, the problem of trust arises when each cooperator is individually oriented to obtain maximum gain at minimum cost to himself (without regard to the gains or costs to the other cooperators), making cooperation unrewarding for all or for some (Deutsch, ibid). This shows that effective cooperation is maintained by a trusting relationship among cooperating members working towards the group goals. But when members are more concerned about their personal goals, and exploiting the cooperation relationship, trust is broken and cooperation suffers.

6.3.6 Success or failure in attainment of goal

When a group adopts a goal and embarks upon a program of actions intended to bring about goal attainment, it may encounter success or failure. When certain group goals are not achievable, members should be prepared to form operational subgoals that have some plausible linkage to the general goal. If the group’s efforts are
successful, members who have accepted the group goal have reason to experience gratification. They may be expected to increase their evaluation of the group, to become more attracted to it, and to set higher aspirations for its future performance. Members of a group that is unsuccessful in attaining its goals on the other hand, experience frustrations, decrease their evaluation of the group, become less attracted to it, and set lower goals for its future performance (Cartwright and Zander, ibid).

6.3.7 Summary of Goals

Group goals have been defined as the aims or objectives toward which group members’ activities are directed. In a cooperative situation, the goals of all the members are promotively interdependent, in that successful attainment of the goals is dependent on the coordinated effort and actions of all the members. Two types of group goals were discussed, namely, achievement goals, and group maintenance goals. Both types of goals are equally important for effective cooperation. Individual members of a cooperating group also have personal goals. When these goals are not compatible with group goals, or when members exploit the cooperating relationship to achieve their personal goals, cooperation may suffer, or deteriorate due to lack of trust. Thus, it is important that group goals are established through participation and communication among members. When members are not clear about the group goals or the actions needed to achieve them, poor coordination leading to group ineffectiveness ensues. Groups are also more successful when the formation of group goals is based on an emphasis on the cognitive processes, and rests on an accurate assessment of facts. When group goals are successfully attained, members are satisfied and set higher aspirations for the group.
6.4 Communication

6.4.1 Definition of communication

Clarke and Smyth (1993) wrote, "A principal feature in cooperative behaviour during problem solving is the mutual creation of a commonly shared environment, where the refinement of solutions can be based on logical argument, and where the resolution between differing perspectives takes place." Communication is an essential feature of cooperation. As discussed in Chapter 4 (Section 4.6), communication is necessary for the enhancement of cooperation. Communication is highly eclectic in that many disciplines involve themselves directly and indirectly in the study of communication (Fisher, 1978). In the work described in this thesis, communication refers to the process of symbolic transactions among cooperative partners engaged in problem solving tasks. Communication is a process of symbolic transaction in that it is a phenomenon which changes over time as a result of many elements, such as information available to the partners, or the behaviour patterns of the partners. The term symbolic transaction is borrowed from Kowitz and Knutson (ibid) and means the encoding and decoding of words, information or actions interchanged between two or more people. Communication as discussed here is within the context of problem solving, where the messages and information exchanged are directed towards achieving the group’s goals, and solving the problems that the group are engaged in. This differentiates it from objectiveless conversation, where the subject matter is not predetermined and is only of incidental importance.
6.4.2 Model of communication

The Adler and Rodman (1988) communication model (Figure 6.3) provides a simple representation of the processes of communication. Firstly, communication involves at least two individuals who have agreed to exchange messages and to respond to them. Partner A starts by encoding his idea or intended messages into symbols that could be understood by Partner B. This message is then sent via the communication channels, which could be writing, telecommunication, or speaking. When the message reaches Partner B, he has to decode the message back into feelings, intentions, or thoughts that mean something. This process is cyclical and both partners often send and receive messages simultaneously. Adler and Rodman (ibid) defined the environment in which the communication takes place as "... the personal history that each person brings to a conversation." The overlapping environments represent those experiences and shared knowledge that the partners have in common to enable the communication to take place. A successful transaction would be said to have occurred when what partner A intended to communicate is what is actually received by partner B. However, very often messages are misinterpreted and this could be caused by factors which interfere with the communication process. Adler and Rodman (ibid) named these factors "noises," which could be external, physiological, or psychological.

6.4.3 Communication in cooperation

Clarke (1988) noted two goals underlying discourse during cooperative problem solving, namely task directed cooperativity (TDC) and belief maintenance cooperativity (BMC).
Like goals and informational norms, TDC aims to facilitate an efficient performance of the problem solving task. Here communication centres around the goals that the partners are trying to achieve and means of achieving them. Members exchange basic information relevant to the task, propose and generate possible solutions to the problems, and discuss the implications of the solutions.

BMC aims to foster mutual representations between the partners for effective communication to take place. Oberquelle et al (1983) stated that "Communication depends on comparable premises for understanding. Successful communication is based on a similar use of language and world knowledge by all participants."

This is shown in the communication model (Figure 6.3) as the Shared Environment. The purpose of BMC is to achieve common understanding among the cooperating partners, and to widen and enhance this shared environment. Partners paraphrase and clarify messages to ensure that they are correctly decoded and interpreted.

Another characteristic of communication is that sometimes partners refer to the communication process itself. This was termed meta-communication by Oberquelle et al (ibid). During a conversation, partner A might say to partner B, "Can you please speak a little louder?" Meta-communication is important for improving communication conditions. It makes communication more efficient.

Communication in cooperation also serves to enhance interpersonal relationships among partners to cultivate a better working environment. This helps the group to achieve their task effectively, and also raises satisfaction of the members of the group.

Whether members communicate about the task, or the process, they make statements of facts, opinions or advice. Statements of fact refer to "the descriptive realm of our reality and may be shown to be true or false." Statements of opinion
express value judgements, beliefs and attitudes, and these statements cannot be shown to be true or false. They are evaluated by their desirability or appropriateness. Lastly, statements of advice propose courses of action. Kowitz and Knutson (ibid) contended that all three types of information are needed for effective group decision making. "Statements of fact give your group an accurate and objective description of its task. Statements of opinion identify values, beliefs and attitudes related to the task. Statements of advice specify the options open to the group. When a task-oriented group has an accurate description of its task and a clear picture of related values, beliefs and attitudes, it is in a better position to evaluate proposed courses of action" (Kowitz and Knutson, ibid).

Figure 6.4 provides a model of Partner A and Partner B working towards attainment of the common goal \((G_{AB})\): moving from an initial state to the desired or final state. The process of working on the goals is given the term Goal Oriented Working (GOW) by Clarke and Smyth (ibid) and is adopted here. The general term communication is used in the model to represent the exchange of all the messages and information that have been described in this section. Shared environment and meta-communication between the two partners are also represented in the model.

6.4.4 Cooperation in communication

The communicative behaviour between cooperating participants is both interactive and interdependent. The response of one individual is the cue for the response of the other, which in turn becomes cues for the response of the first. Within the cooperative process, an absolute requirement of communication is for these responses to lead to mutual and positive reinforcement (Clarke and Smyth, ibid).
Figure 6.4: Communication in cooperation

GOW = Goal Oriented Working
\( G_{AB} \) = Common Goal
Communication requires cooperation between the communicating partners. Argyle (1991) wrote, "In order for A to communicate with B, A must send signals which B can understand, and B must be willing to attend to them and decode them. This is equally true of verbal and non-verbal signals, though the two are intricately linked in the process of on-going social interaction. Interaction requires further kinds of cooperation, in order to produce a sequence of social signals that make up an acceptable conversation and enable those involved to achieve their goals." In a conversation, each person is trying to achieve the goal of providing the desired responses from the other. However, because both are usually pursuing their goals simultaneously, they must synchronise their communicative behaviour by taking turns to speak and to listen.

Grice (1975) provided the same argument when he stated that, "Our talk exchanges do not normally consist of a succession of disconnected remarks, and would not be rational if they did. They are characteristically, to some degree at least, cooperative efforts and each participant recognises in them, to some extent, a common purpose or set of purposes, or at least a mutually accepted direction." He suggested the cooperative principle which participants are expected to observe, namely, "Make your conversation contribution such as is required, at the stage which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged." Grice (ibid) identified four categories under which more specific maxims and submaxims can be organised:

A. Quantity

This relates to the quantity of information to be provided. The maxims are, "Make
your contribution as informative as is required," and "Do not make your contribution more informative than is required." This rule guards against information overload and confusion.

B. Quality

Into this category falls the maxim "Try to make your contribution one that is true," and two other sub maxims, "Do not say what you believe to be false," and "Do not say that for which you lack adequate information."

C. Relation

The single maxim "Be relevant" falls under this category. One expects his partner's contribution to be appropriate to the immediate needs at each stage of the transaction.

D. Manner

This relates to HOW what is said is to be said. Grice (ibid) included several other maxims here, namely, "Be perspicuous," "Avoid obscurity of expressions," "Avoid ambiguity," "Be brief (avoid unnecessary prolixity)" and "Be orderly."

Argyle (ibid) contended that there is probably quite a lot of cultural variation on such rules and that people are often not entirely open, helpful or frank. Also, Argyle (ibid) expressed that "If conversationalists did keep to Grice's rules all the time it would make for very boring, formal kinds of conversation; no jokes, metaphors, amusing exaggerations or irrelevancies. But, above all, these conversations would be regarded as very impolite." It is true that Grice's maxims are not exhaustive, as Grice himself stated that, "There are, of course, all sorts of other maxims (aesthetic, social or moral in character), such as 'be polite' .... " Grice's
maxims, however, can serve as guidelines for specifying the communication requirements of the human-computer cooperative system, where the style of communication is more formal and structured.

6.4.5 Factors affecting communication

There are many factors (or "noises") that can cause ineffective communication. These can be psychological, physiological or external. Messages could be interpreted one way or another depending on a person's beliefs, values and plans. Psychological "noises" could stem from a person's unwillingness to be objective or to tolerate alternative positions and ideas. Physiological noises could be due to loss of hearing or illnesses. External factors that could affect communication are the number of people engaged in the conversation at the time, or how they are seated, or even the environment in which the conversation takes place. To ensure that participants accurately encode and decode the messages passed, participants should make the effort to question, paraphrase or make clarifications.

6.4.6 Summary of Communication

Communication is used here to refer to the process of symbolic transactions among cooperative partners occupied in problem solving tasks. Cooperative partners in a group establish goals and means of achieving them. They also ensure that all partners have a shared environment such that misinterpretation and misrepresentation of messages is kept to a minimum. Communication is also directed towards creating better working relationships among participants. The communicative behaviour between participating individuals is both interactive and interdependent. Hence, communication also requires cooperation between communicating partners. Grice's conversational maxims (quantity, quality, relation and manner) should be observed.
for effective communication to take place. However, effective communication cannot be guaranteed as it could be affected by physiological, psychological and external factors.

6.5 Norms

6.5.1 Definition of norms

A norm is a rule or guideline that governs the conduct of every member in a group. It is described by Homans (1950) as "... an idea in the minds of the members of a group, an idea that can be put in the form of a statement specifying what the members should do, ought to do, are expected to do under given circumstances."

6.5.2 Importance of norms

Norms are important because they let individual members know the forms of behaviour that are acceptable or not acceptable, especially in a novel or ambiguous situation. For cooperation to be successful, a high degree of predictability of conduct is needed, and hence setting norms helps to bring order and predictability. Norms are also closely tied to the goals of the group. Norms encourage goal-facilitative actions and coordination of efforts from its members, once the group have developed a clearly defined goal (Brown, 1988).

Norms also help a group to maintain and create a social reality for itself (Cartwright and Zander, *ibid*).
6.5.3 Emergence of norms

Human action is social in character insofar as it takes into account the existence of other people, their expected responses to one’s behaviour, and the shared meanings they place upon these actions (Birenbaum and Sagarin, 1976). Hence, as a group of people interact across time, they create relatively common expectations of behaviour. As the group begins to familiarize itself with its goals, personnel, environment, and procedures, members engage in considerable communication. And as members of the group figure out the manner in which to engage in communication, they either explicitly or implicitly agree on certain group regulations or standards. They begin to make value judgements about what should be done. These judgements, when reinforced through the agreement of a majority of the participants, result in the group norms. In short, norms emerge through interaction and reinforcement during the early stages of the group’s life span.

Groups do not form norms randomly. Nor do they create norms for every possible situation. Groups form norms about behaviours that have a special significance for the group. A group working to solve a particular problem establishes norms emphasizing the information and procedural dimension of small group communication. Norms tend to be those rules of conduct that the group members agree as being important and rewarding. The group perceives norms as regulations designed to facilitate goal achievement (Kowitz and Knutson, ibid). According to Cartwright and Zander (ibid), members who agree upon a goal for their group become aware that the benefits for all depend upon the efforts of each (i.e. they are interdependent) and thus a norm to help one another is established.
As with goals, individual norms could also be transformed into a single, group norm. Ellis and Fisher (1994) wrote, "People come to the group with attitudes and opinions, and these are transformed by the process with interacting with others. Individuals' attitudes and opinions converge toward agreement with others, and the group transforms individual attitudes into group held norms."

6.5.4 Types of norms

Norms can be explicit or implicit. Explicit norms are formal regulations clearly spelt out for the group members either in writing or distributed through conversation. For example, student societies in universities have written constitutions stating how annual general meetings should be conducted and what is expected of members in the group. Implicit norms are never explicitly stated in writing or speech, but are nevertheless important. For example, a person would not say something vulgar in a Bible study group meeting even though this norm is not explicitly stated. Both types of norms are learned and have rewards and punishments associated with them.

Norms are both proscriptive and prescriptive (Birenbaum and Sagarin, ibid). The former are those that forbid an action. For example, "You shall not impose your ideas on the group." Prescriptive norms, on the other hand, can be described as more positive in the sense that they indicate what should be done, and when followed, usually bring approval from group members.

Norms, both explicit and implicit, have also been categorised as informational, procedural and interpersonal (Kowitz and Knutson, ibid). This categorisation is especially useful for formalising norms. Informational norms reflect a common set of beliefs, values and plans about the substance of the group's task. These norms guide and direct the group's consideration of issues related to their task. Information
will be considered important or unimportant given these norms. Other items of information will simply be ignored. Under informational norms, information presented by members of the group is carefully analysed. According to Kowitz and Knutson (ibid), failure to develop this norm will probably result in failure to question evidence, and as a consequence the quality of the group's solution suffers. They stated that "A group that continually accepts information uncritically from only a few of the members invariably winds up dissatisfied or, even worse, embarrassed at the effectiveness of the group's output." Therefore, it is important to make informational norms explicit.

**Procedural norms** deal with control and decision making. They outline how the group should operate in achieving the group goals. They reflect expectations about information search, information processing and decision making. For example, will the group make decisions by accepting the vote of the majority, or will the members keep talking until consensus is reached? Lastly, **interpersonal norms** are rules that regulate the affective, personal relationship among group members. Adler and Rodman (1988) refer to these as **social norms**. How honest and direct will members be with one another? What emotions will and won't be expressed, and in what ways? If a group finds that joking helps to reduce the early tension, humour may emerge as a norm to be employed in future situations characterized by tension. Kowitz and Knutson (ibid) warned that if the group relies too heavily on interpersonal norms, it may find itself making slow progress on the informational and procedural dimensions of the discussion. It is advisable to cultivate those interpersonal norms that assist the group in reaching its goals. The model of cooperation in Figure 6.5 includes the functions of these different types of norms in governing the behaviour of two partners.
Figure 6.5: Norms governing behaviour in cooperation

\( N_I \) = Information Norms
\( N_P \) = Procedural Norms
\( N_{IP} \) = Interpersonal Norms
GOW = Goal Oriented Working
\( G_{AB} \) = Common Goal
6.5.5 Conformity and deviance from group norms

As interaction progresses, members of a cooperating group begin to create systems for solving problems, and develop norms that contribute to the effective and efficient completion of the task. Members become interdependent and rely on each other for successful group work (Kowitz and Knutson, *ibid*). Therefore, members are required to be committed and conform to the group norms. Individual members who fail to comply will be regarded as deviant and a hindrance to successful completion of the task. The non-conformist will be put under pressure to conform to the group norms. Tubbs (1978) described four stages of conformity pressure. The first stage is *reason*, where the deviant is convinced that he is wrong. At this stage, the deviant is expected to change to conform to the group. The second stage is *seduction*. Here, attempt is made to appeal to the deviant's social needs. Comments such as, "Come on, be a sport, you don't want to put us in a difficult position, do you?" are made. The third stage, is *coercion*, where group members "lose their smiles and good nature." The comments begin to take the air of threat, before going on to the final stage, which is *isolation*. This tactic may finally bring conformity if the ostracism is prolonged. Enforcing punishment to ensure conformity may not be a good idea, especially if the deviant person has valuable contributions that he could make to the group. Punishment such as isolation also causes interpersonal conflict, which interferes with group task progress. Reinforcement, which involves compliments and agreement given to members who behave according to group norms may be more appropriate and effective in securing compliance. Another tactic is withholding responses to the deviant member, who may be engaging in the deviant behaviour to bring upon attention to himself or herself.
Conformity by itself is not as important as the norms to which people conform (Kowitz and Knutson, *ibid*). The uncritical acceptance of norms frequently causes problems because members blindly adhere to unquestioned standards of behaviour. The *groupthink* phenomenon is perhaps the most dramatic consequence of pressures to conform to group norms, especially in cohesive groups (Ellis and Fisher, *ibid*). Groupthink occurs when members are very attached to the group, and have reaped many benefits from the group. They have developed the norm of "not rocking the boat," discouraging conflict and individual's opinions. Ellis and Fisher (*ibid*) listed four norms that establish conditions for groupthink to occur:

1. **Mindless cohesion.**
   When a group is extremely optimistic and committed, members feel that the group can do no wrong, and dismiss anything that might threaten the group. Members conform to the norm of cohesion, rather than in critically examining their decisions.

2. **Pressuring nonconformists.**
   Subtle pressure (such as frowning) or direct pressure (such as expulsion) is applied on group members to go along with the group. Self-censorship, where members avoid expressing their own opinions occurs.

3. **Failing to reward critical thinking.**
   When group members give in to strong leaders, who discourage honest opinions, the quality of the group decisions suffers. The group and its leader feel invulnerable, which is a classic symptom of groupthink.

4. **Tendency to justify what they have done.**
   Groupthink produces poor decisions when information that is inconsistent
with an established idea is discounted. True consensus which emerges from discussion and critical evaluation of information, were never reached. The group blindly believes that what it has done in the past is best. Groupthink decisions emerge from rationalisations.

Groups that experience groupthink are quick to agree with one another. Members fail to analyse issues critically, and have "an unhealthy fear of argument" (Ellis and Fisher, *ibid*). In order to avoid groupthink, Ellis and Fisher (*ibid*) recommended that members find the right balance between conformity and critical analysis. Members should be encouraged to critically evaluate the kinds of norm that they are required to conform to.

**6.5.6 Summary of Norms**

Norms are the rules or guidelines that govern the conduct of every member in a group. They are important because they encourage goal facilitative actions and help the group maintain a certain degree of predictability of conduct. Norms emerge through interaction and reinforcement. Group norms, like goals, are also transformed over time from norms held by the different members of the group. Norms can be explicitly stated or implicitly learnt. They have also been categorised as informational, procedural, and interpersonal. It is recommended that informational and procedural norms be made explicit for effective cooperation. It is also more conducive to cultivate interpersonal norms that facilitate the group towards reaching the group's goals. Members may use different strategies to ensure that other members conform to the norms they have established. However, uncritical conformity to norms can lead to groupthink. Groupthink occurs when members constantly "flow with the tide," and are discouraged from voicing their individual opinions.
decisions suffer when information and opinions presented are not critically analysed, and true consensus was never reached. The right balance between conformity and critical analysis needs to be established to avoid groupthink.

6.6 Roles

Unlike norms, which are expectations governing how each group members should or should not behave, roles are expectations that group members hold about particular people within the group. Roles are differing functions that individuals assume in helping the group move toward its goals (Kowitz and Knutson, ibid). Ellis and Fisher (ibid) defined roles as "a set of communicative behaviours performed by an individual, and that it involves the behaviours performed by one member in light of the expectations that other members hold toward those behaviours." A role is a behavioural concept; it's defined in terms of behaviour, and position (Ellis and Fisher, ibid). When a person's behaviour is similar to what other members expect, that behaviour can be considered to be role behaviour. But if a person does something that others didn't expect, his behaviour would be considered as "out of character." In a group setting, a person is also required to fulfil certain positions, e.g. leader of the group. When the person's behaviour in such a formal role is not consistent with the other member's expectation of the behaviours that should be performed by a person occupying that role, then it can be said that that person is not fulfilling his role obligation. For example, a leader who is not doing his leading. Each role is also defined in terms of the communicative behaviours engaged in by the member occupying the role. For example, a person playing the role of the encourager would make statements such as, "Good idea. That was very helpful."
6.6.1 Classification of Roles

Group task roles are behaviours related to the accomplishment of a group’s goals. These roles are task oriented. Group building and maintenance roles are behaviours which contribute to the functioning of the group by striving to maintain constructive interpersonal relations. These roles help alter the way of working, and to strengthen, regulate and perpetuate the group. A third classification of roles is self-centered roles or individual roles. These are behaviours that seek to satisfy individual’s needs rather than to contribute to the needs and goals of the group. Some examples of the three different types of roles are given below (after Kowitz and Knutson, *ibid*; Tubbs, *ibid*; Ellis and Fisher, *ibid*):

**Group Task Roles**

a. **Initiator-contributor**: Suggests new ideas and different ways of thinking about the task or task goals. Proposes solutions and new approach to the task.

b. **Information giver**: Provides and contributes important and relevant information based on experience or authoritative sources.

c. **Opinion giver**: States beliefs or opinions relevant to a suggestion made. Clarifies the values pertinent to the group’s task or proposing values the group should adopt in reaching a decision proposal.

d. **Information seeker**: Asks for clarification, for authoritative information, evidence, and facts relevant to the problem being discussed.

e. **Opinion seeker**: Seeks information relating to the values underlying the suggestions being made.
f. **Evaluator-critic:** Evaluates and questions the adequacy of information presented or the logic and procedure of a suggestion. Applies critical standards.

g. **Elaborator:** Expands on suggestions with examples or restatements. Clarifies and offers a rationale for previously made suggestions.

h. **Coordinator:** Integrates the various ideas and suggestions, and coordinates the activities of group members.

**Group Building and Maintenance Roles**

a. **Gatekeeper and expediter:** Encourages members to relate their research and opinions to the group. Attempts to keep communication channels open by encouraging the participation of some or by curbing the participation of others.

b. **Delegator:** Organises the group’s activity by assigning responsibilities to group members.

c. **Conflict manager:** Helps to resolve and mediate differences between members’ opinions and attempts to reconcile disagreements.

d. **Process evaluator:** Assesses the effectiveness of the group’s discussion pattern, work habits and decision-making rules.

e. **Tension releaser or Harmonizer:** Relieves tension by use of humour or other means.

f. **Encourager:** Praises, shows interest in, agrees with, and accepts the contributions of others to reinforce the work and behaviour of other group members.
Self-centered or Individual Roles

a. **Aggressor**: Criticises and attacks other group members in order to enhance his or her own status.

b. **Recognition Seeker**: Seeks to enhance his own status by citing past accomplishments.

c. **Blocker**: Does not cooperate, and opposes much of what the group tries to do.

d. **Dominator**: Monopolises the group with suggestions on how to do everything.

It is important for group members to cultivate a diversity of task roles and group building and maintenance roles, while avoiding self-centred roles. A role structure that encompasses functions from all the three dimensions mentioned above increases the effectiveness of the group in accomplishing its goals (Kowitz and Knutson, *ibid*). Group productivity will fall if all the members try to mimic each other in their behaviour. Figure 6.6 expands the model of cooperation to show the two broad categories of roles that the partners should assume for effective cooperation.

**6.6.2 Emergence of Roles**

Roles, like norms, emerge through interaction and reinforcement. When the group first meets, members try out various behaviours, and the group, (through reinforcement of individual behaviour) actually determines or teaches the roles that emerge. A member will repeat roles that were positively reinforced, and other members will begin to expect this person to behave in a similar fashion in the future. It is vital that the members do not reinforce roles that will hinder the group towards its
Figure 6.6: Task and/or maintenance roles assumed by partners for effective cooperation.
goals. For example, when an individual concentrates on seeking recognition for himself, the group should not support this behaviour which is detrimental to the effectiveness of the group.

6.6.3 Roles stabilisation

If roles in a group do not stabilise, much of the group's time will be spent deciding who will do what. Conflict will occur and members will have difficulty assessing their progress towards the group's goal. Role stabilisation is important in that it increases a group's progress towards its goals and members' satisfaction.

Role stabilisation is affected by two factors. Firstly, members must behave in roles that satisfy their needs and secondly, these roles must enable a group to move towards its goals. For example, if the members are satisfied with their roles, but the group is not making progress in achieving their goals, these roles will have to change. And if the group is successfully advancing towards its goals, but members are highly dissatisfied with their roles, then members will have to change their expected behaviour too. Stabilisation of member roles is a good indicator that member needs and group goals are being met.

6.6.4 Role conflict

Role conflict occurs when an individual is expected to simultaneously meet role expectations that are inconsistent or contradictory. The conflict results from the pressure to behave in opposing ways at the same time (Barker, et al, ibid). A student who had been asked to invigilate an examination may experience conflict when he catches his friend cheating. He is caught between fulfilling his role as a friend, and an invigilator at the same time. Conflict may also occur when other members hold
contradictory expectations for the same role. A leader of the group may be expected to be firm, yet understanding. Role conflict can also occur when a person is required to fulfil a role which is incompatible with his own personality. For example, a person who considers himself as friendly, may find it hard when appointed to confront another frequently-absent-member of the group. For effective cooperation towards the group goals, it is important to ensure that every member is satisfied with the role, or roles that they have been given.

6.6.5 Summary of Roles

Roles are the common set of expectations that group members hold about the behaviour of its members. Roles emerge through a process of interaction and reinforcement. There are generally three classification of roles, namely, group task roles, group building and maintenance roles, and self-centered roles. Members should be encouraged to cultivate a diversity of task roles, and group building and maintenance roles. However, members should only reinforce roles that do not hinder goal attainment. A good indicator that member needs and group goals are being met is the stabilisation of member roles. It is also important that members are not expected to fulfil roles that are in conflict with each other, and that are not compatible with the personality of the member.

6.7 Conflict

Interaction in small problem solving groups involves exchanging ideas, opinions, proposals, or suggestions. Some of these are accepted, others are discarded or modified. Inevitably conflict will occur, but this is not necessarily bad. It is naive to assume that members agree with each other all the time.
Conflict occurs when there is personality and emotional clashes among group members. Members resort to name-calling, and expressions of personal dislike and make derogatory remarks. These conflicts can be detrimental to the group. Conflict also occurs when members disagree over the content (e.g. facts, opinions, beliefs) of the group discussion, or members misinterpret substantive material. Members also sometimes disagree on the group goals and ways of achieving such goals. Schultz (1989) noted that conflicts over goals can perhaps be more serious than conflicts over means. However, conflict over ideas or issues associated with the tasks and goals of the groups often serves as a means toward accomplishing those goals. Conflict also reflects that members in the group are oriented toward a common interest and are cooperating with one another. Ellis and Fisher (ibid) wrote, "... conflict, in terms of interaction sequences, required a certain amount of cooperation in order for it even to occur. When people are engaged in substantive conflict over ideas, they are engaged in communication with one another. In the process of communication, they are essentially cooperating with one another."

6.7.1 Advantages and disadvantages of conflict

If properly managed, conflict is potentially beneficial to the group. Ellis and Fisher (ibid) listed some advantages of constructive conflicts:

A. Increased understanding of issues.

Conflict helps members to look at the differing ideas and opinions, and forces them to clarify their own positions. Conflict helps members understand the issues better as they are presented and critically assessed.
B. Improved decision quality.

Conflict over ideas causes members to search for more alternatives which improves the quality of the group decision. Schultz (ibid) believed, "... groups can make better decisions when they care enough to argue about alternatives." Conflict encourages members to challenge each other's ideas, and stimulates members to test their ideas. Key issues and points of misunderstanding are exposed as members explore why they disagree. Conflict acts as a check against a group's premature consensus. Conflicts helps to eliminate the groupthink phenomena.

C. Increased cohesiveness.

When members are able to share differences, and there is support for such expression, this serves to increase interest and cohesiveness of group members. Ellis and Fisher (ibid) wrote, "It may be said with some confidence that the cohesive group thrives on social conflict, or in more memorable words, 'The group that fights together stays together'."

D. Increased interest and motivation.

Conflict is a good indication that group members are concerned enough about the task to speak up. Members' interest is aroused as they learn more about the issues and explore options together.

However, if conflict is not managed properly, it can cause frustration, hostility, and, worst of all, it could hinder the group from achieving its goal. Sometimes members can spend too much time arguing over issues that are not directly relevant or of phenomenal importance to the task.
6.7.2 Management of conflict

Many different approaches have been suggested for managing conflict (Tubbs, *ibid*; Schultz, *ibid*; Ellis and Fisher, *ibid*). One important step is to have a positive attitude about the usefulness of conflict. In other words, members should "agree to disagree." Sometimes it is necessary for groups to reduce their hostile behaviour toward each other by taking a step back and looking for the issues that the members can agree on, which are the group goals. Schultz (*ibid*) wrote, "To make conflict a useful part of a group's process, a group must learn not only to accept differences but to confront those differences so that they may be worked out. Participants must learn how to be cooperative and to trust, to be flexible and empathic toward the views of others; but a willingness to be cooperative does not negate using conflict to reach effective solutions." In other words, conflict management involves communication, commitment, and cooperation among members in the group.

6.7.3 Summary of Conflict

Conflict inevitably occurs among members in small problem solving groups. Conflict which involves intellectual opposition over ideas and issues often serves as a means towards accomplishing group goals. As members work out their differences in opinions and searches for alternative solutions, members are able to understand the issues better, and the quality of the group decision improves. The group also becomes more cohesive, and members become more motivated and interested in the group task. However, if conflict is not properly managed, it can cause frustration, and hinder the group from achieving its goals. Conflict management involves commitment, communication and cooperation among the group members.
6.8 Distribution and Coordination of responses

A person working alone can explore possible solution paths in an erratic manner, but when working with others, one has to be predictable for others to anticipate one’s actions, and to coordinate interactions. Argyle (ibid) wrote, "In a sense all social interaction and communication require a minimum level of coordination, ... cooperation fails when there is an absence of social skills, especially extreme cases like schizophrenia and autism, where there is very poor synchrony and little gaze." Coordination is an essential part of cooperation.

Cooperation in a task may take several forms. A familiar metaphor would be a group of human experts working together to complete a task. The experts can assist each other in many ways. First they can divide the task into sub-tasks and each person work alone on the various sub-tasks, and when these are completed, the results can be pooled. Or they may periodically report to each other the partial results they have obtained during the execution of the individual task. Smith and Davis (1981) called these two forms of cooperation "task sharing" and "result sharing." The first type of cooperation can also be seen on assembly lines where labour is divided into small units.

A form of cooperation which has been emphasised in this thesis is simultaneous cooperation, where the experts work together on the task at the same time. Within this form of cooperation, task and result sharing also occur but in sporadic fashion. Another form of cooperation is the simultaneous performance of different but complementary tasks (Argyle, ibid) for example, cooperation between pilot and navigator of an aeroplane, or cooperation among surgeons and nurses in performing surgery.
Whatever the form of cooperation, the distribution of activities and coordination of actions is very important. Activities need to be synchronised, and the different feedbacks need to be considered together. This is to avoid "mimicry" and duplication of work. Coordination is also important to ensure that partners do not "get in each other's way." Coordination of activities and communication helps to avoid confusion and conflict. Coordination is essential for partners to work in a coherent fashion, and coherence requires that each cooperating partner is performing activities that generate tentative partial solutions compatible with the goals of the group. Poor coordination could be a result of members not accepting the group's goals and thus engaging in self-oriented, rather than group task oriented behaviour (Cartwright and Zander, *ibid*). Poor distribution and coordination of activities result in partners not knowing what to do, work is unnecessarily duplicated, and partners work at cross-purposes with one another. Effective coordination implies some degree of mutual predictability and reduction of conflict. The more conflict which has to be solved or managed, the less well coordinated the partners. Nylund (1989) discussed three criteria for a successful network coordination, and these criteria are just as important for successful coordination among cooperating partners. These are:

1. **Coverage:** All portions of the overall problem must be included in at least one partner's activities.

2. **Connectivity:** Partners must interact in a manner which permits activities to be developed and integrated into overall solutions.

3. **Capability:** The above mentioned factors must be achieved with the communication processing resources of the cooperating partners.
Coordination is rarely successful without the use of cues to synchronise activities (Marwell and Schmitt, 1975). For example, mechanical cues are used in an assembly factory. For social coordination, norms governing behaviour are used as social cues.

In summary, coordination is an important requirement in cooperation to avoid duplication of work, or members working at cross purposes with each other. Coordination is also important as predictability of behaviour is essential in cooperation, as discussed in Section 6.5 regarding norms governing behaviour.

6.9 Summary and Discussion

Every element of cooperation that has been discussed involves a task dimension and a social dimension. For example, there were task goals and group maintenance goals; task roles, and group maintenance roles; informational and procedural norms, and social norms, etc. Cooperation involves interdependence among individuals. Every person's actions and behaviour affect and influence the other members of the group. Whereas the task dimension relates to the work they have to perform, the social dimension relates to the working relationships among the partners. Therefore the task and social dimensions are highly interdependent, and it is difficult to separate the two. Both dimensions are equally important in moving the cooperating members towards their goals. Therefore to ensure effective cooperation, issues related to both dimensions have to be considered.

Groups have often been viewed as a system (Tubbs, ibid; Ellis and Fisher, ibid). The first principle of systems, according to Ellis and Fisher (ibid), is wholeness: every component of the system affects and is affected by every other component and that a change in one component necessarily effects changes in all other components.
They wrote, "A system is composed of interdependent parts that function as a whole unit. Because all the parts are related, focusing on one part to the exclusion of another distorts the functioning of the system." In that sense, cooperation can be viewed as a system. The variables that influence cooperation can be divided into three broad categories of elements: **Entry elements, Process elements** and **Outcomes**. Figure 6.7 shows how the factors that have been discussed in this chapter and chapters before, relate to each other in the cooperative system. Entry elements are the variables that are present before cooperation begins. Process elements are the actions of the partners that bring about changes (or outcomes) in the system. For example, the common goal changes from an initial state to a final (achieved) state through these processes. Outcomes are what the partners produce and achieve. Cooperation is **dynamic** in that entry elements affect the process elements, which in turn affect the outcomes of the cooperative system, which are then fed back into the loop to alter the initial influences in the system.

From the discussions of the processes underlying cooperation in small problem solving groups in this chapter, the following conclusions can be made:

1. The existence of a common goal (or a set of common goals) is a prerequisite for cooperation. Members' activities are directed towards achievement of these goals. Effective cooperation refers to the successful attainment of these goals from the process of working together.

2. For effective cooperation:
   a. Partners should have a clear picture of the common goals, and the path that leads to the goals. Thus, participation of partners in the formulation of these goals are recommended.
Figure 6.7: Cooperation as a system
b. Partners should perceive that their goals are congruent, and that each partner is able, willing and interested to work towards achievement of these goals. Participation of members in construction of goals produces greater acceptance and commitment to the goals.

c. Partners must be allowed to communicate with each other.

d. Communication about the task, as well as communication to foster interpersonal relationships should be encouraged.

e. Partners should have a shared environment for effective communication to take place. Communication should serve to enhance and expand this shared environment.

f. Meta-communication which assists in reducing "noise" that affects communication must not be ignored.

g. For effective task directed communication, rules that govern the communication processes (such as Grice's maxims) should be observed.

h. A high degree of predictability of conduct is needed. Thus, informational, procedural, and interpersonal norms which encourage goal facilitative actions, and help the partners maintain predictability of behaviour should be established. Behaviour which is detrimental to cooperation should not be sanctioned.

i. Partners should be encouraged to critically evaluate the kind of norms that they are required to conform to in order to ensure that the groupthink phenomena does not occur.

j. Partners should not mimic each other's behaviour. A diversity of roles encompassing the task and interpersonal dimensions which bring a variety of information and styles of exchanging information, and serve to enhance the productivity of the partners, should be cultivated.
k. Partners should only be encouraged to play roles that are complimentary to each other and to the personality of the member, and which enhance task performance.

l. Constructive conflict over ideas should not be suppressed. In other words, partners should be encouraged to disagree with each other, to present different opinions, and to search for alternative solutions. As mentioned in Chapter 5 and Section 6.2 in this chapter, the ability to exchange and criticise ideas are part of the many advantages of cooperative work.

m. Activities of the partners need to be synchronised, and well coordinated to avoid duplication of work and conflict of actions. Coordination can be regarded as a procedural norm which calls for predictability of behaviour in cooperation.

6.10 Concluding remarks

In Chapter 3, exploration of the theories of cooperation and other related phenomena, and the study of animal cooperation led to the conclusion that:

- cooperation is a form of behaviour involving more than one member;
- it involves a common goal or set of goals (which are not necessarily explicit) that the cooperating members work towards;
- cooperating partners are interdependent; one person’s actions affect another, and vice versa;
- certain underlying processes exist in cooperation;
- cooperation occurs for different purposes; and,
- certain rewards are associated with cooperation.
Chapter 4 discussed the external factors (e.g. partner’s perceptions of each other) and internal variables (e.g. race or personality of the person involved in cooperation) that affect cooperation. The rewards associated with cooperation were elucidated in Chapter 5. In this chapter, the types of task that are more suitable for cooperation were identified, and the underlying processes of cooperation were expounded. In this chapter, the aim has been made to relate all these elements of cooperation by conceptualizing cooperation as a system, with entry and process elements which affect the outcomes (Figure 6.7). A model of cooperation showing its underlying mechanisms has also been offered (Figure 6.6). This model provides the framework with which to discuss and formalise the underlying mechanisms of human-computer cooperation. Together with this, the software exemplar which was developed to demonstrate the working of these mechanisms will be discussed in Chapter 8. In the next chapter, the screen design task which was chosen as the task domain with which to develop the exemplar is described.
Chapter 7: 

Experimental Investigation of Cooperation in Screen Design 

7.1 Introduction

Having extracted from the literature the factors underlying cooperation, it is necessary to develop a software exemplar to represent these factors in the form of mechanisms. As established by Clarke and Smyth (1993), it is not practicable to produce a general-purpose cooperative system. Specific task domains must be addressed. Hence the task domain of screen design was chosen, and the following section discusses the reasons for choosing this particular task domain.
7.2 Why screen design?

During human-computer interaction, the user and the system most commonly communicate with each other via the visual display terminal. What information or data is placed on the display, how it is structured, and where it is located is called screen format design. Well-designed human-computer interfaces can make a substantial difference in learning time, performance speed, error rates, and user satisfaction (Galitz, 1989). Designing comprehensible and meaningful screen layouts implies taking into consideration the limited capabilities of the human information processing system. However, very often screen design responsibility has been left to the programmers, or system analysts, who may not understand or neglect the human factors involved. In a survey via electronic mail, Van der Velden (1991) asked, "Do user interface designers exist in real life?" The general consensus was that they do exist, but there are not many of them. One company had exactly one user interface designer out of 5,000 engineers and 22,000 employees. The majority of interface design is still done by application programmers. A study by Molich and Nielsen (1990) on the identification of human-computer dialogue design problems, concluded that, "... many designers and programmers are not sufficiently aware of the importance of designing dialogues in a way that would either prevent or tolerate errors."

Screen design guidelines and standards have been compiled in an attempt to distil human engineering knowledge into a form useful to software developers. Tullis (1988) provided a short review on the coverage and application domain of some of these guidelines. Mosier and Smith (1986) conducted a survey on the usefulness of guidelines and how they are used. The conclusions drawn were that design guidelines for user interface software have proven useful. Respondents have
read them, used them, plan to use them again, and have recommended them to others. However, the results have also highlighted the two main criticisms of guidelines: they are too general for specific application, and they are often not well presented. As guidelines are written by human factors specialists, they find it easier to understand and reword general guidelines to make them more specific. Software designers, on the other hand, have difficulty in tailoring these guidelines to their own specific needs. Similar to manuals, guidelines are often bulky and cumbersome, and it is not surprising that only 58% of Mosier and Smith's survey subjects were successful in finding what they were looking for. Some respondents suggested that the guidelines be made available as an on-line data base, with appropriate computer aids to permit selection of applicable subsets. This need for designing better computerised screen design tools has also been expressed by Tullis (ibid).

Having reviewed the general concepts of design and design methodology, and studied the psychological aspects of design, Tunnicliffe (1990) concluded that, design is an ill-defined problem. He believed that many designs are executed without necessary and relevant information being taken into account. He cited Landsdown (1988), who wrote, "Indeed it is clear that most design failures arise not because designers are working to the boundaries of current knowledge in their particular disciplines. They generally arise because designers have not employed well-understood and often well-documented principles, procedures, and practices." Tunnicliffe (ibid) noted that his review had highlighted the need for computer tools to aid the design process to overcome such problems.
In summary, guidelines have been found to be useful. However, they are often bulky and not well presented; users find it cumbersome to look for specific guidelines. The need to provide these guidelines as an on-line data base, and better screen design tools have been noted.

Galitz (ibid) asserted, "Design of the human-computer interface still remains more an art than a science." Screen design requires creativity and inventiveness. Galitz (ibid) argued that even if a screen is designed with adherence to all the relevant rules and guidelines, it may still be appalling to look at, though easy to use. Therefore, it is not possible to build an expert system that generates a perfect set of screens. Design trade-offs must be made.

Screen design is chosen as the candidate task domain for the development of a cooperative system exemplar for the following reasons:

a. Screen design is a real world problem, and it is intended that the work in this present thesis should have some practical relevance or potential.

b. It has been established in previous chapters that tasks which will benefit from cooperative work are those which are open ended; requiring members to generate a range of ideas, and select from among the alternatives a "satisficing" solution. Design task, being a problem domain which has no specific solution fits well in this category. The potential advantages of cooperative behaviour within the design process have also been identified by several researchers, including Clarke and Smyth (1993). Interviews with screen designers (discussed in Section 7.4) supported the contention that designers working together often "bounce ideas" off each other, suggest
alternative solutions to the problem, and seek each other's criticisms and opinions. This makes screen design a suitable task for implementation of the cooperative system.

c. Although screen designing is a creative task, nevertheless it is governed by certain design guidelines. These guidelines can form the material from which alternative solutions to the design problem can be generated.

d. There is a need to build helpful design tools specially targeted towards those individuals who have to design screens, but have very little human factors knowledge about screen design. Because we do not yet know all the answers about how to design screens, it is not possible to feed the requirements for some application into an expert system and have a perfect set of screens generated. Therefore, a cooperative system, where alternative screen design solutions governed by the application of design guidelines are suggested by the computer, but the user makes design trade-offs as necessary, is a more viable resolution.

7.3 Objectives of the experimental investigation

According to Galitz (ibid), screen design is an orderly process, and to support this proposal he presented ten "necessary design steps." However, not all designers work in the same fashion, and certainly do not all follow the ten design steps laid out by Galitz. Therefore, to develop the software exemplar, it was first necessary to obtain a general idea of the current practices of screen designers and programmers who have to perform screen design. It was also necessary to acquire a general understanding of the task.
As mentioned above, screen design is commonly governed by certain accepted design rules and guidelines. However, the relative usefulness of these guidelines, and how they are applied in the screen design process, needed to be investigated.

Unlike designing a conventional sort of computer system, in developing a cooperative screen design system, it was necessary not only to identify the functional requirements of the system, but to do this from two different perspectives. First, from the perspective of the functions that the system must support as a screen design tool, and second, from the perspective of mapping the underlying mechanisms of human cooperation on to the system.

In any system development, users' requirements must be identified. Thus, although it was not the aim of this thesis to develop a fully fledged cooperative screen design system, it was necessary to specify certain users' requirements for evaluation purposes. The experimental part of the work was conducted to achieve this. The experimental investigation also aimed to characterise the factors and processes of cooperation described in Chapters 3 to 6, specifically those judged as being relevant to the screen design system.

In summary, the aims of the experimental investigation were:

a. To analyse the current practices of screen designers and programmers.
b. To identify the knowledge sources of screen design, and how such knowledge is applied.
c. To identify the functional requirements of a cooperative screen design system.
d. To identify the user requirements.
e. To verify the stated underlying characteristics and processes of cooperation.
7.4 Rationale for adopted procedures

Having identified the need for computer tools to aid the design process, Tunnicliffe (*ibid*) argued that acquiring design knowledge for the development of such knowledge based design tools becomes a primary concern. He surveyed and examined a vast amount of knowledge acquisition techniques, with the aim of proposing a method for the elicitation of design knowledge.

Tunnicliffe (*ibid*) provided many arguments which led to the proposal of his method. Some of these arguments have served as a guide towards the procedures adopted in this experimental work. These arguments are:

a. When choosing a particular knowledge acquisition method, care must be taken so that the quality of resulting data is high for any given effort. Different methods are likely to address different aspects, viewpoints, or knowledge types of the same domain. More than one approach is likely to be needed. A multi-disciplinary approach is thus recommended.

b. Observation of designers whilst engaged in design activity is both a plausible, and useful endeavour in the attempt to acquire an understanding of design.

c. Thinking aloud strategy provides accurate records of the activity, and can provide data representative of the processing sequence of cognition. However, care must be taken to ensure that the task is typical, realistic, approached in the usual way, and the subjects' normal working environment is preserved.

d. While it is relatively easy to identify the tasks that are being performed the "how" and "why" are more elusive. The heuristic nature of human problem
solving is probably best elicited using Protocol Analysis. Data obtained from protocol analysis may be compared with information gathered from other sources, to validate expert explanation, or the results of induction.

e. Important processes, such as visual perception, probably contribute significantly to design but are unlikely to be available to verbal access. Elicitation procedures for design must at least provide a medium by which spatial and holistic forms of knowledge can be recorded, represented and communicated.

f. A combination of techniques, such as preliminary interviews, structured interviewing and also task-solving situations are probably most appropriate for design applications. Design information may be obtained through the protocol analysis technique.

g. A video camera can capture much of the non-verbal communication, and will record spatial aspects of the design task. Visual and spatial data provide a useful, if not a vital contribution to design elicitation. Video records can capture the holistic, diagrammatic, and dynamic nature of the task, and in addition, there is the soundtrack.

The method proposed by Tunnicliffe (ibid) (a summary is presented in Appendix F) is comprehensive and consists of "3" stages, with different procedures and techniques, to facilitate the development of an unambiguous model of the design knowledge. To achieve the aims of the experimental investigation outlined above, it is not necessary to adopt the comprehensive procedures proposed by Tunnicliffe. The experimental procedures adopted in this study are presented in Table 7.1.
TABLE 7.1: Summary of procedures of experimental work.

<table>
<thead>
<tr>
<th>STAGE</th>
<th>PROCEDURES</th>
<th>TECHNIQUES</th>
<th>ANALYSIS</th>
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<tbody>
<tr>
<td>Experimental</td>
<td></td>
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<tr>
<td>Programme 1</td>
<td>Preliminary</td>
<td>Semi-structured Interview</td>
<td>Transcripts of interview</td>
</tr>
<tr>
<td></td>
<td>Interview</td>
<td>(Tape recorded)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Screen Design</td>
<td>Screen Design Task</td>
<td>Transcripts of protocols</td>
</tr>
<tr>
<td></td>
<td>Exercise</td>
<td>(Video and tape recorded)</td>
<td>Video</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Drawing or sketching</td>
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<tr>
<td></td>
<td>Post-experimental</td>
<td>Self-filling Questionnaires</td>
<td>Questionnaires</td>
</tr>
<tr>
<td></td>
<td>questionnaire</td>
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</tr>
</tbody>
</table>

7.5 Experimental Programme 1: Preliminary interview

7.5.1 Subjects

In Section 7.2, two different groups of people who are involved in screen design were highlighted: user interface specialists who are aware of the human factors of screen design, and software programmers who lack this knowledge. Therefore seven screen designers with human factors knowledge, and six programmers with no or very little human factors knowledge were employed in preliminary interviews. The first group of subjects were human factors specialists working in the HUSAT Research Centre of Loughborough University. Only two of the seven designers interviewed
were full time screen designers. The second group of subjects were members of the technical staff of the Knowledge-Based Systems Laboratory at the Singapore Institute of Information Technology. They were mainly computer programmers who designed screens as part of their job.

7.5.2 Procedure

A semi-structured interview was conducted, so that the experimenter could pursue points and clarify issues that arose. Agreement was obtained from the interviewees to record the session on cassette tapes. Each interview lasted for approximately an hour. The tapes were later transcribed and analysed.

7.5.3 Questions for preliminary interview

The questions were divided into four sections. The first section established the level of experience each individual had in screen design since this affected his or her responses to the subsequent questions.

The second section was concerned with the screen design task. There are many types of screens, such as form filling, data entry, graphic screens and so on. Each type of screen has a different function, and hence the ways in which they are structured and formatted are very different. Subjects were questioned on the various types of screens that they had experience in designing, because this provided the scope and context of the answers to the later questions. Subjects were also asked which type of screen(s) they considered to be most difficult to design, as this provided data about the support a screen design tool should supply. Then the subject's approach to the screen design problem was established, especially if they had fixed objectives as they were going through each design sequence. (Each subject may have
followed a different process of screen design, and it was necessary to establish the
differences between these processes.) Next, subjects were questioned on the
information that they felt was necessary for screen design. The cooperative system
would provide alternatives solutions to the design problem, based on established rules
and screen design guidelines. Hence, it was necessary to ascertain what sort of
sources or guides the subjects used, and if they found them useful. This provided data
about the necessary content of the knowledge base of the cooperative screen design
system. The perceived and real difficulties of screen design were also determined, as
well as the criteria that subjects used to mark a screen design task as being
"complete."

The next section dealt mainly with cooperation. First of all, subjects were asked
if they usually performed the screen design task alone, or with someone else. Then
their attitudes and opinions towards cooperative work were established.

The last section was aimed at identifying the medium and software tools that the
subjects employed in the screen design task. Also a "catch-all" question to identify
the requirements of a cooperative screen design system was included. Subjects were
asked to propose their requirements as they conceived such a system might be, free of
current technological limitations. (A copy of the questionnaire is provided in
Appendix A.)

7.5.4 Results

Results are presented in four parts corresponding to questions regarding the
designers, screen design task, cooperation, and computer systems. To make for easier
reading, the questions presented to the interviewees were paraphrased and presented
prior to the responses of the subjects.
PART A: INFORMATION ON DESIGNERS

Question 1: What is your level of screen design experience?

Figure 7.1 shows the level of experience of both groups of subjects (i.e. human factor [HF] specialists and programmers). The rated level of experience range from "inexperienced" to "very experienced," with most subjects from both groups rating themselves as only "fairly experienced." Programmers rated themselves as less experienced, compared to the HF specialists.

![Figure 7.1: Rated level of experience](image)

Page 198
PART B: SCREEN DESIGN TASK

**Question 1**: What are the various types of screens you had to design?

Most of the subjects had worked on both text based and graphical interfaces. One subject from the HF group had only worked on text based screens, and one subject from both groups only had experience in graphical interfaces. The most common type of screen that the subjects worked on was the data entry or form filling screens.

**Question 2**: What types of screen do you find most difficult to design?

11 out of 13 subjects found that graphical interfaces and windowing environments were the most difficult to design. However, HF specialists related their difficulties to structuring the screens, whereas the programmers experienced their problems in terms of coding the graphical screens. Two HF specialists stated that graphical screen designing is more an art than a science. One of them commented, "It is not sure if the science of a good screen design of complex graphical interfaces exists." Another problem mentioned was the difficulty of making the leap from task analysis to putting what is necessary on the screens.

**Question 3**: What is the sequence you most often follow in screen design?

All the subjects interviewed did not follow a fixed sequence in the screen design process. The HF specialists would talk to the end-users of the system to obtain an idea of their needs, and the tasks they have to perform with the system. From users' requirements and task analysis, they would then perform a functional analysis before they started to design the screen. On the other hand, only one out of the six programmers interviewed claimed to perform a users' requirements analysis. Two
programmers said that they tried to determine what information is to be presented by talking to users. All the HF specialists also mentioned the need to evaluate the screen prototype by talking to the users again. However, screen designing followed very personal and diverse styles. One subject would perform the easy tasks first and tackle the harder issues later, and another subject claimed to perform the exact reverse. Most of the subjects make their decisions based on the "look and feel" of their screens.

**Question 4:** Do you set yourself certain goals when going through the design sequence?

All the subjects interviewed did not have any fixed goals in mind while designing the screens. One of the programmers worked according to the in-house guidelines given. According to one of the HF specialist, "Most designers do not have set explicit goals, but may have some internal goals such as 'I can improve the screens.'" However, this subject thought that it is good for designers to have explicit goals.

**Question 5:** What information do you think are necessary for screen design?

Suggestions were as followed:

<table>
<thead>
<tr>
<th>Information on users' requirements.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information on user population.</td>
</tr>
<tr>
<td>Information on the operating environment, e.g. lighting conditions.</td>
</tr>
<tr>
<td>Hardware support capabilities, e.g. colour capabilities, screen resolution, graphics resolution, and screen sizes.</td>
</tr>
<tr>
<td>Software support capabilities.</td>
</tr>
</tbody>
</table>
Data to be presented, i.e. input and output information.

Task description.

Functionality of the system.

Users' requirements and task description were widely mentioned by the HF specialists and some programmers. However, generally the programmers tend to do what they think is best and then talk to the users, and make changes as appropriate.

Information on the operating environment, hardware and software support capabilities were only mentioned by the HF specialists. This may be because the HF specialists have to design the screens separately from the application environment, and thus, lack information about it. The programmers, on the other hand, had to design screens while writing the codes for the application software itself.

Generally with both groups of subjects, guidelines were not mentioned as an important source for screen design.

**Question 6:** Do you use any documented guidelines, standards, design checklists, handbooks, or textbooks?

There was a big difference between the responses of the HF specialists and the programmers.

All the HF specialists had come across guidelines, checklists and standards, and had used them at some point in time. However, they do not follow these guidelines rigidly but tailor them according to the needs of the screen which they are designing. The experienced designers gleaned guidelines that were considered useful from various sources, and over the years, built up a knowledge of knowing what would
work and what would not. Hence, they are able to perform a mental checklist on the screen they have designed. The fact that these designers had actually applied these guidelines in their screen design showed that they do find them useful, but the guidelines are not without flaws. Responses of some subjects when asked what are the problems with documented guidelines and standards were:

"... guidelines are usually thick and long ..."
"... guidelines are too general ...
"... they contain outdated information ...
"... they do not consider aesthetic advices ...
"... they are aimed at everybody and so are of no use to anybody ...
"... difficult to find the information needed ...
"... contradict themselves at times ...
"... lack prescriptive advice ...
"... lack context ...

According to one subject, sometimes guidelines are written governed by external factors. For example, IBM recommended that every graphical guideline given must also be implementable using the keyboard so that not everyone has to purchase a mouse.

Four out of six of the programmers, however, had not even come across such guidelines and they did not know whether such guidelines existed. One of the programmers had read articles written about guidelines but had not seen any himself. Five out of six of the programmers had never used guidelines for their screen design task. As mentioned earlier, one of the programmers used an in-house style guide provided by the company she works for.
However, only two programmers felt that guidelines are useful. The rest of them felt that there may not be enough time to look at them anyway. The response of one designer is that "... if it (the screen layout) looks alright to me, then it should be ok ...."

**Question 7:** How do you know when the screen design task is complete or otherwise finished?

Most subjects felt that it is difficult to sign off a screen as finished, as more work is usually needed, especially after evaluation with users. Some criteria that subjects would use as an indication of the "end" of the design task are:

"... when I have achieved a general sense of satisfaction ..."

"... functionalities required are completely included ..."

"... it works ...

"... the law of diminishing return applies, in that any further addition will not contribute to the whole design ...

"... evaluation with users yield satisfactory responses ...

"... screen is not overcrowded ...

"... look and feel ok ...

"... money and time run out ...

"... inputs and outputs are provided ...

When working on multi-screens, designers usually work on more than one screen at a time, rather than complete a screen before moving on to the next. However, they would get one screen in working order before moving on, and then check for consistency across the screens.
Question 8: Do you find screen design difficult at all? What are the main difficulties?

Only one HF specialist and one programmer did not find screen design difficult. Some of the difficulties found by the HF specialist are:

- "... having to make compromises with space, time, technology ..."
- "... dealing with the unknowns, anticipating the problems users might have with the screens ..."
- "... screen design is an art ..."
- "... how to balance trade-offs ..."
- "... deciding from the task and user analysis what information to put on the screen ..."

The programmers, on the other hand, related most of their difficulty to the coding of the screens, and the software they were using. Problems in coding were also experienced by one of the HF specialists.

PART C: COOPERATIVE WORK

Question 1: Do you work with other people in the screen design task?

Two of the seven HF specialists do most of the work on their own, but the rest of them have worked with other people and on their own. Likewise two of the six programmers work alone, and one of them often gets a colleague to comment on the screen that he has designed.
Question 2: Do you prefer to work alone or with other people?

Only two out of seven HF specialists preferred to work alone, but then mainly during the design activity. All of the subjects in this group show their design or partial solutions to either colleagues, or end users for comments. Three of the programmers also prefer to design on their own, but would like feedback from others.

Question 3: From your experience, what are the main advantages of working with other people?

Both HF specialists and programmers spoke of the many advantages of working with one or more people. Cooperating with others provides one with new ideas that stem from the different views, experiences and information held by their partner(s). This is especially evident in brainstorming sessions.

Cooperating partners also give feedback, comments and constructive criticisms, especially when shown a partially constructed screen. This is why even though some subjects prefer to work alone during the design phase, they always approach their colleagues for feedback on what they have designed. One of the subjects commented that when somebody else looks at the design, they are running through their "mental checklist." Hence, errors are detected, and also it provides confirmation of the design.

Cooperation work also stops one from sidetracking or going down the wrong road while designing. Subjects felt that working with others stimulates each other towards better design, and generates alternative viewpoints. It also eases the workload.
**Question 4:** What are the disadvantages of working with other people?

The main advantage of cooperative work, which is having different opinions and ideas, was also cited as the main problem. When ideas are dropped, bad feelings such as discouragement occur. Criticisms are not always constructive. When there is a difference in veto power, a designer may be asked to take up an idea which is less than satisfying. Novel ideas are sometimes not entertained, and both groups of subjects felt cooperative work sometimes imposes restrictions. Breakdown in communication occurs. When roles are ill-defined, problems can develop. Programmers also mentioned problems in establishing conventions in the coding process, as very often not only do they have to design the screen on a piece of paper, or screen design tool, but they have to produce a working program for the screen designed. One of the HF specialists very aptly put it, "Design decisions are singular, though design inputs could be multiple." Hence, for good cooperative work to occur, good management of the partnership is necessary.

**Question 5:** Do you think that working with other people affects the quality of the design?

All the HF specialists said that it would improve the design, although one mentioned that careful control must be exercised. Four programmers also felt that it would improve the design but two of them added that it depends on the people that one is working with. Inexperienced partners might affect the design in a negative way.
PART D: COMPUTER SYSTEMS

**Question 1:** What medium (pencil and paper, or software packages) do you use in the screen design?

The medium that subjects used for their screen design task is shown in Figure 7.2.

Most of the HF specialists at HUSAT used Macintosh based tools such as Hypercard, Supercard, MacPaint, and Macromind Director. Hypercard and Supercard are most widely used. The programmers on the other hand did not use Macintosh based tools. Software tools mentioned were ROCKY, VINEY, and object oriented languages. ROCKY was thought to be particularly user friendly, and was preferred by two programmers.

![Figure 7.2: Medium used by subjects](image.png)
Subjects were also asked to indicate the features of the software tools that they favoured. Responses include:

"... easy to put things on screen without having to write lines of codes ..."
"... can put together primitives of Mac style interaction cheaply and easily ...
"... quick and easy to set up interactive style on screen ...
"... able to represent the artifacts that you are using ...
"... immediacy of getting feedback and the style of dialogue and the feel of it ...
"... don’t have to think of screen coordinates or anything like that ...
"... ease of changing things ...
"... good at indicating constraints ...
"... rigid and structured, provide good framework ...
"... could do text based or graphics ...
"... easy to give characteristics to, for example, boxes, or windows quickly and easily ...
"... interactive and fast ...
"... easy to use libraries and functions ...
"... allow you to build your own libraries and functions ...
"... quality of tool in terms of precision and details ...
"... easy to call things up, play with it and see how it looks and feel ...
"... don’t need to remember anything to reuse it ...
"... can specify colour, font and size ...
"... provide interface to drawing packages, for example, import drawing from Paintbrush ..."
**Question 2:** Leaving aside technological limitations, what would you like a system which actively works with you, to do for you?

The following is a list of features that the subjects imagined they would like a cooperative screen design system to provide. Some of these features are not realistic, as subjects were told to state their requirements, regardless of technological limitations. These requirements could be categorised as:

<table>
<thead>
<tr>
<th>1. Desirable features of system as a tool</th>
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<tbody>
<tr>
<td>1. The system provides design objects that can be easily manipulated.</td>
</tr>
<tr>
<td>2. The system allows the designers to scan in paper based forms that need to be redesigned. The designers could then manipulate the captions or entry fields to produce a better layout.</td>
</tr>
<tr>
<td>3. The system can be used by non-programmers to set up a test harness with dummy functionalities for dynamic user testing, without having to write tedious programs.</td>
</tr>
<tr>
<td>4. The system automatically generates the codes for the designed screen.</td>
</tr>
<tr>
<td>5. When designers are working on more than one screen, the system allows them to view all the screens simultaneously.</td>
</tr>
<tr>
<td>6. The system is able to learn.</td>
</tr>
<tr>
<td>7. The system is able to produce faithful output of the screen designs.</td>
</tr>
</tbody>
</table>
### II. Desirable features of system as a cooperative partner

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The system checks that what the designers are doing is sensible.</td>
</tr>
<tr>
<td>2.</td>
<td>The system goes through an evaluation of the designer’s rough prototype,</td>
</tr>
<tr>
<td></td>
<td>and informs him of any violation of the standard or guideline (e.g. MOTIF, CUA) that he is</td>
</tr>
<tr>
<td></td>
<td>trying to follow.</td>
</tr>
<tr>
<td>3.</td>
<td>The system goes through an evaluation of the designer’s rough prototype</td>
</tr>
<tr>
<td></td>
<td>and produces an alternative layout. The system must then be able to explain why its layout</td>
</tr>
<tr>
<td></td>
<td>is better than the designer’s. This suggestion should not be imposed upon the designers and</td>
</tr>
<tr>
<td></td>
<td>they must have the option to switch off this facility.</td>
</tr>
<tr>
<td>4.</td>
<td>The system provides designers with a standard evaluation checklist.</td>
</tr>
<tr>
<td>5.</td>
<td>The system provides context sensitive guidelines (an option which can be switched off or</td>
</tr>
<tr>
<td></td>
<td>suppressed).</td>
</tr>
<tr>
<td>6.</td>
<td>The designers are able to ask the system for suggestions and guidelines at any point in time</td>
</tr>
<tr>
<td></td>
<td>in their design, and expect a reason for the suggestion.</td>
</tr>
<tr>
<td>7.</td>
<td>The system is able to comment on the aesthetics of the screen, and provide suggestions for</td>
</tr>
<tr>
<td></td>
<td>improvements.</td>
</tr>
<tr>
<td>8.</td>
<td>The system is able to spot glaring errors and inform the designers immediately.</td>
</tr>
<tr>
<td>9.</td>
<td>The system is able to communicate verbally with the designers, preferably in a female voice.</td>
</tr>
</tbody>
</table>
7.5.5 Discussion and Conclusions

PART A: INFORMATION ON DESIGNERS

Two groups of subjects were interviewed: the Human Factors (HF) specialists and programmers. The programmers were less experienced than the HF specialists in the screen design task. From the responses of the subjects a few clear distinctions between the two groups of subjects were noted. The programmers viewed the screen design task as part of a larger "programming" task, whereas HF specialists viewed the screen design and programming as separate tasks. HF specialists were also more aware of the needs of the users of the screen that they were designing for. Therefore, most of the HF specialists interviewed had used design guidelines and had found them to be useful and important in crafting good screen layouts for the benefit of end users. However, due to the problems of documentation of guidelines (listed in Section 7.2 above), guidelines were not fully used, even among the HF specialists, some of whom had been involved in improving the documentation of these guidelines. Most of the programmers, however, were not familiar with guidelines and do not have access to this information. Therefore, a cooperative system which allows the users freedom in their design, yet suggests alternative solutions to the users based on established guidelines, to increase the users' awareness of these guidelines, would prove to be very useful.

The second part of this experimental programme aimed to identify how screen designers perform the task, and how guidelines are applied in the design. It is therefore more relevant to employ the HF specialists as the subjects for the screen design exercise.
PART B: SCREEN DESIGN TASKS

Screens have been developed for different purposes and in various styles, and Galitz (ibid) categorised them as data entry screens, inquiry screens, multipurpose screens, question and answer screens, and menu screens. Each type of screen is functionally different, and possesses unique differences in the way in which it is structured and laid out. Therefore, the guidelines governing each type of screen are different. In order to keep the number of rules to be incorporated in the cooperative exemplar (named COSY) to a manageable size, it was thus necessary to choose from these various types of screen one which any screen designer or programmer would most likely have to design. Results of the questionnaire revealed that this would be data entry screens. Therefore, in Part 2 of the experimental programme, subjects will be asked to work on data entry screens.

Screen designing has a very personal style, and most of the subjects did not follow a tightly fixed sequence. However, from the interviews it was gathered that screen designing does follow the three conventional development phases: analysis, design, and evaluation with users. The analysis phase enables the designers to gather all the information thought to be necessary for the design phase, such as users’ requirements, hardware and software capabilities, and so on. It should be stressed here that COSY is for cooperation with designers (users) in the design phase. Therefore, in the next experimental programme, data was only collected regarding the design process, and information from the analysis phase necessary for the subjects was provided.

Screen design guidelines and standards, although not quoted as an important source of information for screen designing, have been widely used, especially by HF specialists. They form part of the "deep knowledge" and "heuristics" that HF
PAGE NUMBERING AS ORIGINAL
PART D: COMPUTER SYSTEMS

The results of the interview and also Van der Veldens's (ibid) electronic mail survey, suggested that there are few, if any, good screen design tools available. The tools that designers and programmers use to mock up the screens or to create storyboards quickly, range from paper and pencil to prototyping tools, with Hypercard and Supercard being the favourite. Designers need good graphic user interface (GUI) editors, but the problem with most GUI builders is that they require the user to know too much about the specifics of the tool. The most desirable feature of a screen design tool is one that requires simple behaviour in setting up screen design elements, such as boxes, or buttons.

It is interesting to note that the main requirement put forward by the subjects for the system as a cooperative partner is that of an evaluator. Suggestions made by the subjects for the possible characteristics of a screen design cooperative system tie in well with the proposals for the different roles that the system should play (see Chapter 6). Some of the functional requirements proposed by the subjects go beyond the technological capabilities of current computer systems. But they are useful in shaping the future research needs of a fully developed cooperative screen design system.

7.6 Experimental Programme 2: Screen design exercise

7.6.1 Aims

The aims of the screen design exercise are:

a. To gain a general understanding of the approach that designers take in a simple task of designing the layout of a form filling screen.

b. To look at the issues that designers consider in designing a form filling screen.

c. To look at the objects that designers work on in the task.
7.6.2 Subjects

Six designers from the HUSAT Research Centre took part in the exercise. Firstly, they were assigned a screen design task which they had to perform individually. The designers were then paired according to their level of experience, and were allocated another screen design exercise, on which they had to work together. (Subjects were paired according to level of experience so that both subjects could contribute equally to the task, and so that any one subject would not feel inferior to his or her partner. This experiment design feature helps to control any contaminating factors.)

7.6.3 Materials

In the experimental work, documents specially designed by the author were used. These include the experimental instructions (Document 1 and 1a), screen design problem specification (Document 2 and 2a), and the post-experimental questionnaire. Subjects were provided with "Supercard Tips;" Handbook of Screen Design Guidelines by W.O. Galitz; and a set of condensed guidelines on form filling and data entry screens that the author had gleaned from various sources of screen design guidelines. This was provided so that subjects could have quick and easy access to guidelines that they might need.

Subjects were equipped with Supercard and MacDraw running on Macintosh Plus II; A3 paper; pencils; and makers of various colours and sizes for construction of the screen.
For recording subjects' performance, the following equipment (and tapes) were used:

JVC video camera and recorder
Sony cassette recorder
Tripod
Fuji VHS videocassette E180
TDK D90 cassettes

7.6.4 Tasks

The screen design task in the individual subject study was concerned with designing a screen layout for an application of employment with an artificial company, COSY Corporation. The task for the paired subjects involved designing a screen layout for a form for claiming travel and out of pocket expenses for the same company. In both studies, subjects were presented with the screen design problem specification (Documents 2a and 2b respectively) which outlined the information that was to be presented on the screen, the user population, the hardware capabilities, and information on workspace, and environment of the users. Both tasks were constructed to be similar to each other in that, firstly they contained roughly the same amount of information to be presented on the screen, and secondly, they consisted of similar, if not the same amount of issues that designers have to make decisions about: for example, use of menus, or auto generation of information. To ensure that the screen design task presented was realistic, an experienced screen designer was employed to verify that the tasks represented those that screen designers or programmers would encounter in their job.
7.6.5 Procedures and instructions

Firstly, subjects were briefed as to the nature of the study, and then they were presented with the instructions (Document 1 for single subjects and 1a for paired subjects).

Subjects were instructed to present the information given in Document 2(a or b) on no more than two screens. They were also allowed to include any other information or instructional messages that they felt were necessary. Subjects were told to spend about forty-five minutes to an hour on the task. They were also told to refer to the condensed guidelines and guide-books freely. Subjects could use either the pen and paper or the prototyping tool, Supercard or MacDraw, as and when they preferred. Subjects working alone were asked to verbalise their thoughts and describe their actions during the entire session. Subjects in the "paired" group were instructed to work together to produce the design solution. All subjects were also assured that the exercise was not a test of competence, but to enable the experimenter to gain a better understanding of the screen design process.

Once subjects indicated that they were ready to begin, the video and cassette recorders were switched on. The experimenter stayed in the room throughout the experiment, to prompt the designers when they stopped verbalising their thoughts, and to answer questions.

Subjects who did not manage to complete the task in the hour, were asked how they would have proceeded with the design, had they been given more time. Subjects were also presented with a post-experimental questionnaire (Document 3 and 3a). Subjects were thanked for their participation before they left. Subjects' designs and sketches were collected for analysis.
(Documents 1, 2, and 3 for individual screen design task are presented in Appendix B. Documents 1a, 2a, and 3a for cooperative screen design task are presented in Appendix C.)

7.6.6 Post-experimental questionnaire

The post-experimental questionnaire was employed to identify potential contaminating variables that could influence the subjects' performance in the screen design task. Although a real design task was presented to the designers, there were certain constraints imposed by the nature of the experiment. These are: time limit; presence of the experimenter; use of recording equipment; the need to verbalise for the protocols; and the amount of information and software provided for their use. Subjects were questioned as to how the above factors affected their design task.

Subjects who did not use the guidelines and guidebooks given were asked to provide their reasons. Subjects who worked in pairs were also questioned on:

- how satisfied they were with the solution proposed when they worked in pairs compared to when they worked alone;
- if it is difficult working with another designer;
- if working with another designer had affected the approach adopted in the design;
- if they were satisfied with the designer they had worked with, or if they would have preferred to work alone or with another designer; and,
- the advantages and disadvantages of working with a partner.

Lastly subjects were also asked to provide ideas on what support they would like to get from a hypothetical interactive and intelligent cooperative screen design system.
7.6.7 Results: Protocol and design sketches analysis

A. SCREEN DESIGN TASK

1. The general approach taken by all the designers (subjects) before they started to design, whether working alone or with a partner, can be condensed to the following:

   |   | Subjects make a list of all the information that has to be presented on the screen, by referring to the documents given. |
   |   | These items are grouped into the different categories. |
   |   | The constraints imposed on the design, such as the hardware capabilities, the workspace and environment of the users, were also listed. |
   |   | The different types of users of the screen were noted. |

2. Subjects generally worked from the top to the bottom of the list of items gleaned from the documents (2 and 2a) presented. For example, the "Title of the screen" was looked at first, followed by "Applicant’s name," "Address," and so on.

3. Subjects often considered a group of items together, and the ways in which they are related to each other. Groups of items were often separated from each other, either by a physical line, spaces in between, or surrounded by a big box.

4. Subjects made constant reference to the needs of the users based on their knowledge. For example:
<table>
<thead>
<tr>
<th>Individual</th>
<th>&quot;I am going to have to keep in mind that the main users of this system are going to be computer novices, so everything has got to be very simple.&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner A</td>
<td>&quot;That seems to me ... that's business about hiding redundant information ... &quot;</td>
</tr>
<tr>
<td>Partner B</td>
<td>Yes, that's quite good for these novice users ... casual users ... &quot;</td>
</tr>
</tbody>
</table>

5. Although most subjects did not physically refer to the sources of guideline provided, most of them manipulated the screen elements within the constraints of design guidelines. For examples:

| Individual | "There is hardly any information on that screen, so I put that on the previous screen." (Subjects not wanting to overcrowd screen, therefore, moving objects to another place.) |

6. Subjects working alone, occasionally expressed the need to refer to certain guidelines to verify their decisions. For example:

| Individual | "I think the convention is the space bar to choose, but I ... now that's something I want to check in the guidelines ..." |

7. Subjects often referred to their previous experiences. For example:
8. All the subjects referred to the need to test the screens with users at the end of the session. The subjects also expressed the need to test verify their decisions, or solution path chosen with users. For example:

9. Even subjects who worked alone often verbalised a variety of alternative solutions, but only adopted the one which they thought was best. Subjects who worked together often suggested alternative solutions, and discussed the trade-offs before adopting a solution.

10. From analysing the sketches produced by the subjects, the common design decisions made by all the subjects can be generalised:
a. The "Title of the screen" was always placed at the top of screen. Some designers placed it at the top left, and some placed it at the top middle.

b. The "Captions" and "Data entry fields" were placed side by side, with the "Captions" to the left of the "Data entry fields."

c. "Entry fields" were signified by use of boxes, continuous lines, or dotted lines.

d. Instructions related to a group of items were always placed before the items (either above, or to the left).

e. Common and related elements were grouped together, and these groups were made obvious (either by using boxes, or by spatial separation).

f. All subjects in the cooperative group used auto-calculation to relieve the users from having to sum up the total amount of claim being made.

11. Table 7.2 lists all the issues that subjects have given consideration to in the task of designing a form filling or data entry screens.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Placement of screen design elements (e.g. Title, Captions, Entry Fields, Error Messages, Instructions, etc.).</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>Types of entry fields to use (e.g. continuous lines, dotted lines, boxes, etc.).</td>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
<td>Length of entry fields to provide.</td>
<td>6.</td>
</tr>
<tr>
<td>9.</td>
<td>Wordings of captions (e.g. Surname or Firstname, use of abbreviations, etc.).</td>
<td>10.</td>
</tr>
<tr>
<td>11.</td>
<td>Number of screens to use (one, two or more).</td>
<td>12.</td>
</tr>
<tr>
<td>15.</td>
<td>Size of monitor that screens will be implemented on.</td>
<td>16.</td>
</tr>
<tr>
<td>17.</td>
<td>User’s ability to cope with input medium (e.g keyboard, mouse, etc.)</td>
<td>18.</td>
</tr>
<tr>
<td>19.</td>
<td>Ways to prompt user for correct entry (e.g. flashing cursor at the relevant entry fields).</td>
<td>20.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>21.</td>
<td>Wordings of error messages.</td>
<td>22.</td>
</tr>
<tr>
<td>23.</td>
<td>Placement of help and error messages.</td>
<td>24.</td>
</tr>
<tr>
<td>25.</td>
<td>Presentation of a list (in box, top to bottom, across, etc.)</td>
<td>26.</td>
</tr>
<tr>
<td>27.</td>
<td>Use of radio buttons.</td>
<td>28.</td>
</tr>
<tr>
<td>29.</td>
<td>Undoing errors.</td>
<td>30.</td>
</tr>
<tr>
<td>33.</td>
<td>Font sizes.</td>
<td>34.</td>
</tr>
<tr>
<td>35.</td>
<td>Grouping of information.</td>
<td>36.</td>
</tr>
<tr>
<td>37.</td>
<td>Menu design</td>
<td></td>
</tr>
</tbody>
</table>
B. COOPERATIVE WORK

In the previous chapters, the underlying processes of cooperation were described. Here, examples of these processes in cooperative work between two partners working towards designing a form filling screens are given.

I. Goal oriented working (GOW)

The most important factor in cooperation is that the partners work towards a common goal. Such communication will be task directed (task directed cooperativity). In any design situation, the designers are required to identify the specific areas of investigation before solutions are proposed and developed, appraised, and accepted by both the designers (Scrivener et al, 1992). Hence, the five categories of goal oriented discourse are:

<table>
<thead>
<tr>
<th>Problem Formulation (PF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution Proposal (SP)</td>
</tr>
<tr>
<td>Solution Development (SD)</td>
</tr>
<tr>
<td>Solution Acceptance (SA)</td>
</tr>
<tr>
<td>Appraisal (Problem and Solution)</td>
</tr>
</tbody>
</table>

Examples of these discourses are shown below:

| Problem Formulation | Partner A | "Well, do you think we'll get all that on one screen?"
|---------------------|-----------|--------------------------------------------------|
| Solution Proposal   | Partner A | "I would have thought we could, if we work across the screen. If it's acceptable to put this information across the screens. Perhaps in two rows."
| Solution Development| Partner B | "Hmm ... perhaps enough room then for some instructions."
Solution Development | Partner A | "On the second screen?"
Solution Development | Partner B | "And then that's the opening ... you know, sort of press to continue and then you go on to the actual ..."
Solution Acceptance | Partner A | "Yes, alright, yes. Yes, that's a good idea."
Solution Appraisal | Partner A | "So you can look at the instruction first, so I suppose they get familiar with it ..."

In task directed communication, subjects often ensure mutual representations by making clarifications. For example:

| Partner A | "... and the total amount of expenses calculated ..." |
| Partner B | "Right, so that will be the amount claimed?" |
| Partner A | "Yes."

II. Agreement of method of achieving goals

This is important because when this aspect is not evident, then partners cannot be said to be cooperating. The communicative acts here is the same as that of accepting the solution (SA). An example is:

| Partner A | "Do you think we should look at it as a form filling task?" |
| Partner B | "Yes." |
III. Roles

While partners in a small group adopt specific roles which they play constantly, roles in cooperation between two partners is demonstrated by their communicative behaviour. Examples of some of these roles which are evident in the cooperation of the screen design tasks are given below.

<table>
<thead>
<tr>
<th>Role</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delegator</td>
<td>&quot;Should I give you ... do you want to list them out and then I will make a note of them?&quot;</td>
</tr>
<tr>
<td>Information seeker</td>
<td>&quot;There is no function key on the Mac is there?&quot;</td>
</tr>
<tr>
<td>Information giver</td>
<td>&quot;No, unless you have an extended keyboard. Not many of the normal price ones do.&quot;</td>
</tr>
<tr>
<td>Opinion giver</td>
<td>Perhaps these sort of more appropriate to put on top of the form ... the reference number and the allocation number.&quot;</td>
</tr>
<tr>
<td>Opinion seeker</td>
<td>&quot;Shall we put that one in?&quot;</td>
</tr>
<tr>
<td>Evaluator (Partner B)</td>
<td>Partner A &quot;Should there be a line across there or something?&quot;</td>
</tr>
<tr>
<td></td>
<td>Partner B &quot;Could be, well it doesn't matter. It's not critical, is it? It doesn't matter.&quot;</td>
</tr>
</tbody>
</table>
IV. Conflict

As mentioned in Chapter 6, it is inevitable that cooperating partners disagree with each other, and conflict may arise. It has been established that in fact, this is a good thing, as it shows that subjects are interested in the task, and that partners benefit from critical evaluation of ideas, information and suggestions. Examples are:

<table>
<thead>
<tr>
<th>Partner A</th>
<th>&quot;Do you want to put all those on the same form as part of the same journey? I suppose it's one form per journey.&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner B</td>
<td>&quot;Hmm ... well ... I don't ... I tend to use an expense form for the amount ...&quot;</td>
</tr>
<tr>
<td>Partner A</td>
<td>&quot;The other thing to do is just like a repeated return to step through the ...&quot;</td>
</tr>
<tr>
<td>Partner B</td>
<td>&quot;Oh yes. That's how most people would probably use it.&quot;</td>
</tr>
<tr>
<td>Partner A</td>
<td>&quot;But then if they did that ... would that help option be in that sequence of step because you didn't want the help ... &quot;</td>
</tr>
</tbody>
</table>

V. Meta-communication

This is discourse which relates to the communication itself, e.g. "See what I mean?" or "Say that again?" This aspect of communication is important if the partners are committed in seeking to understand, and to be understood. This is what is meant by cooperation within communication. Examples of meta-communication found within the transcripts are:
"So what are we saying? Are we saying it would be nice if we could include them in the personal detail ..."

"Err ... what do you mean?"

VI. Interpersonal communication

Here the discourse is aimed at establishing harmonious interpersonal relations, where designers make confirmatory phatic comments, or social phatic comments ("It is hot in here, isn’t it?"). Designers may also occasionally laugh and make jokes.

| Confirmatory phatic comments | Partner A | "The car registration number could only come up if you choose car on the mode of transport."
| Partner B | "Yes. That sounds like a good idea."
| Jokes | Partner A | "So maybe the system could be better ... maybe warning for large claims. Ten thousand pounds."
| [Laughs] | Partner B | [Laughs] "Dodgy, very dodgy."

7.6.8 Results: Post-experimental questionnaire

For easy reading the questions presented to the subjects in the questionnaire are paraphrased and presented together with the result. The results are also separated into three parts: Questions presented to subjects who worked individually and paired subjects, questions presented to subjects who worked individually only, and questions presented to paired subjects only.
GROUP A: QUESTIONS TO BOTH GROUPS

**Question 1:** Did the presence of the experimenter distract you from the design task?

Number of Subjects (Total = 6)

<table>
<thead>
<tr>
<th>Very distracted</th>
<th>Not distracted at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>Pair</td>
</tr>
</tbody>
</table>

**Question 2:** Were you affected by the presence of the video camera?

Number of Subjects (Total = 6)

<table>
<thead>
<tr>
<th>Badly affected</th>
<th>Not affected at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>Pair</td>
</tr>
</tbody>
</table>
**Question 3:** Did the time constraint affect your performance?

![Pie charts showing responses to Question 3]

- **Individual:**
  - Yes: 4
  - No: 2

- **Pair:**
  - Yes: 1
  - No: 5

*Number of subjects = 6*

**Question 4:** If you did not refer to the guidelines, or guidebooks provided, what were your reasons?

<table>
<thead>
<tr>
<th>Number of Subjects</th>
<th>Reasons for not using the guidelines provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>&quot;There was not enough time to do so.&quot;</td>
</tr>
<tr>
<td>3</td>
<td>&quot;Too difficult to look for a specific guideline.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>&quot;Could not be bothered.&quot;</td>
</tr>
<tr>
<td>0</td>
<td>&quot;Guidelines familiar with are sufficient.&quot;</td>
</tr>
<tr>
<td>1</td>
<td>&quot;Design task too simple - no need for guidelines.&quot;</td>
</tr>
<tr>
<td>0</td>
<td>&quot;Not appropriate for the stage in design.&quot;</td>
</tr>
<tr>
<td>0</td>
<td>&quot;Other designer had helped to provide guidelines.&quot;</td>
</tr>
<tr>
<td>Pair</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
**Question 5:** Was the information in Document 2 sufficient for the task?

Individual

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Pair

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Number of subjects = 6

**GROUP B: QUESTIONS TO SUBJECTS WHO WORKED Individually**

**Question 1:**
Did you find it difficult to have to speak aloud and design at the same time?

**Question 2:**
Do you think verbalising your task has affected your design?

Individual

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Pair

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Number of subjects = 6
GROUP C: QUESTIONS TO SUBJECTS WHO WORKED IN PAIRS

Question 1: Are you more or less satisfied with the solution to this design problem as compared to the solution that you proposed in the previous exercise?

Number of Subjects (Total = 6)

<table>
<thead>
<tr>
<th>Satisfied Level</th>
<th>Number of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less Satisfied</td>
<td>1</td>
</tr>
<tr>
<td>Equally Satisfied</td>
<td>4</td>
</tr>
<tr>
<td>More Satisfied</td>
<td>1</td>
</tr>
</tbody>
</table>

Question 2:
Did you find it difficult to work with another designer in this screen design task?

Yes 3
No 6

Number of subjects = 6

Question 3:
Has working with another designer affected the approach you adopted in the design?

Yes 3
No 6

Number of subjects = 6
Question 4: Would you have preferred to do this exercise alone or with another designer, or were you satisfied with the designer assigned to you?

<table>
<thead>
<tr>
<th>Preferences</th>
<th>No. of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work alone</td>
<td>0</td>
</tr>
<tr>
<td>Work with another designer</td>
<td>0</td>
</tr>
<tr>
<td>Work with assigned designer</td>
<td>6</td>
</tr>
</tbody>
</table>

Question 5: What are the advantages you have found working with the designer in this exercise?

More ideas and different perspectives.
Easy to talk through the design with someone else.
Eventual design is a negotiated one rather than just one's own.
Able to reject poor ideas more quickly.
Discussion and debate provide better results.
More fun.
More efficient.
Double the experience.

Question 6: What are the disadvantages you have found working with the designer in this exercise?

Having to justify an idea to the other designer before being able to try it out.
Not always agreeing on the best way to do something.
**Question 7:** What facilities would you like a cooperative screen design system to provide?

- Rapid screen layout facilities.
- Mock up ideas on screen.
- Report or comments on the screen layout, like a critique.
- Online access to guidelines.
- Object oriented design tools.
- Ready made compound objects.
- Alignment of objects.
- Inform users if their design conforms to the chosen standard, for example, CUA, or Apple standards.
- Provide alternative ways of displaying information.

### 7.6.9 Post-experimental questionnaire: Discussion and Conclusions

The presence of the experimenter and the recording of the sessions did not affect most of the subjects, either when working alone, or working in pairs. The subject who was slightly affected by the recording equipment was also affected by the presence of the experimenter. This particular subject rated herself as "inexperienced" during the preliminary interview. Her lack of experience may have contributed to the apprehension of having her performance watched by the experimenter and recorded on video.
The main constraints felt by subjects, especially when working alone, is the amount of time given to complete the design. Although prototyping tools (Supercard and MacDraw) were provided, only two subjects (working alone) attempted to reproduce the sketches using the tools. The other subjects felt that they had covered most of the issues, and reproducing them on the computer would not help them to change any solution paths taken. Most subjects expressed that the next stage to the task would be to produce a proper mock-up of the design, to be tested with users. Some subjects expressed that given more time, they would rethink some decisions they had made. It is interesting to note that when subjects worked with another partner, they did not feel that time was a constraint. The lack of time was stated by most subjects as the main reason for not referring to the guidelines provided.

All but two of the subjects found that the information provided was sufficient to perform the design task. It is believed that this did not affect the design task or solution, because the experimenter was present to answer all queries from the designers.

Verbalising thoughts while performing a task is an unnatural process, and was thought to have a negative influence on the subjects' performance. However, out of all the six subjects working alone, only two found it difficult to verbalise their thoughts. They felt that speaking aloud during designing had affected their task in negative ways in that they were not able to concentrate fully, and unable to pursue different alternatives to the design problems. Also, they felt that it increased the time needed to perform the task, and that it forced fuzzy decisions to be made too early in the design process. On the other hand, two of the designers felt that verbalising their thoughts had helped them to think more clearly, and they had become more aware of the shortcomings in the design earlier.
Subjects who worked in pairs were happy with the partner that they worked with, and cited many advantages of working with their partners. These were similar to those advantages mentioned in the preliminary interview.

With regard to the hypothetical cooperative system, the responses of the subjects were again very similar to those given during the preliminary interview, although more specifically related to the design task that had been performed.

7.7 Summary and Conclusions

The work described in this chapter is summarised by answering certain questions that have been posed, either explicitly or implicitly above. The answers provided are substantiated by the results of the experimental programme that were performed.

1. Why is screen design a suitable task domain for the development of a cooperative screen design exemplar?

As mentioned in Chapters 6, tasks which are more suitable for cooperation are those that are open-ended, allowing partners to choose from a range of alternatives a "satisficing" result. Screen design is an open-ended problem. Designers working together in the screen design exercises proposed alternative design solutions, expanded on each other's ideas and proposals, and provided information relevant to the task. Results from the interview have also pointed to the fact that it is not unusual for screen designers to work together. In fact, people often show their design to other people for constructive criticisms and feedback. Many advantages of working with other people on the screen design were cited by both programmers and human-factor specialists interviewed. Top of the list was that more ideas and differing perspectives
were presented and that the other person can act as an error detection mechanism. These views were repeated by subjects who worked together on the screen design exercise. More important, results from the post-experimental questionnaire showed that subjects were more satisfied with the design they produced working with another partner. Nevertheless, problems can occur in cooperation, especially when there is a breakdown in communication. It should be noted that in order to reap the advantages associated with cooperative work, good management of the partnership is necessary.

Although it has been quoted by several designers that "screen design is more an art than a science," screen design is governed by rules and guidelines that take into consideration the needs of the end-users of the screens. In order to build a cooperative system which actively participates in the task, the system's generation of alternative solutions must be based on rules governing the design knowledge. Screen design knowledge and the application of the guidelines, gleaned from the screen design exercises can be used to form the material in which alternative solutions to the design problem are generated.

2. Is there a need for a cooperative screen design system?

The need for design tools which support users in the design task by taking into consideration well documented design principles, have been noted by Tunnicliffe (ibid). Two groups of "screen designers" have been interviewed, and it was obvious that their approach towards the task were different. While human factor specialists are very aware of the needs of the users, and have internalised many of the guidelines that formed their "know-how" knowledge, programmers are often not aware of the needs of the users, and are often not familiar with these guidelines. Although guidelines have been proven to be useful and used, they are often bulky, and specific guidelines are hard to find. Human factor specialists, who are usually people who
write these guidelines, have the skill and knowledge to tailor the guidelines to their needs. Such expertise is often missing in the programmers. Therefore, a screen design system which helps the users by suggesting alternative solutions to the design problem based on the application of these guidelines, supplemented by explaining its rationale in relation to the needs of the users, would be very useful.

Suggestions given by the subjects in the preliminary interview and post-experimental questionnaires on the features of such a system revolved around the capability of the system in evaluating the design against some sort of standard, and in producing alternatives based on such standards.

3. Are the underlying processes of cooperation described in the previous chapter evident in screen designing?

Analysis of the transcripts on the verbal protocols of subjects working together on a form filling or data entry task provided evidence of agreement of a common goal and goal directed behaviour. (This was also substantiated by assessment of the activities of the subjects on video). Subjects also demonstrated different role behaviour. It was also evident that subjects did not always agree with each other, and often presented each other with a different opinion. Meta-communication to avoid misinterpretation was apparent in the message behaviour of the subjects. Subjects also occasionally made light comments and jokes to enforce interpersonal relationships.
4. What have we learnt about the screen design task that could be applied to the development of the cooperative screen design exemplar?

Designers do not follow a fixed sequence in screen design, but the general production phase of analysis, design, and users' evaluation were quoted as the general procedures that are followed. It should be noted that the cooperative exemplar (COSY) will be developed to support the design phase only.

There are many different types of screen, but the most common type is the data entry screen. It is also easier and a more straightforward problem than designing other types of screen (e.g. graphical screens). However, as demonstrated in the results of the protocol analysis, what seemed to be a simple design problem (i.e. the data entry screen design exercise presented to the subjects) raised many design issues (see Table 7.2). In order to keep the number of rules to be incorporated in the cooperative screen design exemplar to a manageable size, it is necessary to scale down the problem further.

Results from the screen design exercises have shown that certain screen design elements are manipulated by the subjects (e.g. "Title of the screen," Screen captions," "Entry fields," etc.). To scale down the problem, the rules and guidelines associated with three or four of these elements can be incorporated within the knowledge base of the cooperative system's exemplar. These elements also form the design objects of the system.

The next chapter described the development of the cooperative screen design exemplar (COSY). The rules governing the screen design elements which forms the heart of the COSY will be elaborated.
Chapter 8:

Formalism Of The Mechanisms Of A Cooperative Screen Design Computer System (COSY)

8.1 Introduction

In the previous chapters, theories of cooperation have been examined and the processes underlying cooperation have been identified and expounded. The requirements for effective cooperation have also been established. From these, the requirements of a cooperative computer system are defined; these are presented in the next section. Following this is a description of a software exemplar named COSY that was developed to demonstrate the underlying mechanisms of human-computer cooperation. COSY supports users in the task of screen design. Results and conclusions drawn from the evaluation of COSY are provided in the last section of this chapter.
8.2 Requirements of a cooperative computer system

Working towards a common goal, communication between partners, development of norms and roles to effectuate goal attainment, and management of conflicts, are the processes underlying cooperation in living systems. The development of a cooperative computer requires the formalisation of these processes. In this section, the mapping of the processes from human-human cooperation to human-computer cooperation is discussed. A model of human-computer cooperation is presented in Figure 8.1. This model is a reflection of the model of human-human cooperation as shown in Figure 6.6. The underlying mechanisms of cooperation represented in the model are discussed here.

In human-computer cooperation, the partners involved are the users of the system, and the cooperative system. The requirements of a cooperative computer and its success depend on the nature of the task that it is developed to support the user in. It has been established that suitable task domains are those that do not have absolute answers. Therefore, discussion of the requirements of a cooperative computer system presented in this section focuses on tasks of this nature.

8.2.1 Goal directed work

Cooperation essentially means working towards a common goal. Therefore, a principal feature of a cooperative system is to know what the goal is, and to actively participate with the user in achieving the goal. This requirement had also been affirmed by Smyth and Clarke (1990). They defined goal as the intended state of an object, or the intended relationship between two or more objects. Therefore, goal directed or goal oriented work often involves moving the goal objects from an initial state to the final state (see Figure 8.1). It is important to note that, "The computer as a
Figure 8.1: Model of human-computer cooperation

N_I = Information Norms
N_I = Interaction Norms
GOW = Goal Oriented Working
machine does not have any needs and thus no intentions either" (Oberquelle, 1983). Therefore, the cooperative system is entrusted with a goal that mirrors that of the users. Fischer et al (1991) suggested several ways in which a critic can acquire an understanding of the users' goals. The simplest approach (and the one implemented in COSY) is "implicit goal acquisition," where a general goal is directly built into the critic system. For example, COSY has been constructed to actively participate with the user in the task of changing the screen from an initial state to a desired state of completion.

However, at the outset, each cooperating partner may only have a general idea of what the "final" state should be, and the model of this state held by both partners may not be the same. As Fischer (1990) noted, users may not have definite, or well-formulated goals to start with. Suchman (1987) proposed that human communicative behaviour is more situated than planned; being guided more by the social circumstances in which it takes place than by some internalised plan. Likewise, when pursuing a task people do not necessarily follow an explicit step-by-step plan they have mentally worked out ahead of time. Rather, they respond to their changing environment based on tacit skills. As mentioned in previous chapters, cooperative partners are interdependent, in that one person's actions affect the other. In the process of cooperative problem solving, the goals of the partners are modified and a clearer picture of the goals slowly evolves. Fischer (ibid) stated that whereas expert systems require a complete specification in order that they are able to solve a problem, cooperative problem solving systems should support the incremental construction of queries and goals. For example, the user of COSY may have a general goal of designing a screen, but only a fuzzy idea of how the screen will look in the end. Through cooperation with COSY, users slowly form a clearer picture of the design, and design ideas may change as users receive feedback, criticisms, or
suggestions from COSY. The active participation of the system with the user in the problem solving task is a distinguishing feature of cooperative systems in comparison with traditional computer systems and expert systems. In sharing the activities involved in goal attainment, the user is also more likely to accept the final solution to the problem.

For the user to be willing to cooperate with (or use) the system, the user must perceive that cooperation with the system will lead to the achievement of their goal. Failure in cooperative achievement of the goal causes frustration and possible rejection of the system. A cooperative system must demonstrate features that will reward the user in cooperating, while keeping the cost or "overhead" of cooperation to a minimum. Thus, a cooperative system must have sufficient and operable task knowledge to help the user in working towards the goal. The system must be relatively easy to use, and be able to provide helpful support, when and where necessary. These are the interaction norms governing the goal oriented work of the partners. For example, COSY has been developed with the aim of cooperating with the user to achieve better design solutions, through application of screen design knowledge or guidelines that users may not be familiar with. Ease of use was also one of the main criteria in the development of COSY. Fischer (ibid) wrote, "In many situations, humans enjoy the process, not just the product; they want to take part in something." Chapter 5 of this thesis established that cooperation not only leads to better task performance, but also to positive psychological and social outcomes. Therefore, it can be argued that a cooperative system is naturally more rewarding compared to traditional computer systems.
8.2.2 Roles

In a small group, members assume different roles after a period of time, to help the group move towards its goals. Even in cooperation between two persons, the partners take on a diversity of roles in their communicative behaviour, (as shown by the designers in the screen design exercise) rather than mimic each other's behaviour.

As discussed in Chapter 5, cooperative work is superior to individual work because partners are able to:

- recall and exchange information, resources and expertise;
- stimulate and inspire each other towards new ideas, and a greater variety of alternatives;
- criticise knowledge and proposed solutions; and,
- check inconsistencies.

Therefore, a requirement of a cooperative system is to be "given" a diversity of roles to prompt the user towards a more diverse way of thinking about the problem, and to generate and communicate alternative solutions.

Fischer (ibid) wrote, "Humans often learn by receiving answers to questions which they have never posed or which they were unable to pose. To ask a question, one must know how to ask it, and one cannot ask questions about knowledge whose existence is unknown." He asserted that a cooperative system has to assume different roles in supporting the user in the task, by looking "over the shoulder" of the user, as it were, to see when and if extra information is needed, display it when necessary and in the appropriate form.
Referring to Figure 8.1, a user can assume many different roles, but the number of roles assigned to the system is finite. A cooperative system can be given the role of a Critic, an Evaluator, an Elaborator, and so on (see Chapter 6). These roles must be suitable for the task of the cooperating partners, and be complimentary to the user.

It has been established in the previous chapter that the benefits of cooperation in screen design stem from the ability of the partners to:

- expand on each other's ideas;
- generate alternative design solutions to stimulate each other towards a more disparate style of thinking;
- evaluate the partner's partial design solutions and provide constructive criticisms;
- stop the partner from "going down the wrong track;" and,
- evaluate the design to spot glaring errors.

Therefore, a system which supports the user in the screen design task must also demonstrate this behaviour. Thus, the following roles were attributed to COSY:

**Evaluator:** Evaluates the proposed solutions of the users.

**Contributor:** Suggests alternative design solutions to the user.

**Information Provider:** Offers the rationale of the suggestions.

**Critic:** Applies critical standards to user's designs, and informs user if such standards are violated.

**Coordinator:** Coordinates the activities of the partners.

### 8.2.3 Communication requirements

Communication is an essential mechanism in effecting and maintaining cooperation. In human-computer cooperation, communication between the two partners is the central process which supports the cooperative work. As stated by
Fischer (ibid), the communication requirement of a cooperative system goes "beyond the user interface." In other words, human-computer communication is more than just the design of the screen the user sees.

Communication between humans is informal and is often non-verbal (such as the use of physical gestures, facial expression, and tone of voice) and takes place via many different types of channels. Human-computer communication has to be formalised, and occurs via the user-computer interface in the form of either written text or simple illustrations (e.g. metaphors, pictures, or graphics) (Silverman, 1992b). The dialogue style chosen for the cooperative system must be representative of the task that the partners are working on, and allow for the skill level of the users of the system. For example, partners working on a design task often represent their ideas in some visual way (e.g. sketching). Therefore, a cooperative system which serves to support the user in the design task has to allow communication to take place via a graphical interface, and provides the appropriate tools for the task.

Successful communication depends on comparable premise for understanding (Oberquelle, ibid). Communication between the partners must operate within a shared environment, where a similar language and knowledge is employed. This was referred to as the Agreed Definition Knowledge Based (ADKB) by Smyth and Clarke (ibid). Within the ADKB, the body of knowledge encompassing the task domain is held. This may include, for example, the common definitions of the goal objects, or the rules and heuristics for problem solving. In human-computer communication, this knowledge is formalised. The body of knowledge held by the system is not necessarily identical to that held by the user. If it is, then cooperation will not benefit
either of the partners. Grice's (1975) maxim of "Quality" forms the informational norm that governs the content of the knowledge base of the system. This rule requires that the knowledge held by the system is:

- sufficient for the task;
- based on established facts and rules;
- relevant to the task;
- up-to-date;
- acceptable to the users;
- beneficial to the users; and,
- comprehensible by the users.

In human-computer cooperation, criticisms and alternative solutions are generated utilising the knowledge and rules within the ADKB. Messages, responses, and the intent of the users are interpreted based on the knowledge within the system. Thus, as in the development of second generation expert systems, it is not enough to build only domain heuristics into the knowledge base (Devedzic and Velasevic, 1990). Other kinds of knowledge, such as, the user goals, problem solving strategies, and model of the users must also be incorporated into the knowledge base of the system. Also, the ways in which knowledge and the decision networks are structured, and the ways in which relevant portion of the knowledge or rules are appropriately retrieved in response to user's activities or queries are important for effective cooperation (Fischer, *ibid*). Activities of the partners have to be coordinated such that responses of the system correspond to the actions of the user. There is also a trend towards economical behaviour in communication (Oberquelle, *ibid*). Users should not be overloaded with unnecessary information and unwarranted repetitions. Grice's (*ibid*) "Relation" maxim which states, "One expects his partner's contribution to be
appropriate to the immediate needs at each stage of the transaction," is an important
guiding principle for the manifestation of effective communication. For example, if
advice on a design decision is required by the user, it would be inappropriate to
present the user with twenty lines of design rationale. Fischer (1993) wrote,
"Relevancy to the task at hand (saying the 'right' thing at the 'right' time) plays an
important role here because the more given information is relevant to the current
problem situation, the more understandable the information is for a human."

The question "what is the right time?" remained a difficult one to answer.
Information could be volunteered by the system before, after, or during the task, or it
could be presented upon request by the users. In the development of critiquing
systems, intervention strategies is a major concern. Different strategies have been
implemented by Fischer et al (ibid) in their development of the "Colorado Critics," to
different degree of success. It is believed that the appropriate strategy depends on the
nature of the task, and the needs of the users. The strategy adopted by the system,
however, should not hinder the partner (especially the user) in performance of the
task.

"Saying the right thing in the right manner" is equally important in
human-computer cooperation. The cooperative system must not only present the user
with the relevant queries, but deliver them in a manner corresponding to that expected
by the user. For example, if a user requests advice on a design problem, this
information should be presented in a manner equivalent to that of a human advisor.
In other words, the message behaviour of the system must correspond to the roles that
have been attributed to the system. The manner in which the messages or information
are structured affect the ways in which the information is interpreted. The maxims of "Relation" and "Manner" are the interaction norms governing the exchange of information between the cooperative partners.

As mentioned in Chapter 6, communicating partners sometimes refer to the communication process itself. Meta-communication serves to make communication more efficient. In human-computer cooperation, meta-communication can be represented as help functions, declarations, implicit default values, and interrupts to support the user in their cooperation with the system, and to enhance the usability of the cooperative system.

As mentioned above, the system and the user must share the same object definitions and cognitive model of the knowledge for effective cooperation. However, these objects and knowledge are formalised and represented in a format different to that of the user. Human-communication is not possible if the partners do not share a common language. A machine translator which converts the output of the system into a form that the user can understand is therefore essential.

8.2.4 Conflict resolution

One of the major requirements of a cooperative computer is the ability of the system to generate alternative solutions to the problem being addressed by the partners. Smyth and Clarke (ibid) wrote, "Such machine generated alternatives, it is contended, could act as catalysts and so play a more active role in the formation of ideas by changing the context in which the user perceives the problem, thereby providing ... a 'greater perceptual span'." A system which is in constant agreement and acceptance of the users' proposals, or simply copies the behaviour of the partner will not allow the user to reap the true benefits of cooperation. However, potential
conflict could occur in this exchange of ideas, information, proposals or suggestions. It is important that strategies for resolving these potential conflicts are integrated into the cooperative system.

Conflict can occur when a user does not agree with the alternative solutions proposed by the system. Suggestions produced by the system must never be imposed upon the users. Control should be placed in the hands of the users, in that they can override the alternative proposals of the system. This is especially relevant to a cooperative system which supports users in a design task, where there are no right or wrong answers, and often design decisions are based on intuition. For example, the design workspace of COSY is separated from that of the user; if the user is happy with COSY’s suggestions of alternative solutions, a facility is provided for the user to "adopt" this into their design workspace. However, when a particularly vital rule is violated in the design proposal of the user, the system must help the user to rectify the error. Therefore it is important that the cooperative system has a full working understanding of the task; knowing what design rules could possibly be "broken," and what rules are indispensable.

One advantage of "conflict" in cooperation is that decision quality is improved as partners challenge each other’s ideas, and explore why they disagree. Therefore, a cooperative computer not only should inform the user of the potential problem in their solutions, but also present the rationale for their alternative solutions, or the principles guiding the proposals. Fischer (1993) argued that there are two components in design: action (as construction) and reflection (as argumentation). A cooperative system which supports users in a design task should possess these two components of the design task. COSY supports the "construction" component through provision of design tools and interface. COSY supports the "argumentation" component of the
screen design task by providing the explanation of the alternative design solutions based on guidelines which link the needs of the end users of the screen to the design solutions.

8.2.5 Distribution and coordination of activities

In agent-based computer systems, often the system is entrusted with the whole problem of the user. This problem is divided into subproblems and distributed to different agents. The results are then integrated into a whole solution to be presented to the user.

In a cooperative computer, the user and the system share the problem solving task. However, the asymmetry of the two cooperating partners could be exploited in that tasks which are particularly difficult for a human partner (e.g. huge amounts of calculation, large database searches) can be allocated to the system, and tasks which are more suitable for a human (e.g. making decisions on the aesthetics property) can be allocated to the user. Task allocation should be carefully coordinated such that the partners do not duplicate each other's work unnecessarily, get in each other's way, or become confused as a result of not knowing what to do. The activities of the partners should be complimentary to facilitate each other towards goal achievement. If cooperation is over a large task, it is important to ensure that all portions of the overall problem are included in at least one partner's activities. Results from each of the sub-tasks need to be properly coordinated and integrated to form a coherent solution.

Besides ensuring that there is a proper coordination of activities between the partners, coordination of behaviour (or interaction) between the partners is important to ensure a certain amount of predictability. Coordination requires the presence of cues to synchronise activities (Clarke and Smyth, *ibid*). In human-computer
cooperation, the cues for synchronising the system's and the user's responses could be based on interaction events (i.e., a keystroke, mouse clicks). For example, a user could ask for help from a tool provided by double clicking on the tool. This provides the cues for the system to display the help information required by the user.

8.2.6 Norms

In a cooperative group, norms are established to govern what members should do, ought to do, and are expected to do. Group norms are like roles in that they let the individual members know the forms of acceptable behaviour expected of them. Norms can be established implicitly or explicitly. The literature survey showed that research on the "cooperative computers" often concentrates on goals and communication, or even roles, but norms are hardly mentioned. However, norms are very important in that they help to bring order and predictability, and encourage goal facilitative actions. In the development of a truly cooperative computer system, it is important to address the issue of norms.

Norms have been categorised as informational, procedural and interpersonal by Kowitz and Knutson (1980). Informational norms reflect a common set of beliefs, values and plans about the group's task. They guide and direct the group's consideration of issues related to their task. They impose a standard by which group members critically and carefully assess information that has been presented towards solving the problem. Procedural norms deal with control and decision making. They regulate the manner in which a group structures its task. A norm is the shared set of expectations about methods for achieving the group's goals. Interpersonal norms are rules that regulate the affective, personal relationship among group members. (These are, in effect, social norms.)
In human-computer cooperation, the partners interact to move towards goal achievement by sharing the task knowledge. Therefore, norms governing the behaviour of the system and the users are the informational norms, and the interaction norms (i.e. interpersonal).

In human-computer interaction, users have a mental representation of how they could use the system to help them with their task. Human factors specialists have always advocated that in interface design, the user's mental model must be mapped onto the system's model such that the system would behave as the users expected. However, in human-computer cooperation, where users and the system exchange ideas and work jointly towards a task, it is not sufficient that the system responds to the user purely as expected on a functional level. It is also expected that the system will be governed by informational norms. The information provided by the cooperative system must be sufficient for the task at hand, and the contribution given must be one that is true, reliable, relevant, up-to-date, and acceptable (Grice, *ibid*). As mentioned above informational norms thus govern the rule and database of the system and also the ways in which this information is presented to the user.

Interaction norms govern the ways in which the system works towards the agreed goal. They presume that the system cooperates with the users at the appropriate level and respond to the users in the appropriate manner. Grice's maxims of "Relevance" and "Manner" constitute the interaction norms governing the activities of the partners. Interaction norms also control the conflict resolution strategies adopted by the system, in that they do not impose their proposals on the user.

In the next section, the ways in which these requirements are demonstrated in a cooperative computer system, COSY, are described.
8.3 COSY: A cooperative screen design system

8.3.1 Introduction

COSY is a screen design system that was developed to demonstrate the underlying mechanisms of human-computer cooperation. Results from the experimental investigation revealed that often screen design is performed with little observance to the rules of screen design. It was established that a screen design system which supports users in the screen design problem by providing alternative suggestions based on the application of screen design guidelines would be very useful. COSY is therefore developed based on a model of users who have little or no knowledge about the human factors issues relating to screen design.

COSY was constructed to assist in the design of a simple form filling, text based screen. This is the most common type of screen that a screen designer would come across. The standard guidelines commonly used for the design of form filling screens were easily handled within the time available for developing the system.

8.3.2 Interface of COSY

In screen design, often the ideas and partial solutions are represented visually, either on paper or by means of a computer based drawing tool. Since screen design is a visual task, the interaction between the system and the user must be graphically based. One desirable feature expressed by the subjects interviewed was that the system should provide design objects that can be easily manipulated. Therefore, it was believed that a direct manipulation dialogue interface which supported simple graphics was more suitable for COSY. LPA MacProlog was chosen as the programming platform as it allows easy generation of windows, tools, menus and
other graphical objects. The Graphical Editor that was provided by LPA MacProlog was adopted and modified in the development of COSY. The Macintosh-based system was constructed over a period of six months, and is only intended as a demonstrator and not a fully working commercial system.

Two graphical windows displayed on separate Macintosh monitors were provided as separate design workspaces for COSY and the user. Alternative design solutions contributed by the system are displayed in the "Suggestion" window, while the user works on the "Graphical Editor" window, which is equipped with standard editing tools and Macintosh based software facilities (such as text entry, cut and paste, font sizes and style options, etc.). This system decision which overcame the problem of presenting alternative designs without interrupting the user from the current task, was adopted from Clarke and Smyth (ibid). It is also based on the contention that while human partners may tolerate sketching on each other's work area, interruption by a computer system may not be well accepted. Implementing the windows on separate display monitors also allows the user and the cooperative system sufficient area to work on.

Alternative design suggestions were also presented as statements of advice displayed in the "Advice" window, which is placed below the "Graphic Editor." The rationale of the design proposals are delivered in the "Explanation" window, which is installed below the "Suggestion window" in the second monitor. The "Advice" and "Explanation" windows are text based. The text windows can be scrolled, and all windows can be switched off at any time.

A pull down menu presents the screen design objects or elements, which are "Title," "Caption and Entry Fields," "Screen Identifier," "Subheadings," and "Messages." The classification of these elements is adapted from Galitz (1989), and
is in agreement with the common terms of reference used by screen designers (as demonstrated in the screen design experiment). Users can also adopt the suggestions given by COSY, ask for a new page, or run the critique facility by choosing the appropriate item from the "Screen Design Utility" menu.

COSY communicates with the user via the interface, and receives "messages" from the user via the keyboard and mouse clicks.

8.3.3 Cooperation between user and COSY

Figure 8.2 presents a model of cooperation between user and COSY. COSY was developed to actively participate with the user in the goal of transforming a data entry screen from an initial state to a desired state. This involves creation of the goal objects, placement of the objects in relation to each other, and/or changing the attributes held by each object. Therefore, a user starts by creating a goal object, positioning it in a chosen location on the workspace, and declares what the goal object is by selecting the appropriate screen design elements from the menu.

Associated with each of the screen design elements are guidelines and screen design rules which are stored in the Agreed Definition Knowledge Based, as shown in Figure 8.2. These rules relate to three main factors: spatial positions of each element, recommended attributes of the element, and the spatial positions of one element in relation to another. These rules were acquired from the screen design experiments and a survey of published guidelines (Galitz, ibid; Tullis, 1983; Tullis, 1988; Sutcliffe, 1988). Table 8.1 shows the screen design rules which are held by COSY. Figures 8.3 and 8.4 show the cooperation between COSY and the user in the layout of "screen title" and "captions and entry fields." On declaration of the goal objects, COSY evaluates the proposals of the user against the embedded rules within
ADKB: Screen Design Rules and Guidelines
Explanations, advice, etc.

User's Environment

Screen Design Elements (Initial State)

COSY's Environment: Macintosh Based

N_I

Translator

Screen Design Elements (Final State)

GOW

N_IC

N_I

N_IC

N_I

Information Norms
N = Interaction Norms
IC
GOW = Goal Oriented Working
ADKB = Agreed Definition
Knowledge Base

Figure 8.2: A model of cooperation between user and COSY

Page 259
<table>
<thead>
<tr>
<th>Screen Design Element: TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Title is placed at the centred position at the top of the screen.</td>
</tr>
<tr>
<td>2. Title should be in bigger, bold and uppercase font.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Screen Design Element: Screen Identification (ID) or Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Screen ID should be in the upper right-hand corner of the screen.</td>
</tr>
<tr>
<td>4. Screen ID should be placed one line above the title.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Screen Design Element: CAPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Captions should be placed five spaces from the edge to create a margin.</td>
</tr>
<tr>
<td>6. Captions should be left justified and aligned.</td>
</tr>
<tr>
<td>7. Captions in a group are kept apart by a single line spacing.</td>
</tr>
<tr>
<td>8. Captions should be placed below title and screen ID.</td>
</tr>
<tr>
<td>9. Separate long captions into two lines.</td>
</tr>
<tr>
<td>10. Captions should be in uppercase.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Screen Design Element: ENTRY FIELDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Identify entry fields by using lines.</td>
</tr>
<tr>
<td>12. Groups of entry fields must be left aligned.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Screen Design Element: CAPTIONS AND ENTRY FIELDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Captions and entry fields should distinguishable by being separated by a colon and a space.</td>
</tr>
<tr>
<td>14. Caption colon should be placed immediately next to the caption.</td>
</tr>
<tr>
<td>15. Captions and entry fields in a group should be left justified, and a space should be left between the longest caption and its entry field.</td>
</tr>
</tbody>
</table>
TITLE ATTRIBUTE
Use bold, bigger, uppercase font for the title.

POSITIONING OF TITLE
Place the title in the centered position at the top of the screen.

The alternative design solution is presented graphically in the “Suggestion” window, and textually in the "Advisor" window. The rationale of the proposal is given in the "Explanation" window.

Figure 8.3: Cooperation between COSY and the user in the layout of a screen title.
CAPTION AND ENTRY FIELD
Separate the caption from the entry field by a colon and one space.

CAPTIONS ALIGNMENT
Place captions five spaces from the edge of the screen to create a margin and left justify all captions in a group.

Explanation

CAPTIONS AND ENTRY FIELD
The caption and the entry field should be clearly separated from each other using a space and a unique symbol. The colon (:) is recommended because it provides a definitive and yet unobtrusive break between the two, so a margin should be created.

CAPTIONS ALIGNMENT
Captions should not be placed too near to the edge of the screen, so a margin should be created. Captions in a group should be aligned to provide a visually pleasing composition.

Figure 8.4: Cooperation between COSY and the user in the layout of screen captions and entry fields.
the system. When differences beyond a satisfactory threshold occur, COSY advises
the user of an alternative design. These thresholds are based on the layout coordinate
limits which have been derived from the screen design guidelines and rules. The
graphical format of the suggestion is presented in the "Suggestion" window, and the
associated advice given is displayed in the "Advisor" window.

Although there are rules and guidelines governing screen design, it is still
considered an art rather than a science. Even when a screen is designed with
adherence to all the rules and guidelines, it may still be appalling to look at.
Therefore, although COSY provides alternative design solutions that are guided by
these guidelines, control is still placed in the hands of the users as to whether to adopt
these suggestions or to ignore them. In other words, COSY does not have an aesthetic
judgement capability. The user has the option of adopting the full design proposal
offered by COSY, or selecting specific elements to adopt into their workspace.
User's partial solutions are deleted before COSY's proposal is placed on the user's
workspace so that these elements do not appear twice or overlap each other. The user
can also simply ignore COSY's suggestion and continue with the design task in the
workspace provided. COSY, by displaying alternative design ideas on its own
workspace, does not impose its design on the user at any time or in any way. The
strategy utilised by COSY is "cooperation upon request."

One of the roles that COSY plays in supporting the user in the screen design task
is that of a "Information Provider." High quality screens (interfaces) emanate from
inherent quality features that are achieved by thoughtful planning, sensitivity to user
needs, careful attention to detail in design and development (Shneiderman, 1987).
Providing the link between design proposals and the needs of the end-users of the screen in the argument enable the user (of COSY) to produce better quality screens. This design rationale is displayed in the "Explanation" window.

COSY is able to handle more than one goal object at a time. COSY not only checks the positions of a single element, but also the placement of elements in relation to each other. COSY supports the screen design task on a developing and cumulative basis. A step towards meta-communication between COSY and the user is implemented as help messages displayed by the system. The user activates these messages by double-clicking on the tools for which help is required.

When all the required screen elements have been laid out, the user can request COSY to provide a critique of the design. According to Tullis (1984), there are four basic characteristics of display formats that affect how well users can extract information from the displays. These are: overall density, local density, grouping, and layout complexity. These factors constitute the criteria for evaluating the usability of layout of screens. Aesthetic evaluation of the screen is left to the designer. Due to time constraints, only the overall density factor was implemented. When the user chooses the "Critique" facility, COSY computes the density value of the screen and presents it via a pop-up window. COSY also informs the user of the optimum density based on recommendation by Tullis (ibid).

COSY cooperates with the user by emulating four distinctive roles: Contributor, Advisor, Information Provider, and Critic. A cooperative processor coordinates the activities of the user and the system, activating the appropriate process and dialogue modules attached to each role. Figure 8.5 presents a conceptual model of the roles of COSY. A translator which converts the MacProlog syntax into a comprehensible discourse is provided by the LPA MacProlog programming environment.
Figure 8.5: Conceptual model of the roles of COSY
8.4 Evaluation of COSY

8.4.1 Introduction

The cooperative system developed in this project is unique and different from traditional computing systems. A standard evaluation methodology for such a system is currently not available. Silverman (1992c) proposed a methodology for evaluating expert critiquing systems. He suggested four dimensions for evaluating critics. These are: cue coverage, strategies, human factors, and performance improvement. Cues are defined as "the normative variable settings the subject factors into his decision making process" (Silverman, ibid). These could be the series of rules, schemas, templates, lessons learned, and/or knowledge chunks for making a judgement or decision. Evaluation of this dimension comprises evaluating how exhaustive the cue coverage is, and what error toleration is appropriate, so that users would not be interrupted on the smaller errors. Evaluation of criticism strategies involves evaluation of the timing and ways that effective feedback and advice are presented to the users. The human factors dimension covers the interface issues and skill level appropriateness of the system. The most important dimension of evaluation is performance improvement. Basically this asks the question whether the critic makes a difference. Silverman's (ibid) critic evaluation methodology uses an integration of several methods. COSY is only a demonstrator of the proposed underlying mechanisms of a cooperative system. It is by no means a full working screen design cooperative system. Therefore, Silverman's full evaluation methodology was not employed in the evaluation of COSY. However, the four dimensions suggested by Silverman were used as guiding principles for the evaluation of COSY. Thus, COSY was evaluated on the following dimensions:
A. Performance Effectiveness

In the process of screen design, problem identification can be defined as understanding the specific and functional relationship between the objects (screen elements), the rules (screen design guidelines) and users' needs.

Problem solving involves translating the understanding of these relationships into design actions. A hypothetical model of the cooperation between a user and COSY in the screen design task is shown in Figure 8.6. The user analyses the screen design problem and proposes a solution (A). COSY evaluates the design solution, and presents the user with an alternative design solution. The user can either ignore COSY’s idea and retain his solution (A) or adopt COSY’s solution and move on to the next problem. The user may also adopt COSY’s suggestion and modify the solution or produces a different design solution (C), having learnt from the knowledge shared by COSY. A synergistic effect is said to occur in the second or third case. It was hypothesised that COSY would have made a difference when:
Figure 8.6: Hypothetical model of cooperation in a screen design task between a user and COSY.
- through their interaction with COSY, subjects increased their awareness of the relationship between screen elements, rules and needs of users;
- the ultimate solution was perceived by the subjects to be better than the one that they would have come out with when working on their own;
- the subjects had learned more about screen design issues after interaction with COSY.

These hypotheses formed the criteria for the evaluation of performance improvement brought about by COSY.

B. Cooperation strategies

Certain strategies have been implemented in COSY to facilitate the cooperative processes between COSY and the user. These were the separation of the workspace of COSY and the users; the identification of goals through declaration of screen elements; and the ability to adopt COSY’s solutions. The usefulness of each of these strategies was evaluated.

C. Information provided by COSY

The information provided by COSY is measured in terms of its helpfulness, sufficiency, clarity and acceptability, both in the Advisor and Explanation windows.

D. Usability of COSY

Ease of use of COSY was also evaluated.
A questionnaire which addresses the issues discussed above was formulated. Users were also requested to propose ways in which COSY could be improved, and to add further comments that they deemed appropriate. (A copy of the questionnaire is presented in Appendix G.)

8.4.2 Subjects

Subjects who were engaged for the evaluation programme consisted of the targeted user population of COSY, namely, people who have to design screen layouts, but have very little human factors knowledge relating to screen design. Six subjects were employed for the evaluation, due to time and resource constraints.

8.4.3 Screen redesign task

COSY in its current state, is incorporated with a selection of screen design guidelines, presented in Table 8.1. A suitable task for this evaluation was one that would involved the consideration of only the screen design elements provided by COSY. The task should have been structured such that all the guidelines incorporated would be evoked. The task should also have been simple and achievable within a half hour period.

With these constraints in mind, a screen redesign task, rather than a design from scratch was chosen. Subjects were presented with a "screen dump" of part of a data entry screen. The screen dump consisted of screen elements that "broke" all the rules of a good screen design. Subjects were instructed to cooperate with COSY to redesign the screen layout. They were also informed that extra information other than that already given on the screen dump was not necessary. (The full instructions are offered in Appendix G.)
8.4.4 Procedure

Subjects were presented with the instruction and a copy of the screen dump. This was followed by a short demonstration on the use of COSY. Subjects were also given five to ten minutes to explore COSY and to query the experimenter regarding COSY. This was followed by the screen redesign task for which subjects were given thirty minutes to complete. Finally, subjects were presented with the questionnaire. The design activities of the subjects were logged for analysis of the activities described in the hypothetical model shown in Figure 8.4. The experimenter stayed with the subjects throughout the redesign task to answer questions.

8.4.5 Results

As in Chapter 7, some of the questions posed to the subjects in the questionnaire are paraphrased and presented together with the results.
Question 1: Do you agree that COSY cooperated with you by helping you to identify screen design problems?

Number of Subjects (Total = 6)

Question 2: Do you agree that by providing you with alternative design solutions, COSY prompted you to produce better screen layout?
Question 3: Are you satisfied with the design solutions that you produced using COSY?

Number of Subjects (Total = 6)

Question 4: Do you agree that cooperating with COSY has helped you to learn more about issues of screen design?

Number of Subjects (Total = 6)
Question 5 and 6: Are the information provided in the Advisor and Explanation windows:

Number of Subjects (Total = 6)

![Bar chart showing the number of subjects marked as Unhelpful or Helpful in the Advisor and Explanation windows.]

Number of Subjects (Total = 6)

![Bar chart showing the number of subjects marked as Insufficient or Sufficient in the Advisor and Explanation windows.]

Page 274
Number of Subjects (Total=6)

Confusing Clear

Confusing Clear

Not acceptable Acceptable

Advisor window  Explanation window
Question 7: Is the graphical presentation of COSY's design solutions:

**Number of Subjects (Total = 6)**

Unhelpful

Helpful

Not acceptable

Acceptable
Question 8: COSY’s workspace are clearly separated and independent to its users. Do you find this arrangement satisfactory?

Number of Subjects (Total = 6)

Question 9: Do you find it useful to be able to adopt COSY’s suggestions?

Number of Subjects (Total = 6)
Question 10: Do you find it acceptable to have to identify screen elements such as "Title," or "Caption," etc.?

Number of Subjects (Total = 6)

![Bar chart showing number of subjects' responses to Question 10]

Question 11: Do you find COSY easy to use, or difficult to use?

Number of Subjects (Total = 6)

![Bar chart showing number of subjects' responses to Question 11]
Question 12: Do you agree that COSY is a different kind of support system compared to others that you have previously used?

Number of Subjects (Total = 6)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not agree</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partially agree</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fully agree</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Question 13: Would you use COSY again?

Number of Subjects = 6
8.4.6 Discussion

Results from Questions 1 and 2 showed that COSY successfully cooperated with the subjects in the screen design task by firstly, helping them to identify the problems in the original design, and prompting them to produce better screens. Subjects also learnt more about screen design through cooperation with COSY. However, 2 out of 6 of the subjects were not satisfied with the design solution that they produced using COSY, and two others were only moderately satisfied. This can be due firstly, to the time limit imposed on the subjects. Subjects were only given half an hour on the redesign task; therefore, just managing to produce a first pass solution. From previous interviews with screen designers, it emerged that they were not satisfied with the solution unless it had been tested out on real users, with reiteration of the design process. As COSY was not a complete cooperative screen design system, other screen design objects (e.g. buttons, pull down menus, etc.) that subjects could have incorporated in their design were not made available.

The subjects activity log showed that all the subjects adopted COSY's solutions on more than one occasion. As hypothesised, subjects were also found to adopt the design proposed by COSY and modified the design. For example, one of the subjects created a "title" and placed it at the top middle of the screen. COSY's suggestion was that the "title" be in bold. The subject adopted COSY's suggestion and then boxed the "title." Subjects were also found to propose new solutions through exchange of ideas with COSY. For example, a subject created the "title" and placed it on the left hand corner at the top of the screen. COSY placed its "title" at the top centred position of the screen in bold. The subject then deleted his own design, and placed a new "title" at the top centred position of the screen, in bold and italicised.
The information provided by COSY in the "Advisor" and "Explanation" windows were generally found to be helpful, sufficient and acceptable. Subjects' ratings on clarity of information in both the windows were more widespread. One subject pointed out that the headings of the issues presented in the windows should be bold so that users could quickly search for the relevant information. One of the subjects showed a clear preference for the information provided in the "Advisor" window (by giving the maximum ratings on all the four properties), but gave very low ratings on the properties of information in the "Explanation" window. This subject felt that the information given in the "Advisor" window was good for quick decisions, but the information displayed in the "Explanation" window was too involved. However, another subject felt the information in the "Advisor" window was insufficient and unclear, and preferred COSY to provide more knowledge on the task domain. Although information presented in these two windows aimed to follow Grice's rules of "Quantity," and "Quality," further evaluation was necessary to gauge the optimum amount of information to be displayed. Hayes and Reddy (1983) wrote, "There is a social dimension to the interaction of people with computers which often leads us to describe that interaction as 'dialogue' involving the 'communication' of information. However, once this metaphor is adopted, it becomes clear that the quality of current human-computer communication is inferior to that of most human-human communication in a number of respects." Further research into the development of "bidirectional mixed initiative control characteristic of natural conversation," and exploration in "alternative ways of sharing control between users and computers to increase the interactivity of the interactive systems" (Frohlich and Luff, 1989) would be very useful in the development of cooperative computer systems.
All the subjects were happy with the independent workspaces between COSY and the subject, and all but one subject found it very useful to be able to adopt the suggestions offered by COSY. The graphical representation of COSY's design displayed in the "Suggestion" window was considered helpful by most of the subjects. One of the subjects expressed the view that, "The graphical solution presentation was particularly useful for making the recommendations clear." However, ratings on acceptability of this display were not as favourable. Some subjects felt that the ability to edit the recommendations before adopting them would be very useful. Another recommendation was a greater use of highlighting in the "Suggestion" window to reinforce the recommendations.

Most subjects accepted the procedure of declaring the goal objects in COSY. However, half the subjects did not find COSY an easy system to use. This could be due to the fact that COSY was still a prototype and functionalities offered by a normal design tool were not available. As a demonstrator, subjects were provided with the basic tools for a text based screen design. One of the subjects stated that tools similar to those of MacDraw would be easier to work with. Another subject also suggested an exploratory "What if?" style of interaction, in which one can return to a previous layout state if desired. Most subjects agreed that COSY is a very different kind of support system. One of the subjects wrote, "I found working with this system interesting." All the subjects affirmed that they would use COSY again.

8.5 Conclusions

The requirements of a human-computer cooperative system were discussed in this chapter. These requirements provided the foundation on which a software exemplar, COSY, was constructed to demonstrate the mechanisms of a cooperative
computer system. It can be concluded that COSY has demonstrated cooperative behaviour by supporting the users in identifying the screen design problem and prompting them to produce better screen layout through the suggestion of alternative design solutions. The different roles played by COSY have been proven to be useful in supporting the cooperative activities of the partners. The strategies adopted by COSY to facilitate the cooperative processes were effective and acceptable. COSY helped the users to learn more about screen design. COSY was perceived as a different kind of computer system. Most importantly, cooperation between COSY and the users has demonstrated the synergistic effect which is believed to be the major advantage of cooperative work.

However, the evaluation process had highlighted certain limitations of COSY. The restricted functionalities and limited amount of knowledge provided by COSY had affected the usability of the system as a screen design tool. The usability of COSY could be improved given more time and resources to develop the system. Results of the evaluation had also underlined the importance of the communicative processes between the cooperative partners in human-computer cooperation.
Chapter 9:

Conclusions and Further Research

9.1 Conclusions

Computers have come a long way from being merely "fast calculating machines." Research in computer systems is in the realm of "beyond computable numbers." Computer systems that mimic human intelligence are now a reality, although not without their drawbacks. The quest is now for systems that are not only able to provide knowledge, but are actively involved in the tasks of the users. Interest in building systems that work together with users to support and augment creativity is increasing. For example, Microsoft has incorporated the much-vaunted "IntelliSense" technology in its wordprocessing software (WORD 6.0), which works together with users in the creation of different document formats. It is believed that cooperative computing would be a major contribution to this field of work. However,
it is argued in this thesis that the theoretical foundations of cooperation are still poorly defined. The fundamental contribution of the work described in this thesis is in establishing the underlying mechanisms of a cooperative computer system based on the principles of cooperation, and the successful instantiation of these mechanisms in a cooperative screen design exemplar named COSY.

From the studies of human-human cooperation, and animal cooperation, it has been established that cooperation is often a goal directed act. Cooperative partners are interdependent, facilitating each other towards a desired goal. Communication was found to be a major contributor for effective cooperation. Previous chapters have discussed in detail other factors that influence and maintain cooperation over a task. These are summarised in the first column of Table 9.1. A model of cooperation encapsulating these factors has been presented in Figure 6.6 (in Chapter 6). From these, guidelines for the requirements of cooperative systems and a conceptual model of human-computer cooperation (presented in Figure 8.1) were developed and discussed. A summary of the guidelines is presented in the second column of Table 9.1. These in turn provided the framework in which the requirements of the cooperative computer system (COSY) were successfully defined (outlined in the last column of Table 9.1). However, the guidelines provided in the table can be applied to the development of future cooperative systems.

Cooperation was viewed as a system consisting of a task and social dimensions. Elements within these two dimensions are highly interdependent; a change in one component effects changes in other components. Likewise, in human-computer cooperation, it is necessary to place equal importance on considerations of the interaction and task components of the system. It has also been established that some types of task are more suitable for cooperation than others; particularly tasks which
are open ended, and which there are several alternatives to the solutions. It is therefore concluded that it is difficult to consider a cooperative system independently from the task which the system serves to support.

The work described in this thesis has also revealed that the communication requirement of a cooperative system goes beyond the user interface. A computer system that actively participates with the user must not only provide an interface that is ergonomically favourable, but incorporate cooperative processes (e.g. different roles represented by the system) that facilitate the user towards task achievement.

A cooperative system must contain sufficient, relevant and operable knowledge of the task domain to enable it to be an active and equal partner in the cooperative process. Although the user and the system must share common definitions of the objects of the task, the knowledge held by the system and the application of this knowledge by the system must be sufficiently different and complimentary to the user to avoid the occurrence of mimicry. It is also important for knowledge held by the system to be updated and developed so that the system does not become static and predictable in its generation of alternative solutions. A similar conclusion was drawn by Clarke and Smyth (1993) in their work.

From the discussions of the rewards associated with cooperation, it was shown that the main advantage of cooperation in problem solving is the potential for synergy, in which partners inspire each other with new ideas, and stimulate one another towards a more diverse style of thinking. The potential for achieving synergy in the cooperation between a human and a computer is the main motivation for the work undertaken in this research. Synergy is achieved through the exchange of ideas, constructive criticisms of knowledge, and evaluation of each other's proposals. Therefore, the ability to generate alternative solutions and the critical evaluation of
information is conceived to be a major requirement in representing cooperation in a computer system. The software exemplar, COSY, that was constructed to instantiate the identified mechanisms underlying cooperation has demonstrated successfully this synergistic relationship in its cooperation with its users.

9.2 Further research

Several issues related to the development of cooperative computer systems arose during the course of this work. The most promising of these questions for further research are:

A. Representing the "social" dimension of the cooperative system.

In human-human cooperation, partners foster interpersonal relationships to cultivate a better working environment; one that leads to both tangible and emotional rewards. The ways in which a cooperative system can be developed to incorporate the "social" dimension needs to be further investigated. For example, the system can be given the role as an "Encourager." The use of multimedia (such as moving pictures, voice generation, etc.) in support of the cooperative processes in order to make the cooperative system more enjoyable and interesting to use should be looked at.

B. Learning and adaptation capability of the cooperative system.

In human cooperation, the partners learn from each other through the exchange of information and ideas. Results from the evaluation of COSY demonstrated that users learnt more about the screen design task through their interaction with COSY. However, the ways in which a cooperative system learns from its users require further research. As previously discussed, a cooperative system must be capable of being
updated and expanded, so that its suggestion of alternative solutions does not become predictable and stagnant. A cooperative system can be also be adaptive, in that it automatically changes its behaviour based on information that is observed and inferred (Fischer et al, 1991). The system can also be developed to alter its behaviour relative to the user of the system. These adaptation capabilities of a cooperative system offer an interesting challenge for further development of the system.

C. Communication strategies for exchange of ideas.

Grice's communicative maxims can be paraphrased as, "Saying the right thing at the right time, and in the right manner." The timing and manner in which information (knowledge, suggestions, critiques, etc.) are presented to the user, and the amount of information contributed by a cooperative system need to be further investigated. The relationship between appropriate communication strategies and the type of tasks that the system serves to support the user in presents an issue for further research in cooperative systems.

Research in human-computer cooperative systems is an area of growing interest. Human-computer cooperation results in synergism, which holds great promise for the development of knowledge based systems that serve to augment the creativity of the users of the systems.
<table>
<thead>
<tr>
<th>Features of human-human cooperation</th>
<th>Requirements of human-computer cooperation</th>
<th>Characteristics of user-COSY cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL: Figure 6.6 (Page 173)</td>
<td>MODEL: Figure 8.1 (Page 243)</td>
<td>MODEL: Figure 8.2 (Page 259)</td>
</tr>
<tr>
<td><strong>Goal</strong></td>
<td><strong>Goal</strong></td>
<td><strong>Goal</strong></td>
</tr>
<tr>
<td>Activities of the members are goal directed.</td>
<td>A cooperative system should know the goals of the users and actively participate with them in achieving these goals. Therefore, it is important to consider ways in which the goals of the users are understood by the system or vice versa.</td>
<td>COSY works with users in the goal of changing the screen from an initial state to a desired state of completion.</td>
</tr>
<tr>
<td>Member’s participation in the formulation of these goals is recommended so that they have a clear picture of these goals, and the path leading to the goals.</td>
<td>The system should support incremental construction of the users’ goals.</td>
<td>COSY participates with the user in the incremental construction of the layout of a form-filling screen.</td>
</tr>
<tr>
<td>Members trust each other to be able, willing and interested in working towards achievement of these goals.</td>
<td>Users must perceive that working with the system will lead to the achievement of their goals, while keeping overheads of cooperation to minimum. Hence, a cooperative system must have sufficient and operable task knowledge to support users in the task, while easy to use and providing practical support when necessary.</td>
<td>COSY cooperates with the user in achieving better design solutions through the application of screen design knowledge and guidelines.</td>
</tr>
<tr>
<td><strong>Norms</strong></td>
<td><strong>Norms</strong></td>
<td><strong>Norms</strong></td>
</tr>
<tr>
<td>A high degree of predictability of conduct is needed.</td>
<td>The norms governing a cooperative system are &quot;informational&quot; and &quot;interaction&quot; norms.</td>
<td>Although the communicative acts of COSY were governed by Grice’s norms of &quot;Relation&quot; and &quot;Manner,&quot; more research is needed in this area.</td>
</tr>
<tr>
<td>Informational, procedural and interpersonal norms which encourage goal facilitative actions should be established.</td>
<td>Informational norms govern the knowledge base of the system, and the ways in which information is presented to the users.</td>
<td></td>
</tr>
<tr>
<td>Members should critically evaluate the norms that they are asked to conform to.</td>
<td>Interaction norms govern the cooperative processes, in that a cooperative system must support the users at the appropriate level, and respond to the users in the appropriate manner.</td>
<td></td>
</tr>
</tbody>
</table>
Communication must be allowed between the partners.

Communication about the task and to foster interpersonal relationship should be encouraged.

Partners must have a shared environment for effective communication to take place.

Norms that govern the communicative process should be encouraged.

Meta-communication to reduce "noise" must not be ignored.

Human-computer communication is the central process which supports cooperation between the user and the system.

Unlike human-human communication, human-computer communication needs to be formalised.

The chosen dialogue style must be representative of the task that the partners are working on.

It is essential to have an agreed definition knowledge base in which the shared body of knowledge encompassing the task domain is held. This knowledge should not be totally identical to that held by the users. Knowledge held in the knowledge base should be governed by informational norms (e.g. Grice's maxims of "Quality").

Human-computer communication should be governed by norms of communication (e.g. Grice's maxims of "Relevance," "Relation," and "Manner").

Intervention strategies adopted must not hinder the performance of the users. The success of the strategy for any system is dependent on the nature of the task and the needs of the users.

Meta-communication to enhance the usability of the system can be implemented as help functions, implicit default values, interrupts, etc.

Direct manipulation dialogue and graphical interface (which are more suitable for design tasks and are easier to use) were chosen for COSY.

COSY communicates with the users via the interface, and receives messages from the users via the keyboard and mouse clicks.

Users declare the nature of the goal objects by selecting the appropriate screen design elements from the menu.

Associated with each screen design element are guidelines and screen design rules held in the Agreed Definition Knowledge Base. These rules were derived from experiments and published guidelines.

"Cooperation upon request" was the intervention strategy adopted for COSY. A step towards meta-communication between COSY and the users is implemented as help messages displayed by the system.
<table>
<thead>
<tr>
<th>Roles</th>
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<tr>
<td>Partners should not mimic each other's behaviour.</td>
<td>Cooperative system should be given a diversity of roles to prompt the users towards a more diverse style of thinking about the problem, and to generate and communicate alternative solutions.</td>
<td>The following roles were attributed to COSY:</td>
</tr>
<tr>
<td>A diversity of roles which bring a variety of information and styles of exchanging information should be cultivated.</td>
<td>A user can assume many different roles, but the number of roles assigned to the system is finite.</td>
<td>Evaluator: Evaluates the proposed solutions of the users.</td>
</tr>
<tr>
<td>Only roles which are complimentary to the partners personality and which will enhance task performance should be encouraged.</td>
<td>The roles attributed to the system must be suitable and complimentary to the tasks of the users.</td>
<td>Contributor: Suggests alternative design solutions to the users.</td>
</tr>
<tr>
<td>Cooperative systems should generate alternative solutions to act as catalyst to increase users' perceptual span.</td>
<td>Strategies for resolving potential conflicts should be integrated into the cooperative system. For example, suggestions produced by the system must never be imposed on the users, and control should be placed in the hands of the users.</td>
<td>Information Provider: Offers the rationale of the suggestions.</td>
</tr>
<tr>
<td>Constructive conflict over ideas should not be suppressed.</td>
<td>COSY evaluates the proposals of users against embedded rules within the system. When differences beyond a suboptimal level occurs, COSY advises the users of alternative design solutions. This is displayed in COSY's own workspace, so as not to impose its design upon the users.</td>
<td>Critic: Applies critical standards to users' designs and informs users if such standards are violated.</td>
</tr>
<tr>
<td>Conflict between the partners must be properly managed.</td>
<td>Users have the options to adopt or ignore COSY's suggestions.</td>
<td>Coordinator: Coordinates the activities of the partners.</td>
</tr>
<tr>
<td>Partners should present differing views and ideas, and search for alternative solutions. The ability to exchange and criticise ideas is a major advantage of cooperative work.</td>
<td>COSY also aims to avoid users' rejection of its suggestions by providing rationale for those suggestions.</td>
<td></td>
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291
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<thead>
<tr>
<th>Coordination</th>
<th>Coordination</th>
<th>Coordination</th>
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<tbody>
<tr>
<td>Effective coordination implies some degree of mutual predictability and reduction of conflict.</td>
<td>Task allocation should be carefully coordinated such that human and system do not unnecessarily duplicate each other's work, and to ensure that all portions of the task are included.</td>
<td>The activities of the different roles played by COSY are coordinated by a cooperative processor which activates the appropriate processes and dialogue modules attached to each role.</td>
</tr>
<tr>
<td>Activities of the cooperating partners need to be synchronised to avoid duplication of work and conflict of actions.</td>
<td>Activities of system and users should be complimentary to facilitate each other in goal attainment.</td>
<td></td>
</tr>
<tr>
<td>Cues could be used to synchronise activities.</td>
<td>Cues for synchronisation of activities can be based on interaction events, such as keystrokes and mouse clicks.</td>
<td></td>
</tr>
<tr>
<td>Author(s)</td>
<td>Title</td>
<td>Publisher/Year</td>
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<tr>
<td>Ahlgren and Johnson, 1979</td>
<td>Sex differences in cooperative and competitive attitudes from 2nd through to the 12th graders.</td>
<td>Developmental Psychology, 1979, vol 15, no 1, pp 45-49.</td>
</tr>
</tbody>
</table>


Birenbaum and Sagarin, 1976
Birenbaum, A., and Sagarin, E., Norms and human

Bixenstine and Wilson, 1963
Bixenstine, V.E., and Wilson, K.V., Effects of level of
cooperative choice by other player on choice in a
PDG. Journal of Abnormal and Social Psychology,
1963, vol 67, no 2, pp 139-147.

Boesch, 1990
Boesch, C., First hunters of the forest. New Scientist,

Bogardus, 1959
Bogardus, E.S., Cooperation as a concept. Sociology

Bornstein and Rapoport, 1988
Bornstein, G., and Rapoport, A., Intergroup
competition for the provision of step-level public
goods: Effects of preplay communication. European
Journal of Social Psychology, 1988, vol 18, no 2, pp
125-142.

Brams, 1985
Brams, S.J., Superpower games. Yale University

Bridgeman, 1977
Bridgeman, D., Cooperative, interdependent learning
and its enhancement of role taking in fifth grade
students. Paper presented at the American
Psychological Association Convention, San Francisco,

Brotsky and Thomas, 1967
Brotsky, S., and Thomas, K., Cooperative behavior in
preschool children. Psychonomic Science, 1967, vol 9,
pp 337-338.

Broverman et al, 1970
Broverman, I.K., Broverman, D.M., Clarkson, F.E.,
Rosenkrantz, P.S., and Vogel, S.R., Sex-role
stereotypes and clinical judgments of mental health.
Journal of Consulting and Clinical Psychology, 1970,
vol 34, pp 1-7.

Brown, 1988
Brown, R., Group Processes: Dynamics within and
Buchanan and Shortliffe, 1984


Buckley et al, 1974


Carment, 1970


Carment, 1974


Cartwright and Zander, 1968


Chase, 1980


Chertkoff and Esser, 1976


Chodorow, 1974


Christie et al, 1970


Clarke, 1988

<table>
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<th>Author(s)</th>
<th>Year</th>
<th>Title</th>
<th>Journal/Publication Details</th>
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Crokenberg and Bryant, 1978


Davis, 1969


Dawes et al, 1988


Deutsch, 1949a


Deutsch, 1949b


Deutsch, 1960


Deutsch, 1962


Devedzic and Velasevic, 1990


DeWaal and Harcourt, 1992

Eason, 1979


Edmonds, 1987


Edmonds, 1993


Ellis and Fisher, 1994


Ells and Sermat, 1968


Engelhard, 1985


Engelhard and Monsaas, 1989


Evans, 1964

Evans and Crumbaugh, 1966

Fischer, 1987

Fischer, 1990

Fischer, 1993

Fischer and Mastaglio, 1989

Fischer and Girgensohn, 1990

Fischer et al, 1989
Fischer et al, 1991


Fisher, 1978


Fisher and Smith, 1969


Frohlich and Luff, 1989


Galitz, 1989


Gallo, 1966


Gallo, 1972


Gallo and McClintock, 1972

<table>
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<th>Author(s)</th>
<th>Year</th>
<th>Title</th>
<th>Journal/Publication Details</th>
</tr>
</thead>
</table>
Harrison and McClintock, 1965


Hayes and Reddy, 1983


Heller, 1967


Herndon and Carpenter, 1982


Hodges, 1987


Holland and Danielsen, 1989


Homans, 1950


Homans, 1961


Hottes and Kahn, 1974


Huntingford, 1982

<table>
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<th>Author(s) and Year</th>
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Loomis, 1959


Lutzker, 1961


Macoby and Jacklin, 1974


Madsen, 1967


Madsen, 1971


Madsen and Shapira, 1970


Madsen and Shapira, 1977


Madsen and Yi, 1975


Marin et al, 1975


<table>
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<th>Reference</th>
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<th>Journal/Proceedings</th>
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Pepitone, 1980  

Pepitone and Hannah, 1980  

Philips and D'Amico, 1956  

Piaget, 1932  

Pilisuk and Skolnick, 1968  

Pruitt, 1967  

Radlow et al, 1968  

Rapoport and Chammah, 1965  

Rice and White, 1964  


Schwartz and Howard, 1982


Scodel, 1962


Scrivener et al, 1992


Seeley and Visscher, 1988


Sermat, 1967


Shaw and Thorslund, 1975


Shears and Behrens, 1969


Sherif, 1966

<table>
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<tr>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
</table>


Terhune, 1968

Thomas, 1975

Tjosvold, 1988

Tjosvold et al, 1983

Tjosvold and Johnson, 1978
Tjosvold, D., and Johnson, D.W., Controversy within a cooperative or competitive context and cognitive perspective taking. Contemporary Educational Psychology, 1978.

Tjosvold and Tsao, 1989

Tjosvold et al, 1977

Trivers, 1971

Tubbs, 1978


Van der Velden, 1991  Van der Velden, P., Summary: User Interface designers. Email survey. For a copy of result, send message to: velden@serc.nl.


Whitworth and
Lucker, 1970


Wichman, 1972


Wilkinson, 1988


Willis and Joseph, 1959


Wispe, 1972


Wrightsman, 1966


Wrightsman et al, 1972


Wrightsman et al, 1967

Appendix A

Preliminary Interview Questionnaire.
ANALYSIS OF CURRENT PRACTICES

A. DESIGNERS

1. What do you consider your level of experience of screen design or layout of information of screen to be?

   
   
   
   1 2 3 4 5
   
   Inexperienced Fairly Very Experienced
   
   Experienced

B. SCREEN DESIGN TASKS

1. Please tell me about the various types of screen that you have designed.

   Examples:
   - Form filling screens
   - Data entry screens - used with a dedicated source document
   - Data entry screens - used without a dedicated source document
   - Inquiry screens - e.g. used to display the results of an inquiry request or contents of a computer files.
   - Questions & Answers screens
   - Menu screens
   - Graphics screens

2. Of all of these types of screen, which one, in your opinion, is most difficult to design and should (could) be supported by a computer system?

   (Explain objective of question if necessary.)

3. When you are designing a screen, please tell me the sequence that you most often follow (e.g. what would be the first thing that you would do, if you are starting from scratch?) (E.g. Analysis, design, evaluation. ) (Show example of design sequence.)

4. When working through the design sequence, do you set yourself a goal or set of goals for each steps in the sequence? Can you tell me what they are in relation to the sequence you have mentioned above. (E.g. at this stage/step, this is what I want to achieve - logical grouping of information, uncluttered screens, consistency, etc.)
5. What information do you think you should have, to be able to design a screen?

**Examples:**
- user requirements
- task descriptions
- guidelines (from handbooks, textbooks, journals)
- checklists
- information from previous design or designers manuals

(Prompt: Is there anything else?
If there is no mention of guidelines: What about guidelines?)

6. In your experience of screen designing, do you use any documented guidelines, standards, design checklists, or specific handbooks or textbooks?

(Show Galitz book.)

If yes,
6a. Can you tell me what they are?
6b. Do you entirely agree with them?
If not,
6bi. Why not?
6bii. Do you modify them in any way?

If no,
6c. Why not?
6d. Do you use your own guidelines, heuristics (rule of thumb) or principles?

(If they use none of the above, ask them what exactly do they use.)

7. How do you know when the screen design task is complete or otherwise finished? (e.g. do you use some sort of criteria?)

8. Do you find screen design difficult at all?
8a. Could you tell me what the main difficulties are?
8b. Which parts of the screen design do you find easy?
C. COOPERATIVE WORK.

1. Do you usually go through the whole process of screen design on your own, or do you work with other people?

1a. (If work with other people), is that usually with one other person or more than one other person?

2. On the whole, do you prefer to work alone or with someone else in screen design?

3. From your experience, what are the main advantages of working with other people? What sort of help do you get or do they give you? (E.g. sharing of information or sharing of tasks)

4. What are the disadvantages of working with other people?

5. Do you think that cooperating with other people affects the quality of the design?

D. COMPUTER SYSTEM

1. Do you perform the screen design task using pencil and paper alone, or do you use any sort of prototyping tools or software packages to help you in the screen design at present? Or do you use both?

If both,
1a. Can you tell me when do you use pencil and paper and when do you use the prototyping tool or any software packages?

1b. What is the name of the tool or software packages that you have used? (E.g. Prototyper, Hypercard, etc.)

1c. What are the main features of that tool or package that you find most helpful?

If do not use prototyping tools or any software package at all, 1d. Why not?

2. Lastly, leaving aside technological limitations, can you imagine a highly interactive system that will actively cooperate with you in the task of screen design.

2a. What would you like it to do for you?
2b. Can you think of any problems that kind of system would pose?
Appendix B

Documents for Screen Design Exercise:
Individual Group.
Document 1. Instructions to designer.

Please read the instructions carefully and ask if you have any questions.

You are given an exercise where you are asked to design the layout of a screen given the information provided in Document 2. You are allowed to present the information on no more than 2 screens. Please make sure that you include all the necessary information needed by the system as given in Document 2 on the screen(s). You may also wish to include any information or messages that you think are necessary to guide the users through the use of the screen(s). Please spend about 45 minutes to 1 hour to come out with a complete solution as far as possible. If you cannot complete the design in time, please summarise what you intend to do to complete the design if given more time.

You are provided with pen and paper for any sketching work that you need to do. You are also presented with a software package, Supercard, and some Supercard tips to prototype your design. Please feel free to use any medium at any time you wish. As far as possible, please perform the design task as you would normally do in your job. You are also given a set of compiled guidelines, gleaned from books by Galitz, Brown, Tullis and Rubin. The published guidebooks by Galitz and Brown are also provided. Please feel free to refer to any of them.

Please think aloud during the entire session - say out loud what you are saying to yourself while you are doing the task. For example, WHAT are you doing? WHY are you doing it? WHY did you choose one object or way instead of another? WHAT do you plan to do next? Things you intend to come back to later.

Do not worry if the commentary slows you down as it is the most important part of this study. During the task, I may also prompt you to talk about what you are doing when and if appropriate.

The session will be tape recorded and a video camera has also been set up to record your sketches and the computer screen. All the information collected will be held in the strictest confidence and is of no consequence to anyone other than me.

The session is not a test of competence and I am not concerned with the efficiency of the solution. What I aim to gain from these exercises is to better understand the process that designers go through in the laying out of information on a screen or screens, and the kind of information, knowledge and human factors guidelines that they use and apply in the task.

Lastly, I would like to thank you sincerely for your willingness to participate in this exercise, knowing how busy your schedule is.
You have been asked by COSY Corporation to design the computer screens for a system that is to be used for the application for employment with COSY Corporation.

Information needed by the system

First of all, it is necessary to obtain some personal information of the applicant. This include the applicant's surname and forename as well as his/her address and date of birth. It may also be good to obtain the title of the applicant.

Applicant is then asked to choose up to 3 (no more than 3) preferences of the type of work that he/she is interested in. The types of work available within COSY Corporation are:

- General Executive Officer
- Computer Work
- Trainee Accountant
- Statistical Work
- Immigration Officer

Applicant is then asked to indicate which centre he/she would like to attend for a test session and an interview session. They can choose a different centre for each session if he/she likes. The codes of the centre must be provided on the screen for verification by the personnel officer in COSY. The following are the available centres and their respective codes:

- Aberdeen 01
- London 67
- Brighton 14
- Manchester 54
- Cambridge 18
- Birmingham 16

Having completed the screen, it will be verified by a personnel officer in COSY Corporation. Having ensure that all the information are correctly entered, the officer must enter the applicant's reference number and his own name for approval of the application.
You may find the following information useful for the design of the screens.

**USERS**

There are two categories of users of the system:

a. **applicant**: it is to be assumed that these users are computer novices and have no experience whatsoever with computer systems.

b. **personnel officers**: this group of users have some computing experiences but they cannot be considered as experts. Their use of the screens is to ensure that the applicant had provided all the necessary information and to approve of the application.

**HARDWARE CAPABILITIES**

The screens will be implemented on a system that is able to support colour and high resolution graphics. Responsiveness of system is fast. The size of the screen is that of an Apple MacintoshPlus monitor.

**WORKSPACE AND ENVIRONMENT**

Users are provided with standard keyboard, mouse and mouse pad. Users will be working in standard office environment.
Questionnaire

1. Did the presence of the experimenter distract you from the design task? (Please circle number.)

1  2  3  4  5

very much not at all

2. Were you affected by the presence of the video camera? (Please circle number.)

1  2  3  4  5

very badly not at all

affected affected

Please tick where appropriate.

3. Did you find it difficult to have to speak aloud and design at the same time?

YES___ NO___

4. Do you think verbalising the task has affected your design?

YES___ NO___

If YES, in what way?

________________________________________________________

________________________________________________________

________________________________________________________

5. Did the time constraint affect your performance?

YES___ NO___
6. Was your design constrained by the software that you were using? (eg. made it easier, quicker, more difficult etc.)

YES___  NO___

If YES, in what way?

7. If you did not refer to the guidelines or guidebooks provided, was it because:

___ there wasn’t enough time to do so.

___ you couldn’t be bothered.

___ the guidelines that you are familiar with is sufficient

___ you think it is difficult to look for a specific guideline

others__________________________________________

8. Do you think the information provided in Document 2 is sufficient for you to perform the task?

YES___  NO___

If NO, what other information do you think is necessary?___

__________________________________________
Appendix C

Documents for Screen Design Exercise:
Cooperative Group.
Document 1a. Instructions to designer.

Please read the instructions carefully and ask if you have any questions.

You are given an exercise where you are asked to work together with another designer to design the layout of a screen given the information provided in Document 2a. You are allowed to present the information on no more than 2 screens. Please make sure that you include all the necessary information needed by the system as given in Document 2a on the screen(s). You may also wish to include any information or messages that you think are necessary to guide the users through the use of the screen(s). Please spend about 1 hour to come out with a complete solution as far as possible. If you cannot complete the design in time, please summarise what you intend to do to complete the design if given more time.

You are provided with pen and paper for any sketching work that you need to do. You are also given a set of compiled guidelines, gleaned from books by Galitz, Brown, Tullis and Rubin. The published guidebooks by Galitz and Brown are also provided. Please feel free to refer to any of them.

The session will be tape recorded and a video camera has also been set up to record the whole experimental session. All the information collected will be held in the strictest confidence and is of no consequence to anyone other than me.

The session is not a test of competence and I am not concerned with the efficiency of the solution. What I aim to gain from these exercises is to better understand the process that designers go through when working together in the laying out of information on a screen or screens, and the kind of information, knowledge and human factors guidelines that they use, apply and provide each other with in the task.

Thank you once again for participating in this experiment.
You have been asked by COSY Corporation to design the interactive computer screens for a system that is to be used for claim for travelling and out of pocket expenses.

Information needed by the system

First of all, it is necessary to obtain some personal information of the claimant. This include his/her surname and forename. The department in which the claimant is working in is to be obtained as well as his post. It may also be good to know his /her title.

For claim for travelling by car, the date and purpose of each journey must be specified. The car registration number and the mileage made must also be specified. The amount claimed for each journey is to be calculated. Please note that the claimant is paid £2 for each mile that was travelled.

For claim for travelling other than by car, again the date and purpose of each journey must be specified. Claimant must also specified the mode of transport that they used. Claim can only be made if person had travelled by the following mode of transport:

- taxi
- bus
- train
- flight
- underground

The amount claimed must be specified.

The total amount of the expenses claimed must be clearly presented.

The form will then be verified by the expenses officer at COSY Corporation and he/she will have to enter the reference number and also the allocation number for the claim.
You may find the following information useful for the design of the screens.

**USERS**

There are two categories of user of the system:

a. **claimant**: it is to be assumed that these users are computer novices and have no experience whatsoever with computer systems.

b. **expense officer**: this group of users have some computing experiences but they cannot be considered as experts. Their use of the screen is to ensure that the claimant had provided all the necessary information to make the claim. They are extremely busy people and it is your task to ensure that they can do this job as efficiently and as quickly as possible.

**HARDWARE CAPABILITIES**

The screens will be implemented on a system that is able to support colour and high resolution graphics. Responsiveness of the system is fast. The size of the screen is that of a MacPlus monitor.

**WORKSPACE AND ENVIRONMENT**

Users are provided with standard keyboard, mouse and mouse pad. Users will be working in standard office environment.
Name: ________________________________

Questionnaire

Please answer the following questions as thoroughly as you can. The answers will be treated with strict confidence.

1. Did the presence of the experimenter distract you from the design task? (Please circle number.)

   1  2  3  4  5
   |________|________|
   very much not at all

2. Were you affected by the presence of the video camera? (Please circle number.)

   1  2  3  4  5
   |________|________|
   very badly not at all
   affected affected

3. Are you more or less satisfied with the solution to this design problem as compared to the solution that you proposed in the previous exercise? (Please circle number.)

   1  2  3  4  5
   |________|________|
   less equally more
   satisfied satisfied satisfied

Please tick where appropriate.

4. Did the time constraint affect your performance?

   YES__  NO__
5. If you did not refer to the guidelines or guidebooks provided, was it because:

____ there wasn't enough time to do so.
____ you couldn't be bothered.
____ the guidelines that you are familiar with is sufficient
____ you think it is difficult to look for a specific guideline
____ the other designer has helped in providing you with guidelines

others ____________________________________________

6. Do you think the information provided in Document 2a is sufficient for you to perform the task?

YES___  NO___

If NO, what other information do you think is necessary?

_________________________________________________

_________________________________________________

7. Did you find it difficult to work with another designer in this screen design task?

YES___  NO___

If YES, why? _____________________________________________

_________________________________________________

_________________________________________________
8. Have working with another designer affected the approach you adopted in the design?

YES__

NO__

If YES, in what ways?

________________________________________________________________________

________________________________________________________________________

9. Would you have preferred to do this exercise:

___ alone.

___ with the designer that you have been assigned with.

___ with another designer.

10. What are the advantages have you found in working with the designer in this exercise?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

11. What are the disadvantages have you found in working with the designer in this exercise?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
12. If I replaced the designer with a highly interactive and intelligent screen design computer support system, what would you like it to do for you in this particular design task?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________


Please return the questionnaire to:

Miss Yoon-Ping Chui
Research Student
Department of Computer Studies
Loughborough University of Technology
Appendix D

Transcripts of the verbal protocol of a single designer in the screen design task.
Transcripts of the verbal protocol of a single designer in the screen design task:

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<th>Transcript</th>
<th>Actions</th>
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<tbody>
<tr>
<td>0:00</td>
<td>First of all, I want to keep in mind that the main users of this system are going to be computer novices. Therefore everything has got to be very simple. Err ... in fact, I'm wondering now, whether I would even want those pull down menus, because in my experience, with novice users, they don't know how to use pull down menus. So I probably would not want to include those at all, ok? I think that all the information has to be on the screen and has to be accessible just by the pressing of keys, to scroll down the screen ... So err ... oh dear ...</td>
<td>1] Wrote &quot;COSY CORPORATION&quot; and &quot;Application for employment&quot; on top centre of page 1.</td>
</tr>
<tr>
<td>0:52</td>
<td>Put the main title on so the users know what he or she is doing. [1] Cosy corporation application for employment.</td>
<td>[2] Wrote &quot;Applicant's Name&quot; on left hand corner of page 1.</td>
</tr>
<tr>
<td>1:21</td>
<td>Ok, err ...</td>
<td></td>
</tr>
<tr>
<td>1:42</td>
<td>[2]</td>
<td></td>
</tr>
<tr>
<td>1:46</td>
<td>Experimenter: What are you thinking?</td>
<td></td>
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<tr>
<td>1:47</td>
<td>Just thinking of the best way to put the name of the applicant. I can't remember how ... (laughs).</td>
<td></td>
</tr>
<tr>
<td>1:54</td>
<td>I want the form to look as the applicant would usually see it. So I suppose the surname is going to come first. [3] I'll worry about this part later and then the forename will come next.</td>
<td>[3] Drew a line on the right hand side of &quot;Applicant's Name&quot; and wrote &quot;Surname&quot; at the bottom of the line drawn.</td>
</tr>
<tr>
<td></td>
<td>And I think that when the user comes to this screen the cursor is going to be right there [5], flashing so that user will be ready to print.</td>
<td>[5] Drew a dash on the left hand side of entry field of &quot;Surname.&quot;</td>
</tr>
<tr>
<td>Time</td>
<td>Action</td>
<td>Notes</td>
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<tr>
<td>2:27</td>
<td>So this is going to be a field. [6]</td>
<td>[6] Boxed the entry field of &quot;Surname&quot; and &quot;Forename&quot;</td>
</tr>
<tr>
<td></td>
<td>Maybe what I ought to do is use a different colour. In blue is</td>
<td>[7] Redrew box above with a red marker.</td>
</tr>
<tr>
<td></td>
<td>what I'll say as the text on the screen, you know, solid. In red is</td>
<td></td>
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<td></td>
<td>the field. [7]</td>
<td></td>
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<tr>
<td>2:49</td>
<td>That's going to be highlighted, I guess when the users come to it.</td>
<td></td>
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<tr>
<td></td>
<td>We're going to play with that.</td>
<td></td>
</tr>
<tr>
<td>2:52</td>
<td>The cursor is going to be in that position ready for the user to print.</td>
<td>[7a] Pointed to the dash drawn at action 5 above.</td>
</tr>
<tr>
<td>2:58</td>
<td>I think it might be a good idea to ... err ... maybe we can make this</td>
<td>[8] Separated the &quot;Surname&quot; and &quot;Forename&quot; fields by drawing [1] over the box drawn earlier.</td>
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<td>into two fields [8] so that all the user has to do is tab, is another</td>
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<td></td>
<td>way of doing it ah ... to get to the forename and then the next tab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>will take you down to the next field which is going to be the address.</td>
<td></td>
</tr>
<tr>
<td>3:30</td>
<td>[9] So tabbing across will take you to each field. Now I can't</td>
<td>[9] Drew a box for &quot;Address&quot; field.</td>
</tr>
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<td></td>
<td>remember without checking but I think that would be standard in</td>
<td></td>
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<td></td>
<td>something like CUA. You know, tabbing through the fields and I think</td>
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<td>that would be easiest for novice users to be able to get to the</td>
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<td></td>
<td>different information.</td>
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<tr>
<td>3:55</td>
<td>We say this is the address field. [10]</td>
<td>[10] Wrote &quot;Address&quot; below &quot;Applicant's Name&quot; caption.</td>
</tr>
<tr>
<td></td>
<td>that field because there is more than one line. That's [11a] something</td>
<td>[11a] Pointed to the word &quot;return.&quot;</td>
</tr>
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<td></td>
<td>I have to check in the guidelines and also check with the users to see</td>
<td></td>
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<td></td>
<td>whether the user is going to know where the return key is. Novice</td>
<td></td>
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<td></td>
<td>users, ok? Because I don't want to assume too much knowledge because</td>
<td></td>
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<td></td>
<td>we might have someone who applied for the job who has never use the</td>
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<td></td>
<td>keyboard before, ok?</td>
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<tr>
<td>4:39</td>
<td>Maybe we want an extra line for the address but we have two for the</td>
<td></td>
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<td></td>
<td>time being.</td>
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<tr>
<td>4:43</td>
<td>Date of birth [12] and then another field that we'll get to by</td>
<td>[12] Wrote &quot;Date of Birth&quot; below &quot;Address.&quot;</td>
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<tr>
<td></td>
<td>want to make both the keys work. That way erm ... tab will be</td>
<td></td>
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<td></td>
<td>conforming to CUA, I think.</td>
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<td>5:15</td>
<td>Return would be consistent with a user who is familiar with the keyboard to go on to the next line. But I think also the down cursor key also work. I think each one of those keys work so that all users would be able to ... get to the next line without any trouble.</td>
<td></td>
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<tr>
<td>5:30</td>
<td>Erm ...</td>
<td></td>
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<tr>
<td>5:39</td>
<td>Title ... I'm not sure where to put that now (laughs).</td>
<td></td>
</tr>
<tr>
<td>5:51</td>
<td>Just going to put title in here for now. [13] And worry about how to do that later. Not sure how I'll want to do that. Err ...</td>
<td></td>
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<tr>
<td>6:07</td>
<td>Put a check box or we could ... it might be simpler to ask user to err ... to ... to ... type in title. I'm thinking about other ways of doing it, like check boxes.</td>
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<td>6:20</td>
<td>But you are asking users to do another operation and that users may be a novice and might not know how to get to the various check boxes. I think I might just use a field to be typed in. [15]</td>
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<tr>
<td>6:46</td>
<td>[Reading to self] Applicants are then asked to choose up to three preferences for the type of work.</td>
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<tr>
<td>6:53</td>
<td>Now this is going to be the place for check boxes.</td>
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<tr>
<td>7:20</td>
<td>I think I am going to go on to the next page here ...</td>
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<tr>
<td>7:39</td>
<td>Experimenter: What are you thinking?</td>
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<tr>
<td>7:40</td>
<td>I'm just ... I'm just wondering whether our novice user ... there are so many things to think of here ... Is our novice user going to know how to use a mouse button? Because if we are using Supercard, an obvious way is to click on this button to go to the next screen. I mean you could have err ... [16]</td>
<td></td>
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<tr>
<td>8:04</td>
<td>You could have [17] to go to next page for example, ok? And if our users know how to use the mouse they can click on that button but we can't work on that assumption.</td>
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<td>8:15</td>
<td>Err ... and so I don't know, I think we could allow that but we could also [18] ... In fact I'll prefer to steer clear of all the Supercard or Hypercard mechanisms like buttons because we just can't assume knowledge on that. [19]</td>
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<tr>
<td>Time</td>
<td>Discussion</td>
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<td>9:00</td>
<td>So, I'm going to get rid of that. Press return bar to go to the next page.</td>
<td>Now we might find that we could put more information on this screen but I'm not sure that we ought to. On this screen we have the information about the applicant, ok?</td>
</tr>
<tr>
<td>9:19</td>
<td>So if we go to the next screen ... I've got to think it through all on paper first. So I'm not sure when I'm going to put anything on Supercard.</td>
<td>Experimenter: It's ok.</td>
</tr>
<tr>
<td>9:30</td>
<td>Alright now you're going to have err ... [20] choose up to three types of work you are interested in.</td>
<td>[20] Wrote &quot;Choose up to 3 types of work you are interested in&quot; at the top of page 2.</td>
</tr>
<tr>
<td>10:00</td>
<td>I'll just abbreviate ... [21] clerk work, trainee accountant, statistical work, immigration office err ...</td>
<td>[21] Wrote the different types of work in abbreviated forms (e.g. GEO) one below each other.</td>
</tr>
<tr>
<td>10:22</td>
<td>So when you get tho this screen [22] you're going to have your cursor in that box [23], I think. We have to give instructions to the user though, how to get to each field.</td>
<td>[22] Drew boxes as fields for the different types of work. [23] Put a small dash inside the &quot;GEO&quot; field (box).</td>
</tr>
<tr>
<td>10:57</td>
<td>Err ... [24] use down arrow to move to choices. Press ... now we got to give them a number of options here to press as well in order to choose ... Looking through this now maybe that is the same system we can use for titles, though I am not sure.</td>
<td>[24] Wrote &quot;(Use down arrows to move to choices)&quot; beside instruction given in action 18 above.</td>
</tr>
<tr>
<td>11:30</td>
<td>Maybe it's simpler just to type in title there. But here you got to allow choice of more than one. [24a] So you got to be able to work your way through these boxes and you got to be able to choose one or not choose it and then go on to the next box.</td>
<td>[24a] Pointed to the captions and fields for different types of work.</td>
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<tr>
<td>11:50</td>
<td>So from here, let's say the user doesn't want to choose that one ... you got to be able to press the down arrow to get to this one, press the down arrow to get to that one ... press the down arrow ... be able to press the up arrow to go back.</td>
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<td>Time</td>
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<tr>
<td>12:03</td>
<td>So ... [25] use up and down arrow to move to choices, ok? So we got up and down arrows and press what, to choose? [pause]</td>
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<td>[25] Added the words &quot;up +&quot; to the instruction given in action 24.</td>
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<td>12:26</td>
<td>I think the convention is the space bar to choose but I ... Now that's something I want to check in the guidelines, depending on what ... But I won't check it now (laughs) ... because I think I don't know where to look. But I would want to know what style guide they are following.</td>
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<td>12:34</td>
<td>Whether COSY Corporation is following a particular style guide. Whether they are following CUA for example or the Apple guidelines ... err ... what are they trying ... if they are trying to follow the Apple guidelines, I am trying to think what is the convention for choosing with Apple. And I want to check that as well (laughs).</td>
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<td>13:11</td>
<td>But you got to have to give more than one choice in any case because your novice user is not going to know whether you are following Apple, CUA or whatever, ok? So I think we could say, [26] you can ... press space bar of enter to choose. Now I might want to extend that as well.</td>
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<td>[26] Wrote &quot;Press space bar or ENTER to choose.&quot;</td>
<td></td>
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<tr>
<td>13:44</td>
<td>Add some others ... just in case they, you know, make a mistake. As far as up and down arrows to move between choices is concern, I think enter is also going to have to work.</td>
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<tr>
<td>13:58</td>
<td>[27] Sorry, not enter, return. Because I think it's a natural reaction to press enter, sorry, press return to go to the next line. Pressing return should not choose. Pressing return should just get you to the next choice. So you got to be able to use the up and down arrows..</td>
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<tr>
<td></td>
<td>[27] Wrote &quot;Ent&quot; and then cancelled and wrote &quot;Return&quot; on the left side of page 2 below the instructions given in actions 20, 24 and 26.</td>
<td></td>
</tr>
<tr>
<td>14:30</td>
<td>You got to be able to press return to move between these [27a] and then to choose any of those while that item is highlighted. You got to either press space bar, enter or maybe something else, ok? Erm ... I don't know if that [27b] is gonna be clear enough for those users. We have to mock it up and test it out with a few people and then we might have to change that very quickly, ok?</td>
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<td></td>
<td>[27a] Pointed to types of work options. [27b] Pointed to the instructions.</td>
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<tr>
<td>Time</td>
<td>Reading to self</td>
<td>Notes</td>
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<td>14:46</td>
<td>Applicant is then asked to indicate which centre he or she would like to attend for a test session and an interview session ... Choose a different centre for the different session. Just to get the two sessions down, I'm not sure how we are going to deal with this yet.</td>
<td>[28] Wrote &quot;Test session&quot; and &quot;Interview session&quot; on the bottom left hand side of page 2.</td>
</tr>
<tr>
<td>15:28</td>
<td>Codes of the centre must be provided for verification ...</td>
<td></td>
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<tr>
<td>15:46</td>
<td>... by the personnel office ...</td>
<td></td>
</tr>
<tr>
<td>15:55</td>
<td>Ok, I think ... I don't think the applicant has to see those codes. Maybe this is the place where the pull down menus could be useful. Because the personnel officer has to verify the codes but we don't want to overload the novice users with the information.</td>
<td>[29] Drew a box at the top left hand corner of page 2 and wrote &quot;Personnel Info&quot; inside the box.</td>
</tr>
<tr>
<td>16:27</td>
<td>So I think, let's have a pull down menu up here. We'll call it personnel information for the time being and it'll have each one of those items for verification. Erm ... so it'll be centres plus codes.</td>
<td>[29A] Pointed to centres on the instruction document 2. [30] Wrote &quot;centres and codes&quot; beside personnel info.</td>
</tr>
<tr>
<td>17:12</td>
<td>Err ... I'm not sure how ... display the centres to the users ...</td>
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</tr>
<tr>
<td>17:40</td>
<td>Experimenter: What are you thinking?</td>
<td></td>
</tr>
<tr>
<td>17:42</td>
<td>Yes ... I'm thinking, you know, if I knew the users can use pull down menus, I mean, it'll be simpler to just sort of choose pull down menus but I'm not allowing myself to use that. Maybe the best way is to pick the centres for the test session and repeat that for the interview session. Better to have the repeated information without changing the methods the user has to use in order to make a choice.</td>
<td></td>
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<tr>
<td>18:27</td>
<td>Erm ... so maybe the simplest way is to use a similar type convention to this and ... this means of course that we have more information on this screen and I'm not sure whether it'll start looking crowded.</td>
<td>[30a] Pointed to the types of work captions and fields.</td>
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<td>Time</td>
<td>Description</td>
<td>Actions</td>
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<tr>
<td>18:48</td>
<td>So we got so little on this screen [30b] and we might want to put this one [30c] on the previous page, ok? Because we need six lines here [31]</td>
<td>[30b] Pointed to first page of the design. [30c] Pointed to the top of page 2. [31] Drew red boxes for the centres of test and interview sessions on the bottom centre of page 2.</td>
</tr>
<tr>
<td>19:13</td>
<td>[32] Let's say, testing session, interview session. [33] [34] Say it has to be 2 pages, is that what you said?</td>
<td>[32] Cancelled &quot;test session&quot; and &quot;interview session&quot; written at action 28. [33] Wrote &quot;Testing session&quot; above the box drawn in action 31. [34] Wrote &quot;Interview session&quot; to the right hand side of “testing session.&quot;</td>
</tr>
<tr>
<td>19:34</td>
<td>Experimenter: Yes.</td>
<td></td>
</tr>
<tr>
<td>19:35</td>
<td>Ok, we'll have to play with this for a little bit but we could keep the same convention again using up and down arrows. [36]</td>
<td>[35] Drew a column of boxes below &quot;Interview session&quot; as its fields. [36] Extended the boxes drawn in action 32.</td>
</tr>
<tr>
<td>19:54</td>
<td>So you can move between these two [36a]. So I mean your down arrow or the return will just scroll through all these [36b] ok? Err ... and then if you want to choose you press the space bar or enter to choose.</td>
<td>[36a] Traced fingers from fields of testing session to fields of interview session. [36b] Pointed to both the fields and moved fingers downwards.</td>
</tr>
<tr>
<td>20:19</td>
<td>Now the users is also got to be able to take the choice off if he wants to change his mind.</td>
<td></td>
</tr>
<tr>
<td>20:26</td>
<td>So it would work in toggle fashion. So if it's ... if ... the cursor is here, [37] and you get that just by pressing the down arrow or pressing return from there, so you haven't changed conventions.</td>
<td>[37] Drew a small dash in the first box of testing session.</td>
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<td>Time</td>
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<td>Transcript</td>
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<td>20:38</td>
<td>And this will say ... this will say Aberdeen, ok [38] and down arrow or return, you move through here [38a] and if you want to choose Cambridge [39], you press the space bar or enter and you get a tick. [40]</td>
<td>![38] Wrote &quot;Aberdeen&quot; in the box. ![38a] Moved fingers down the testing session fields. ![39] Wrote &quot;Cambridge&quot; in the 5th box of the testing session. ![40] Drew a tick in the small extended box beside &quot;Cambridge.&quot;</td>
</tr>
<tr>
<td>21:10</td>
<td>Err ... you have similar sort of ticks in here [41] next to ... how you do that I'm not sure, but ticks ... And then if you press it again, it'll take the tick off. And then continuing the down arrow from here will take you over there [41a]. That's if we are running short of space and we decide to keep all this on 1 page.</td>
<td>![41] Extended the boxes for types of work. ![41a] Traced finger from bottom of testing session to top of interview session fields.</td>
</tr>
<tr>
<td></td>
<td>Experimenter: Would you have preferred to do it on more than 2 screens if you are given a choice?</td>
<td>![41b] Pointed to section on Types of Work. ![41c] Pointed to test and interview session section.</td>
</tr>
<tr>
<td>21:30</td>
<td>Well ... it's gonna ... no.. I think probably not. I think it's just as well to put this [41b] on the previous page. Ok, and then give a little bit more room for this [41c]. And that could probably mean we'll put the interview session down below.</td>
<td>![41b] Pointed to last box on the testing session. ![41c] Pointed to test and interview session section.</td>
</tr>
<tr>
<td>21:58</td>
<td>Because one thing I'm a bit concern about is we press the down arrow here [41d], you go back up again [41e]. I mean ... it's not confusing to us but it could be confusing to a novice user who is not used to using the keyboard or the arrows or scrolling.</td>
<td>![41d] Pointed to last box on the testing session. ![41e] Pointed to first box on interview session.</td>
</tr>
<tr>
<td>Time</td>
<td>Text</td>
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<td>22:17</td>
<td>Err ... yes, I think that's probably better. There's hardly any information on that screen. [41f] Pointed to page 1 of the design. So I put that on the previous page. [42] That will give us more room and then we can err ... let me see, we can have the applicant's reference number and the approval so that's just a form down here [42a] that the ... the personnel officer is gonna have to fill in.</td>
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<td>[41f] Pointed to page 1 of the design. [42] Drew a line separating the section on &quot;types of work&quot; and &quot;testing and interview session.&quot; [42a] Pointed to the bottom of page 2.</td>
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<tr>
<td>23:00</td>
<td>[43] So you gonna have [44] have for personnel use and sort of detail so that the err ... that's just gonna be, you know... [45] reference number, [46] name of approval ... approved by and ... (laughs).</td>
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<td></td>
<td>Ok, you gonna have a field there [47] and a field there [48], ok?</td>
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<td>[47] [48] Drew a box for the &quot;ref no&quot; caption and a box for &quot;approved by&quot; caption.</td>
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<td>23:40</td>
<td>Now ... See if I have taken everything into consideration, on the page. Err ... so we have applicants ... sort of computer novices ... I think I have made it simple enough but we might need more instructions. Err ... but I also think that whenever novice is filling out something on a computer ... if they have never used the computer before you can't put all the instructions on the screen. You gonna to have somebody there who's going to tell them what to do and I think we shouldn't at the moment worry about providing too many instructions to the novice. A personnel officer is not going to be too far away.</td>
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<td>Time</td>
<td>Description</td>
<td>Pointer Details</td>
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<td>24:43</td>
<td>Because the responsiveness is going to be fast ... I think that ... you got to have a facility of getting back to the previous page. Once user gets here [48a] ... might find they want to make a change as the previous page, so might want to get back ...</td>
<td>[48a] Pointed to test and interview session section.</td>
</tr>
<tr>
<td>25:20</td>
<td>I'm not sure the best way to do that without testing a few things out. Err ...</td>
<td></td>
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<tr>
<td>25:31</td>
<td>If the cursor is here [48b] here, or here or here, [48c] I think if the user keeps pressing up arrow it ought to take the user back to the previous page when it gets to this point [48d].</td>
<td>[48b] Pointed to GEO field. [48c] Fingers traced from top of &quot;types of work&quot; to bottom. [48d] Pointed to GEO field.</td>
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<tr>
<td></td>
<td>I'm not sure if another screen ought to do the same thing ... I'm sorry if another key ... or another method ought to do the same thing but you got to get back to the previous screen and then pressing the return bar will take you to this page. [48e] Also from here [48f] pressing the down arrow will take you to the next page. Pressing that tab [48g] will take you to the forename but I think also the arrow will gonna have to take you to the forename.</td>
<td>[48e] Pointed to test and interview session section. [48f] Pointed to &quot;Date of birth&quot; caption. [48g] Pointed to the gap between &quot;surname&quot; and &quot;forename.&quot;</td>
</tr>
<tr>
<td>26:29</td>
<td>Just realised that this is the only place that I have used a tab. So I think I don't want to use that ... no, because it's adding another key to the user. So I think it'll be better to put this [49] and this on separate lines.</td>
<td>[49] Drew a box over forename and indicated using an arrow that forename should be below surname.</td>
</tr>
<tr>
<td>26:49</td>
<td>So you have the same convention all the time. So you press return to get to the next line and you press the down arrow. You press the up arrow to go back. So, I'm gonna forget the tab convention from CUA (laughs).</td>
<td></td>
</tr>
<tr>
<td>27:09</td>
<td>I'm trying to keep this as simple as possible. And so when you get to this field here [49a] and you press return will take you to the next page or the down arrow will take you to the next page. When you get there [49b] the up arrow will take you to the previous page. OK?</td>
<td>[49a] Pointed to &quot;Date of birth&quot; caption. [49b] Pointed to &quot;types of work&quot; section.</td>
</tr>
<tr>
<td>Time</td>
<td>Text</td>
<td>Notes</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>27:27</td>
<td>So I might be in the position to do some design although I'm not sure how much time I have ... Err ... what do you think?</td>
<td></td>
</tr>
<tr>
<td>27:35</td>
<td>Experimenter: It's up to you whether you want to or no.</td>
<td></td>
</tr>
<tr>
<td>27:39</td>
<td>I'm not ... to be honest ... I'm not sure whether you're gonna get much more by mocking this up. I mean I think that the ideas are on paper. Err ... it will take a while to make those ideas consistent, you know ... to what I've written down.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I think it might be more important to show that ... return bar will got to the next page [50], down arrow will also go to the next page.</td>
<td></td>
</tr>
<tr>
<td>28:19</td>
<td>Err ... return or down arrow will take you to the next field. [51]</td>
<td>[51] Pointed to the word &quot;return&quot; beside address field and then drew a down arrow in a box.</td>
</tr>
<tr>
<td>28:36</td>
<td>Err ... I think I will put this on previous page. [52]</td>
<td>[52] Pointed to section on types of work and wrote &quot;put this on previous page.&quot;</td>
</tr>
<tr>
<td>28:42</td>
<td>I put this underneath [53]. so we don't have to move sideways ... it's all down or return, consistent throughout.</td>
<td>[53] Drew a big circle over interview session's captions and fields to indicated that it should now be placed at the bottom of testing session.</td>
</tr>
<tr>
<td>28:57</td>
<td>Err ... down or up arrows to move down fields [53a].</td>
<td>[53a] Pointed to &quot;types of work&quot; fields.</td>
</tr>
<tr>
<td></td>
<td>Up arrow to go back [54] to previous page.</td>
<td>[54] Drew a box with an up arrow and wrote &quot;to go back to previous page&quot; at the top left hand corner of page 2, above the instruction given at action 20.</td>
</tr>
<tr>
<td>Time</td>
<td>Description</td>
<td>Annotations</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| 29:16 | Press space bar or enter to choose [54a], when you get here, pressing return or the down arrow will take you to this field [54b] and you go through those and you then press return or down arrow and you continue going through those [54c] and then the screen is just going to be left on the machine. | [54a] Pointed to instructions regarding choosing the interested types of work.  
[54b] Pointed to "testing session."  
[54c] Pointed to interview session." |
| 29:34 | The user is not going to try to exit or do anything else with ... that I feel ought to be up to the personnel office.  
The personnel officer comes along, wants to check the codes because err ... you might have to fill in the code elsewhere on another form. |                                                        |
| 29:41 | Err ... the personnel office can go up to the pull down menu to check the codes and I'm assuming that the personnel officer is going to record the codes on another form.  
I don't see any reason to have it on this form although the personnel officer might want the facility to key it in.  
There could be hidden field here. [55] | [55] Drew some boxes with dotted lines on the left of the testing sessions fields to indicate hidden fields. |
| 30:40 | Err ... personnel officer can fill in code [56]. I think that field ought to be hidden from the user.                                                                                                 | [56] Wrote "per officer can fill in code" above the dotted line boxes. |
| 30:51 | So that information can be checked from the pull down menu [56a].  
Personnel officer can fill that [56b] in if required an then this information is filled in the field. [56c]  
And I think having mocked it up, I will not do much more until I test it out with some novice users. | [56a] Pointed to "personnel info" written in action 29 and 30.  
[56b] Pointed to dotted boxes.  
[56c] Pointed to "approved by." |
| Experimenter: Could you tell me a little bit more where you would put those messages for the users?                                                                                       |                                                        |
| 31:21 | Err ... just above the fields. [56d]                                                                                                               | [56d] Pointed to "types of work" fields. |
After this [56c] now because this [56f] will go on the previous page, yes.

[56e] Pointed to the last field of types of work.

[56f] Again, pointed to types of work section.

At the bottom ... because the eye will follow to the end of the page ... err ... this is going to have to be repeated though. [56g]

[56g] Pointed to the instructions given about choosing the interested types of work.

Err ... press up and down arrow to move to choices but there is no entering here.
I think this information [56h] is going to have to be filled in.

[56h] Pointed to "date of birth" caption.

32:09 So got to repeat [57].
Press up or down arrows to move between line and type information about yourself.
So there won’t be check boxes here [57a].
We’re not talking about pressing the enter or space bar to choose. I think that ought to be typed in.

[57] Wrote "Press up or down arrows to move between lines + type information about yourself" on the first page of the design just above the caption and field of "Applicant’s Name."

[57a] Pointed to "title" caption.

32:40 So as you move between these fields [57b], the cursor is going to be at the beginning at the filed so that you are able to type, yes?

[57b] Pointed to section on applicant’s personal information.

33:07 And then you press return bar or the down arrow to go to the next page after you finish this one.

33:17 Experimenter: Yes.

33:20 Does that make any sense?

33:22 Experimenter: Yes, that’s fine.

33:23 I think it’ll be useful to put something up on the screen but I think it’ll take err ... more time than I have right now.
And I think you are not going to get further information. Is that alright?

33:40 Experimenter: Ok. If given more time, what else would you do for this particular piece of work?
<table>
<thead>
<tr>
<th>Time</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 33:45 | I would put it into Supercard, ok?  
Just to see how it looks on the screen.  
Err ... but I wouldn't change anything from here.  
The trouble is you really got to program so that your various keys are all going to do the same work, you know.  
And to move between the fields. |
| | And as soon as I've mocked it up, I don't think I'll make any substantial changes to this, but I'll test it out on anybody who hasn't used the computer before because I think this is one of the major problems I've had with non-computer users or very naive users.  
There are things which you just totally take for granted.  
Just moving down a line might not be as simple as that. |
| | I'm not sure how much more simple you can make it and I think that you have to have a personnel office there anyway to give some advice. |
| 34:55 | Experimenter: So what you will do if given more time is to put it on Supercard, mock it up, see how it looks like and then test it on some users or anybody who is available? |
| 35:07 | I would just ... find somebody who has never used the computer before.  
Now that's very difficult to do.  
But there is no point with testing this out with somebody here who is too familiar with the conventions, alright?  
I would find someone whom err ... you know has very little experience on the computer.  
Otherwise the testing is not going to be much use. |
| 35:36 | Experimenter: So when you said you'll put it on the screen to see how it looks like, do you mean to see if it's cluttered or do you see whether the fonts that you have used are legible? |
I think the first thing is to see if it's cluttered. Now these [57c] could go on to the previous page. Ideally, I like to see just the information about the applicant and then the information about the choices and the sessions, ok? But I think this screen [57d] will look too cluttered, ok, and I think we got more room to play with on this one [57e] except of course, if we find that more instructions are required, or a little bit more space is required on this one, [57f], then I probably suggest better to go on to the third page. Because I think this screen is going to be cluttered once those items [57g] are going to be put down below.

But it is hard to tell until I've put it up on the screen and tested different fonts. But you can't have the fonts too small and you don't want the lines to look cluttered. So and if you want to have fair amount of space here ... at the bottom. There might be something else that the personnel officer has to include.

So yes, I'll be looking at different things. I'll be looking at what information really has to go on each screen and whether or not it's too much to fit this [57h] on the previous screen, and then the fonts. But I think the font is a minor thing in comparison.

Experimenter: Ok, so you are quite happy with the solution.
Experimenter: Right, thank you.
Appendix E

Transcripts of the verbal protocol of a pair of designers in the screen design task.
### Transcripts of the verbal protocol of a pair of designers in the screen design task.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SH</strong></td>
<td>Well, I think we could list all the things that needed to be entered into the system.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Uh-huh.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>And then group those.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Yes, ok.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Should I give you ... do you want to list them out and then I will make a note of them?</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Yes, ok. Erm ... so, the first thing is person's first name and fore name. And the department. And the title. Right, so ... for car travel ... date, purpose of journey and car registration, mileage.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Yup.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>And the amount claim is to be calculated.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Uh-huh.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>For none car travel, again the date and purpose of journey.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Ya.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>And mode of transport ... list five that is ...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Do you want to ... taxi ...</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Ya ... taxi, bus, train, flight, underground.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Yup.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Err ... and then the total amount of expenses calculated, and ...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Right. so that will be the amount claimed?</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Yes. And then ...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Plus the total.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Ya. And the expenses officer, XX, the reference number, the allocation number ....</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Sorry, err ... the reference number ...</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>The reference number and ...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>What is the reference number?</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>I'm not sure. Presumably for office purposes.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Right, ok.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>So they can get back to it. Allocation number ... I'm not sure.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Do another ... Does it have to have details of the expenses officer?</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Err ... I don't think so. XXX</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Uh -huh.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Ok. So that's the basic information that we need and ...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Right.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Do you think we should look at it as a form filling task?</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Ya. Perhaps these sort of more appropriate to put on top of the form ... the reference number and allocation number. Right?</td>
</tr>
</tbody>
</table>
MM Yes.

SH That's going to be entered by the expenses officer. If it is physically separated out from the claim, that's better.

MM Ya .. yes, that's right. Could be easy to check those numbers through again. Going back to the ... instruction ... 2 screens maximum. Ok, so ...

SH Going back to our own expenses form, if I can remember rightly, err ... they will give you the option ... it's a generic sort of grid. We always sort the information, but the last of those is the mode of transport ... one which is car and the last .. for the car registration. I wonder whether they need two separate fields.

MM Right. You mean they wouldn't need to be perhaps ...

SH Yes.

MM The car registration number could only come up if you choose car on the mode of transport.

SH Yes.

MM Ya, that sounds like a good idea.

SH And mileage of ... is the mileage ... no, it isn't .. the mileage isn't necessary either so.

MM No, I suppose ... ya, ya ... the other thing is just the mode of transport and how much you spend for each. Does it imply that we need a different amount for each ... you know ... you can say you went by taxi and then train. Do you want to put all those on the same form as part of the same journey. I suppose it's one form per journey.

SH Hmm ... well ... I ... I don't ... I tend to use an expense form for the amount ... when I'm filling them out, I put the whole journey together, separate them by and then put details of the XX journey and the XXX. But mainly I leave them to the last minute, then I got several to fill in all at the same time. It isn't very good.

MM Err ... perhaps ... anyway it saves administration time, I suppose. Probably deal with a set of claims ... on one form more quickly.

SH Uh-huh. That seem to me ... that's business about hiding redundant information.

MM Ya, that's quite good for these novice users, casual users.

SH Ya.

MM What do you think should come first? Is it possible to ...

SH Think about the layout.
<table>
<thead>
<tr>
<th>MM</th>
<th>Ya, just in general terms.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH</td>
<td>Err ... these reference numbers and allocation numbers at the top, and then the claimant details following on. Then the date and purpose of journey ... and then at the bottom, the total. And then along here, the amount claimed.</td>
</tr>
<tr>
<td>MM</td>
<td>Ya ... that seems like our format ... claimant's details first.</td>
</tr>
<tr>
<td>SH</td>
<td>Oh, what a coincidence.</td>
</tr>
<tr>
<td>MM</td>
<td>(Laughs) (Read document 2 again.) Although for people ... the claimants, they are assumed to have no experience for computer systems.</td>
</tr>
<tr>
<td>SH</td>
<td>Uh-huh.</td>
</tr>
<tr>
<td>MM</td>
<td>And are they likely to need any special help or extra instruction or anything to guide them through?</td>
</tr>
<tr>
<td>SH</td>
<td>Well, do you think we'll get all that on one screen? I would have thought we could do, if we work across the screen. If it's acceptable to put this information across the screen. Perhaps in two rows. Err...</td>
</tr>
<tr>
<td>MM</td>
<td>Hmm ... ya, ya. Perhaps enough room then for some instructions ...</td>
</tr>
<tr>
<td>SH</td>
<td>On the second screen?</td>
</tr>
<tr>
<td>MM</td>
<td>Yes. I suppose so, yes.</td>
</tr>
<tr>
<td>SH</td>
<td>And then that's the opening ... you know, sort of press to continue and then you go on to the actual ...</td>
</tr>
<tr>
<td>MM</td>
<td>Yes, alright, yes. Yes, that's a good idea. So you can look at the instruction first, 'cause I suppose until they get familiar with it ...</td>
</tr>
<tr>
<td>SH</td>
<td>Yes, they just ...</td>
</tr>
<tr>
<td>MM</td>
<td>Get on.</td>
</tr>
<tr>
<td>SH</td>
<td>Yes. So looking at the other user, the expense officer, err ... So they just have to scan to make sure that the information is correct and they just got to do that as efficiently as possible. I wouldn't have thought there would be any problem.</td>
</tr>
<tr>
<td>MM</td>
<td>No. They just really want to look through. I suppose they then just get a batch of those claimants produced and just scan through them in group.</td>
</tr>
<tr>
<td>SH</td>
<td>Yes.</td>
</tr>
<tr>
<td>MM</td>
<td>So, if we can get all the information on one screen.</td>
</tr>
<tr>
<td>SH</td>
<td>So there is a minor sort of conflict, you know, user group conflict.</td>
</tr>
</tbody>
</table>
| MM | Ya.  
I mean I have seen some systems ... data entry screen ... it's the same as the screen on somebody scanning the data ... but they sometimes simplify it, like leaving off field brackets and things like that. |
| SH | Right. |
| MM | So that, you know, the screen are a bit clearer, maybe empty fields they might leave off as well. But err ... Perhaps that's make it less flexible if the expense officer want to correct something. |
| SH | Right. |
| MM | He actually haven't got a data entry screens. |
| SH | I'd assumed that the expense officer, the only thing that will be taken off is some of the amount claimed and the total amount claimed. That was my assumption anyway. |
| MM | Ya, crmm ... I mean what else could they check, really? |
| SH | Well, what they will be taking off as opposed to just checking will be ... |
| MM | Yeah, I suppose, err (read document 2 again) ... well it says their use of the screen is to ensure that claimant had provided all the information. |
| SH | Ya. so that's checking. |
| MM | Ya. |
| SH | But the ... from the aspect ... it doesn't look as though they are taking off .. is it? |
| MM | No.  
The claim might be done kind of automatically. |
| SH | Hmm ... |
| MM | They, they ... |
| SH | Verify it. |
| MM | Ya.  
I suppose the verification is .. I wonder how they indicate the verification.  
(Read document 2)  
Maybe they try to use these numbers.  
Perhaps that's a bit ... |
| SH | Ya. |
| MM | ... difficult.  
I suppose that's how it might work. |
| SH | Ya, but once they check, they check and allocate the reference number, it means it's a legitimate claim. |
| MM | Ya. |
| SH | Ok.  
So what are we using ... are we using the extra screen and if we do ... what are we using it for? Help information or through a window?  
Or ...? |
<p>| MM | Err ... well, err ... are we going to have the first screen as the. did you say, instruction screen? |
| SH | But if we did that ... ya ... and the expense officer has several hundred .. is it logical ... to do that and then to keep opening it ... |
| MM | Ya ... I see what you mean, ya ... Perhaps it's better to use the actual screen on the help screen. Ya, that would probably be better. The screen could say ... for details press such and such a help and normally they probably wouldn't need it. |
| SH | Ya, ok. So there's some form of a help option. And what sort of dialogue are we ... |
| MM | Err ... for the help, or for ... what do you mean? |
| SH | For all. |
| MM | Ya. |
| SH | Are we using a combination of mouse, or keyboard, or we could have both, couldn't we, ... parallel ... |
| MM | Ya, I suppose the beauty of the mouse is if you got different fields, you can err ... just point to the field and alter it, or fill it in. |
| SH | Yes. |
| MM | But I suppose, if you have it with the keyboard ... |
| SH | Yes. |
| MM | So, try go and the ... |
| SH | Directional keys. |
| MM | Ya ... they could use those keys as well. On the other hand, they are not so well placed either. They are a bit hidden in the keyboard layout. |
| SH | The other thing to do is just like a repeated return to step through the ... |
| MM | Oh, yes. That's how most people would probably use it. |
| SH | But then, if they did that ... would that help option be in that sequence of steps because you get to a certain part and you didn't want the help and you access it as a ... |
| MM | Oh, I see. |
| SH | ... a matter of ... |
| MM | Ya ... I think there must be an extra key, wouldn't they? |
| SH | Yes. |
| MM | Either in the keyboard or a screen key that they can press with the mouse. |
| SH | Yes. |
| MM | Another area, I suppose is what sort of error checking that they system can give? I don't think we can escape from that. Err ... I mean things like name, you can't really error check that. |</p>
<table>
<thead>
<tr>
<th>SH</th>
<th>Yes. I think that's more ... I think the ... perhaps the most appropriate is the amount claim because it can certainly tell them if they are claiming more than £2 a mile for the car and it can automatically put in the total.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM</td>
<td>Yes. In fact I suppose it can put in ... it can calculate the amount ...</td>
</tr>
<tr>
<td>SH</td>
<td>It can calculate the amount from the mileage.</td>
</tr>
<tr>
<td>MM</td>
<td>Yes. So maybe XXX system could be better ... maybe warning for large claims. Ten thousand pounds (laughs).</td>
</tr>
<tr>
<td>SH</td>
<td>(Laughs) Dodgy, very dodgy.</td>
</tr>
<tr>
<td>MM</td>
<td>Well, see how we get on with paper.</td>
</tr>
<tr>
<td>SH</td>
<td>Well, are you going to ... or what? (pass MM the pen).</td>
</tr>
<tr>
<td>MM</td>
<td>Well, ok, ya. This is a bit big (referring the A3 paper provided.) I just call that screen two.</td>
</tr>
<tr>
<td>SH</td>
<td>Do you want pencil?</td>
</tr>
<tr>
<td>MM</td>
<td>No, it's ok. I'll stick with this for the while.</td>
</tr>
<tr>
<td>SH</td>
<td>(Directed to experimenter) You should give him some cigarette package or used envelopes (laughs).</td>
</tr>
<tr>
<td>MM</td>
<td>(Laughs) Well, just to ... perhaps we could look at ... just the overall layout.</td>
</tr>
<tr>
<td>SH</td>
<td>Ok, so the reference and the allocation number.</td>
</tr>
<tr>
<td>MM</td>
<td>Ya. (Scribbled ideas on a small section of the A3 paper.)</td>
</tr>
<tr>
<td>SH</td>
<td>Perhaps the company title too ... to refer to the document mainly ... it's a ... that's an expense claim.</td>
</tr>
<tr>
<td>MM</td>
<td>(Wrote 'Reference number' and 'Allocation number'.) Something like that across the screen.</td>
</tr>
<tr>
<td>SH</td>
<td>Uh-huh.</td>
</tr>
<tr>
<td>MM</td>
<td>Should the err ...</td>
</tr>
<tr>
<td>SH</td>
<td>Ya. the field in box.</td>
</tr>
<tr>
<td>MM</td>
<td>Err ...</td>
</tr>
<tr>
<td>SH</td>
<td>Claimant ... va ... put the title</td>
</tr>
<tr>
<td>MM</td>
<td>Ya. I could say expense officer use only</td>
</tr>
<tr>
<td>SH</td>
<td>Maybe that's obvious.</td>
</tr>
<tr>
<td>MM</td>
<td>(Wrote 'Claimant's Details'.) Do you go across screen?</td>
</tr>
<tr>
<td>MM</td>
<td>Do you put forename first?</td>
</tr>
<tr>
<td>SH</td>
<td>Uh-huh.</td>
</tr>
<tr>
<td>MM</td>
<td>I hope I can get all that one line.</td>
</tr>
<tr>
<td>SH</td>
<td>Yeah.</td>
</tr>
<tr>
<td>MM</td>
<td>Oh ...</td>
</tr>
<tr>
<td>-----</td>
<td>--------</td>
</tr>
<tr>
<td>SH</td>
<td>Expense detail.</td>
</tr>
<tr>
<td>MM</td>
<td>Erm ... how do you do this?</td>
</tr>
<tr>
<td>SH</td>
<td>Date, purpose ....</td>
</tr>
<tr>
<td>MM</td>
<td>Should that be in column or ...</td>
</tr>
<tr>
<td>SH</td>
<td>Ya.</td>
</tr>
<tr>
<td>MM</td>
<td>Are we doing a series of journeys or just the one? And I suppose that's a column if it's series.</td>
</tr>
<tr>
<td>SH</td>
<td>Series ......</td>
</tr>
<tr>
<td>MM</td>
<td>That's purpose ... that could be ...</td>
</tr>
<tr>
<td>SH</td>
<td>Quite a large ... although not on the paper version ... They only give you ...</td>
</tr>
<tr>
<td>MM</td>
<td>Yeah. Just a short one.</td>
</tr>
<tr>
<td>SH</td>
<td>Yes. It's only half the A4.</td>
</tr>
<tr>
<td>MM</td>
<td>Yes ... people actually summarise XX..</td>
</tr>
<tr>
<td>SH</td>
<td>Yes.</td>
</tr>
<tr>
<td>MM</td>
<td>Car ...</td>
</tr>
<tr>
<td>SH</td>
<td>Mode.</td>
</tr>
<tr>
<td>MM</td>
<td>The mode, ya. Now, err ... how should we do that?</td>
</tr>
<tr>
<td>SH</td>
<td>Ah, yes. We could give them a pick list. So when they put the ... number ... I don't know ... when the cursor goes in that box a pick list comes out in the ...</td>
</tr>
<tr>
<td>MM</td>
<td>Uh ... right. Yes. So, it's ... so this is the cursor and some sort of list appear in the overlay.</td>
</tr>
<tr>
<td>SH</td>
<td>Yes.</td>
</tr>
<tr>
<td>MM</td>
<td>Yes. I suppose what they could do is when they get pretty familiar they can short cut that and just put ...</td>
</tr>
<tr>
<td>SH</td>
<td>Yes.</td>
</tr>
<tr>
<td>MM</td>
<td>... mileage. Ah ... well, possibly mileage ..</td>
</tr>
<tr>
<td>SH</td>
<td>Uh-huh.</td>
</tr>
<tr>
<td>MM</td>
<td>I suppose ...</td>
</tr>
<tr>
<td>SH</td>
<td>Registration number as well. To get across one what was it, a Mac2 screen ... no, that's a MacPlus. A MacPlus is an A4 width is it?</td>
</tr>
<tr>
<td>MM</td>
<td>No, err... being a graphic screen you got a variable number of characters.</td>
</tr>
<tr>
<td>SH</td>
<td>Right.</td>
</tr>
<tr>
<td>MM</td>
<td>You wouldn't want them too small.</td>
</tr>
<tr>
<td>SH</td>
<td>You wouldn't also want ... like WORD facility for shifting the size of the page because of the ... The expenses office would suddenly have to check and there's a bit that was hidden.</td>
</tr>
<tr>
<td>MM</td>
<td>(Laughs) Oh, right, yes. That would be a real pain.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>I think it does definitely need to be compact ... you know across the screen. I mean... there's no... you couldn't manage it splitting those... you know... putting one on top of the another... you know... say two lots of three.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>You couldn't...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>It would be very undesirable.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Ya, with more than one journey.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Hmm... then you'll have to correlate which line is...</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Ya. I suppose you could group them by having... sort of like, date, purpose, mode and mileage.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Right.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>And let them have...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>A drag... a real drag for the person checking.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Ya.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Unless... unless... err... you put those in a scrolling field.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Oh, right, ya.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>I don't like it.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Well, so the person would check by scrolling through.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Hmm...</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>I'm wondering about... perhaps have one screen for journey but you wouldn't want to re-type the details through.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>No.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>I can't...</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>That would be no problem would it... to have... a copy of the contents without taking off... making the template... for that particular...</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>Ya... you get something like more buttons, you can say like another claim or finish. You just hit one button or another.</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>Ya.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>There's no function key on the Mac. is there?</td>
</tr>
<tr>
<td><strong>SH</strong></td>
<td>No, unless you have an extended keyboard. Not many of the normal price ones do.</td>
</tr>
<tr>
<td><strong>MM</strong></td>
<td>No. So I suppose... ermm.</td>
</tr>
</tbody>
</table>

We see how it looks then, on the screen. We are assuming about 85, 25, or something, rows and columns. So it's what... COSY Corporation. (Started to sketch ideas on a fresh sheet of A3. Wrote 'COSY Corporation - expense claim system'.) So we just put two fields. |

| **SH** | Yeah. |
| **MM** | (Wrote 'Reference No' and 'Allocation No' and boxes as the entry fields.) Should there be a line across there or something? |
| **SH** | Could be... well... it doesn't matter, it's not critical is it? It doesn't matter. |
MM Yes, that's right. I suppose there is shading technique that you could use to sort of maybe shade that ... doesn't look too much like you're highlighting it.

SH Yes.

MM Claimant's details.
(Wrote 'Claimant's Details' as subheadings, and then 'Title', 'Forename' and 'Surname' and their entry fields, all in a row, and 'Department' and 'Position' in a second row.)
Err ... I don't know if you need using help there really.
So it's just straightforward.

SH Uh-huh.

MM Is that ... shouldn't be another way ... natural way to input ... is that ...?

SH Uh-huh.

MM (Wrote 'Expense Details' as another subheading and 'Date' and a box as the entry field below.)
Ya, I suppose that could be a pick list.
Err ... right, just the ... what do you think ... right across or leave it to two lines?

SH If you got multiple mode journey ...

MM Oh ya.
(Wrote 'Purpose' and drew a set of boxes as it's entry fields)

SH Then, you know ... you don't have to put one date and your purpose is going to be the same. You can use 3 or 4 lines to describe the whole journey.

MM Oh, I see ... ya ... I forgotten about that so, put that in above the ... don't know is that thing inconsistent if I put ...

SH Ya ... if you use it as a heading.

MM Ya.

SH I don't think so.

MM Because this mode one is going to be heading and list.
I see what you mean.
Purpose, could be quite short and narrowish.

SH Yes.
In actual fact, whether you need space between them 'cos ... it's like ... you know, continuous grid.

MM Oh, I see, yes.

SH Then you, err ... save some space.

MM It's difficult to know how much room you got on the screen, in fact.

SH Uh-huh.

MM Ermm ... you got mode.
(Wrote 'Mode' and drew boxes as entry fields')
Now that's gonna be, I suppose it's gonna be ... maybe a set of numbers and then the ... if you type in numbers, perhaps it ought to ... if you type in one, you'll get taxi up, as a check.

SH Ya, I mean you could ...
<table>
<thead>
<tr>
<th>Role</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM</td>
<td>I don't know how ... are we going to have a list where they pick on?</td>
</tr>
<tr>
<td>SH</td>
<td>Yes.</td>
</tr>
<tr>
<td>MM</td>
<td>The cursor ... with that line there ... the cursor goes here, and then we get sort of a disappearing ...</td>
</tr>
<tr>
<td>SH</td>
<td>Ya, it sort of overlap that field.</td>
</tr>
<tr>
<td>MM</td>
<td>Ya ... go on ... (pass pen to SH). Ya, it says, car ... (Wrote overlapping fields on the 'Mode' field.) Taxi ...</td>
</tr>
<tr>
<td>MM</td>
<td>Ya, bus, train flight, underground.</td>
</tr>
<tr>
<td>SH</td>
<td>Err ... and then sort of mouse selection, and highlighted selection or inverse selection. So that will be ... car. (Shaded Car's entry field, and placed a tick next to it.) If you have the function keys like they do on the Macs, where you just hit the one and then car will automatically put on.</td>
</tr>
<tr>
<td>MM</td>
<td>Ya.</td>
</tr>
<tr>
<td>SH</td>
<td>But if all you got to do is put the cursor ... get the cursor into the box as it appears, then you know... ah ... but that's showing ... and then ... you see that anyway, and you hit the one and it goes ... err ...</td>
</tr>
<tr>
<td>MM</td>
<td>Ya, I suppose you got the choice .. you could have the choice of putting the one in or moving the cursor.</td>
</tr>
<tr>
<td>SH</td>
<td>So you don't need that technique .. the selection is indicated by the ... this (highlighting) ...</td>
</tr>
<tr>
<td>MM</td>
<td>Oh, I see, yes.</td>
</tr>
<tr>
<td>SH</td>
<td>... sorry It's the function key. So you got 1,2 ,3,4,5,6,7.</td>
</tr>
<tr>
<td>MM</td>
<td>Yes ... so, it's highlighted instantaneously and then disappearing.</td>
</tr>
<tr>
<td>SH</td>
<td>Yes, yes.</td>
</tr>
<tr>
<td>MM</td>
<td>Yes.</td>
</tr>
<tr>
<td>SH</td>
<td>Now that's going to be 2 layout, isn't there? If the ... ya ... we might as well get the longer list like this ... because the person checking it will want that information to check.</td>
</tr>
<tr>
<td>MM</td>
<td>Yes, yes. Just thinking that the registration, err ... on our forms they err ... that's like a separate, ... that's like the personal details almost ...</td>
</tr>
<tr>
<td>SH</td>
<td>Yes.</td>
</tr>
<tr>
<td>MM</td>
<td>I know you don't ... and you sometimes fill ... you don't have to put it in when you haven't been by car.</td>
</tr>
<tr>
<td>SH</td>
<td>Ya, that is like a good idea because it's unlikely you are jumping about, you know ... jump about from car to car. unless ... unless you use a hired car.</td>
</tr>
<tr>
<td>MM</td>
<td>Oh, yes. You have to go back to the users and ask them what difference they want to ...</td>
</tr>
</tbody>
</table>
SH: Ya, it would be assumed ... if you used a private car ... err ...
MM: Errmm.
SH: Mind you, you might want to buy petrol for it, you know, and it's still the tank .. the tank's empty ... you still want to claim for it the usual way, wouldn't you?
MM: If it's a hired car, yes.
SH: Ya .. crmm ... ya, that's right, depends on how the hire car ... 'coz here we don't need rent it, do you think?
MM: If it's a hired car, yes.
SH: No.
MM: Ya, so you might want mileage for that, and then it's simpler with hired car here as you just put hired car and you don't need to claim anything.
SH: So what are we saying?
MM: What are we saying that it would be nice if we could include them in the personal details but probably say ...
SH: Err ... yes ... unless you have another category like your own car and hired car.
MM: Hmm ...
SH: And I suppose it's. ... ya ...
MM: And I suppose it's. ... ya ...
SH: In fact you are right.
MM: Ya, so you, yes ...
SH: Shall we put that one in?
MM: Shall we go for that one?
SH: So here we got car, and here we put in car registration.
MM: You know, the advance system you could almost have the car ... maybe you can type your surname in, it might be able to print out the other details automatically from the database.
SH: Ya.
MM: Including car registration.
SH: In actual fact, you could do ... if you ... if it was a car hired and they wanted the details for the ... you could get another pick list or you can get another data entry field overlaying that XXX. Rather than just put in hired car it puts in registration of the car. In which case that's indicating it's a car and that's giving you the registration number.
MM: Err ... what you mean ... the registration number is held on the system?
SH: Ya.
MM: (Nods)
<table>
<thead>
<tr>
<th><strong>SH</strong></th>
<th><strong>MM</strong></th>
<th><strong>SH</strong></th>
<th><strong>MM</strong></th>
<th><strong>SH</strong></th>
<th><strong>MM</strong></th>
<th><strong>SH</strong></th>
<th><strong>MM</strong></th>
<th><strong>SH</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>No, no, sorry. You go in this mode of transport, you pick hired car, alright, form this list. Rather than the list disappearing, it stays on yet, a dialogue box with 'please enter the registration number', you type in, ok, and then the whole lot disappear but then the car registration goes in.</td>
<td>Oh, I see. That makes it ... that distinguishes between own car and hired car. Alright, ya.</td>
<td>And it's obvious, then that the mode was a hired car. And it saves, if you have that as a separate field, you could intelligently copy that ... copy the registration into that field. So, err ...</td>
<td>Yes ... that's quite a good Idea. I suppose I mean I can see that bit, good, maybe I could see the registration still being a list in a way. Then you end up with a car registration but you wouldn't know whether it was a hired car or ...</td>
<td>But ... well it's just a cross inspection.</td>
<td>Yes, it would tell you. Yes, ermm ... yes, that seems ok.</td>
<td>So shall I just mock in the rest. Dialogue box and ....</td>
<td>Yes. I'm with it now. (Drew a pop up window over the 'Mode' entry field and wrote 'Enter car registration', and also 'Cancel' and 'Ok' buttons.) If they choose own car, you don't get the box, because it sends it up here.</td>
<td>Uh-huh. So you get your ok, or cancel.</td>
</tr>
<tr>
<td>Yes. (laughs). Well, it's implying in respect because it's saying its a Mac2 screen.</td>
<td>(Nods). Yes.</td>
<td>Graphical Interface.</td>
<td>So, err ....</td>
<td>So, amount ....</td>
<td>Yes. (Wrote 'Mileage' and 'Amount Claimed', with boxes as the entry fields.) Mileage, cars ....</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SH (Wrote 'Total Claimed' below 'Amount Claimed'.) I suppose the total claimed is going to fill up automatically.

MM Yeah.

SH And it's going to be small boxes.

MM Yes, of course, yes. So if you put car onto XXX, or other then it would jump to this box.

SH Uh-huh.

MM And then just wait for you to put in the fields.

SH Otherwise that box would be greyed ... rather than just disappear.

MM Oh ya.

SH It could just greyed out, couldn't it?

MM Yes.
Ok, mileage. You don't want to merge these two, would you? Where you type the mileage in and it automatically converts it to pounds.
So if you lose the mileage then you can't ... you can't check them.

SH No.

MM Uh-huh. Ya, it's better ... if you then put taxi in then it just jump straight across.

SH Yes.

MM Oh, I think that seems fine. Do you want this, err... we are assuming now one screen per journey, aren't we? 'Cos we needing a set of entries for one journey.

SH Yes, but you know, I think the same thing goes here. That you make a continuous field, you know, across, you wouldn't need any, you know, complete group.

MM No.

SH 'Cos, it's the same on the form, aren't they?

MM Ya, that's right. I think, err ...

SH What's that?

MM That's at the end to indicate whether, err ...

SH Another flag?

MM Yes.

SH If it was a button, does it need to be something like that, with a label on it rather than ... to distinguish it from the field? I suppose then you can have ... I was going to say default box but I'm not quite sure ...

MM Where is the instruction going, where's the help? It's not really help, is it? It's instructions ...
| MM      | Well, it could be instruction or it could be contextual help.  
|         | Or it could be both, I suppose. 
|         | So if you are there, well ... 
|         | You don't need irrelevant contextual help ... |
| SH      | Showing the current selection ... |
| MM      | Ya. 
|         | If you just have titles showing what is permissible. 
|         | You may not want to bother about it. 
|         | You might just want to put the XXX that you want. 
|         | How do you normally XXX? 
|         | XXX format would be one useful bit of information. |
| SH      | If you are using an electronic medium that's ... you know, that has got intelligence about the current time, you can put that on automatically. 
|         | Now that's for the date of the claim. |
| MM      | Oh, I see. ya. |
| SH      | That's not from the form, is it? 
|         | Usually you have to sign them and date them. 
|         | Or is that somebody else's problem? |
| MM      | Look, we can assume it would be useful maybe to have a date. 
|         | (Wrote date at the top of the paper.) |
| SH      | Uh-huh. |
| MM      | I was just wondering about the amount of real help you could give. It's so small, really. 
|         | You could give it all as one screen. 
|         | Maybe we can decide what goes on in the help. |
| SH      | Hmm ... 
|         | We could do ... what I'm suggesting is that we cheat. 
|         | You know, like in the Hypercard ... the Hypercard guidelines ... like at the top of reference ... alright, you pick, or your selection picks for you what's the context sensitive help. 
|         | You want ... and then it jumps down the scrolling list, you get the title and the contextual information that goes with it. 
|         | So although you got one page really, you got a mile of information. |
| MM      | Yes, oh ya. 
|         | I see what you mean. 
|         | Ya, that would be quite nice. 
|         | In fact on the actual help here, I reckon it's fairly minimal. 
|         | I mean the only thing is really the format of the date. 
|         | So whether you put a space in between ... well, actually that could be automatic here, the cursor could jump. 
|         | I don't know about car registration. 
|         | No, probably there are too many. |
| SH      | (Mumbles. Laughs.) 
|         | Personalised number plates. |
MM (Laughs)
Ya ... format of the date.
I mean you can always put that here.
You can always put dd, mm, and yy, or whatever.

SH Ya.

MM I suppose one of the problem is ...

SH Navigation.
Instructions for navigation.
I would think that the information screen would
give instruction on that.
It's more important that you could use either
mouse, or the arrow keys.

MM Yes.

SH Or in certain cases, it's possible to use the function
keys.

MM Right.
(Wrote 'Help' and "Use mouse or arrow keys to
move between fields. Function keys for pick lists'
at the bottom of the page, as the second screen.)
Err ... I suppose, to go back a field, you just use the
left arrow keys?

SH Yes.

MM I suppose these fields should be more justified so
you could see more clearly which arrows it
regress to.

SH Yes.

MM It's something to be fine tuned.

SH Yes.

MM So it's use the mouse or the arrow keys, or function
keys.

SH So your instruction will appear as a separate
button.

MM Oh, right, ya.
(Drew help button on the first screen.)
Alright, help or instruction.
Err ... to make a correction, you could just overtype
something.

SH Uh-huh.

MM Actually to move between fields.
Say you finish entering the title ... how do you ...
how do you then ... just use the arrow keys, or the
enter keys, or ...

SH Well ... return.

MM (Wrote 'return' above the word 'mouse' in the help
instruction.
Right.
The normal ways to just step through is to just keep
pressing return.

SH Hmm.

MM I suppose the instruction need also to say, to move
back use the arrow keys.

SH Uh-huh.

MM Right, do you think we have done the job now?
**SH** In fact, I suppose, you know, what if they, err ... the car is the peculiar case ... a special case ... because once you put the mileage in, the amount automatically comes up. Whereas if you claim a taxi, that's not XXX. And you are allowed to enter your own amount there. But there's no point in, I don't think there's going to be any confusion resulting in ... say you've done a 100 miles, and it in fact comes up to 200 pounds, there's going to be confusion in ... say you want to claim £250 then. Is that to cause confusion, you think? I mean whether you want to save the real XXX you going to claim ... not a navigation help, but the real reason of the claim form.

**MM** Oh, I see what you mean. The actual limits of the claim.

**SH** Yes.

**MM** But you might want to say, it's £2 per mile. Something that might be useful to include.

**SH** Yes. Well, you could even have them here. You know, this is getting ridiculous ... If you pick car, put your registration number, your mileage comes up, and it says £2 per mile. Then you mileage in there, that will disappear, and the actual, sort of ...

**MM** Yes, that will become useful if the mileage changes quite a lot. Yes, that's how a lot of system are doing lots of things popping up with information, which makes it a lot easier. Err ... we could have some kind of validation here on date ... give a message on valid date .... or incorrect date, or something. That could be something like a dialogues box, an overlay, that will go away again.

**SH and MM** Well, that's it.
Appendix F

Summary of procedures for design knowledge acquisition and analysis.
Summary of procedures for design knowledge acquisition and analysis.

(After Tunnicliffe, 1990.)

<table>
<thead>
<tr>
<th>STAGE</th>
<th>PROCEDURES</th>
<th>TECHNIQUES</th>
<th>ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary</td>
<td>Casual Discussion</td>
<td>Create Friendly relationship.</td>
<td>Study of preferred communication.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Study Environment.</td>
<td>Prepare questions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design of problem solving task.</td>
<td>Feasibility study.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Prepare questions.</td>
</tr>
<tr>
<td>Stage 1</td>
<td>Problem Solving Task</td>
<td>Drawing.</td>
<td>Transcription.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Video record.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Categorisation</td>
<td>Perceptual Data.</td>
<td>Procedure Map.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discuss Examples.</td>
<td>Simple Index.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drawing/ Sketching.</td>
<td>Structured Index.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diagram construction and refinement.</td>
<td>Structure Diagrams.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Report Development.</td>
</tr>
</tbody>
</table>
Appendix G

Documents for the evaluation of COSY.
Instructions to designer.

Please read the instructions carefully before you begin and ask if you have any questions.

You are given a screen dump of part of a data entry screen for an application to be a member of an academic society. You are asked to cooperate with COSY, a cooperative screen design system, to redesign the screen layout. You do not need to present any extra information except that which is already given on the screen dump.

You will be given 30 minutes to perform the task. If you need more time, please inform the experimenter. When you have finished the task, you will be given a questionnaire to fill in.

This session is not a test of competence, and I am not interested with efficiency of the solution. Rather, I am interested in evaluating COSY's characteristics and efficiency as a cooperative system. Therefore, when you fill in the questionnaire, you will have to recall your experience of using COSY.

Before you begin the task, you will be given a short demonstration on how to use COSY. Please notify the experimenter when you are ready.

Thank you very much for your willingness to participate in this evaluation.
Surname __________________________

Firstname:

Home Address: _______________ Term Address ___________

_________________________

_________________________

Secondary Education Establishment __________________________

Membership Application Form

Page 1 of 2
QUESTIONNAIRE

Please answer the following questions based on the screen redesign task that you have just done. Please circle the number on the scale that best describes what you feel, and finally add any further comments at the end that you think would be appropriate.

1. There were certain problems in the data entry screen that you were asked to redesign. For example, the title was in lower case and was not in an eye-catching position. Also the caption and entry fields were not separated by a distinct delimiter. Do you agree that COSY cooperated with you by helping you to identify these and other screen design deficiencies?

```
1  2  3  4  5

Do not agree  Partially agree  Fully agree
```

2. Do you agree that by providing you with alternative design solutions, COSY prompted you to produce a better screen layout?

```
1  2  3  4  5

Do not agree  Partially agree  Fully agree
```

3. How satisfied are you with the design solutions that you produced using COSY?

```
1  2  3  4  5

Very unsatisfied  Very satisfied
```

4. Do you agree that cooperating with COSY has helped you to learn more about issues of screen design?

```
1  2  3  4  5

Do not agree  Partially agree  Fully agree
```

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COSY is intended to cooperate with you as a designer in performing the screen design task. COSY does this by providing you with screen design guidelines in the ADVISOR window, and the rationale of the advice (guidelines) in the EXPLANATION window. COSY also provides a graphical presentation of its alternative design solutions in the SUGGESTION window.

5. Do you think that the information provided in the ADVISOR window is:

5a.  

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

Unhelpful       Helpful

5b.  

| 1 | 2 | 3 | 4 | 5 |

Insufficient   Sufficient

5c.  

| 1 | 2 | 3 | 4 | 5 |

Confusing      Clear

5d.  

| 1 | 2 | 3 | 4 | 5 |

Not acceptable to you  Acceptable to you

6. Do you think that the information provided in the EXPLANATION window is:

6a.  

| 1 | 2 | 3 | 4 | 5 |

Unhelpful       Helpful

6b.  

| 1 | 2 | 3 | 4 | 5 |

Insufficient   Sufficient

6c.  

| 1 | 2 | 3 | 4 | 5 |

Confusing      Clear

6d.  

| 1 | 2 | 3 | 4 | 5 |

Not acceptable to you  Acceptable to you
7. Do you find the graphical presentation of COSY's design solutions:

7a.  

1 2 3 4 5  

Unhelpful  Helpful

7b.  

1 2 3 4 5  

Not acceptable to you  Acceptable to you

8. In the present implementation, the designer's and COSY's work spaces are clearly separated and independent. Do you find this arrangement:

1 2 3 4 5  

Unsatisfactory Satisfactory

9. Do you find it useful to be able to cut and paste COSY's solution into your own design?

1 2 3 4 5  

Not useful Useful

10. For COSY to know what you are trying to do, you have to identify screen elements such as 'title', 'caption and entry fields', etc. Do you find this procedure:

1 2 3 4 5  

Not acceptable to you Acceptable to you

11. Did you find COSY easy to use, or difficult to use?

1 2 3 4 5  

Very difficult Very easy
12. Do you agree that COSY is a different kind of support system compared to others that you have previously used?

1 2 3 4 5

Do not agree  Partially agree  Fully agree

13. Would you use COSY again?

(Please tick) YES ___ NO ___

14. How do you think COSY could be improved?

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15. Please add any further comments.

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