Design and Teamwork: A Contested Alliance

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ABSTRACT

Design research is concerned with the development, articulation and communication of design knowledge; and one aspect of this is the investigation of the relationship between products and the way in which people design them.

This study was prompted by my response to a paper by Gabriela Goldschmidt's[1] (1995a) where she concluded that 'there are almost no differences between the individual and the team in the way they bring their work to fruition.' In order to ascertain the validity of her claim, I carried out a survey among design students and designers from various disciplines in order to investigate both the activities and, more especially, the perceptions of the importance of the individual's influence on the design team.

I was interested to find that Goldschmidt's claim did correspond neither to the subjective experience of those participants who teach on design programmes, nor to the views of those who study on design programmes. However, during the course of my research the initial focus on quantitative data gradually shifted to an enquiry into how people learn to design, the nature of group dynamics and creativity, the development of (design) abilities in individuals and teams, and the production of design as a social process. The study concludes by considering how might development be systematically nurtured in design education.

[1] Goldschmidt, G. (1995a) 'The designer as a team of one', *Design Studies* 16:2, 189–210

INTRODUCTION

In today's environment, design projects are complex because of the disparate technologies which need to be considered and the consequent variety of skills which need to be deployed. Economic pressure has also increased, so the efficiency and effectiveness of design teams is crucial. Gabriella Goldschmidt, in her study: "Who does better in design, loners or teams?", concludes that there are almost no differences between the individual and the team in the way they bring their work to fruition. However, no account is taken of these factors and therefore I am reluctant to agree that her conclusion is relevant to the current design environment.

As part of my work, I carried out a survey among design students and designers in order to investigate both the activities and the perceptions of those working in teams, as opposed to those working individually. The statistical analysis of the results contradicts Goldschmidt's findings and has reinforced my belief in the potential of teamwork.

Chapter One looks at Goldschmidt's work. It starts by stating the problem and goes on to give an account of the background of the participant designers, the solo designer and the team designers, respectively. Her analytic technique is then explained, the chapter expands on my reservations about Goldschmidt's work and ends by questioning her claim.

Chapter Two discusses the survey carried out among designers (both students and qualified practitioners). The results of the survey are then analysed statistically and the chapter ends by reviewing and critically appraising the results.

Chapter Three constitutes the main bulk of the thesis. Here a detailed search on all related works is considered and critically analysed. The chapter itself is subdivided into three major sections with appropriate subheadings and discussion. The first section includes discussion relating to teams, teamwork and team building. The second section focuses on analytical tools – Protocol Analysis, its strengths and weaknesses. The third section looks at design methodology and the concept of intuition in design. The thesis ends by explaining how awareness of issues relating to teamwork can play a crucial role in the future of prospective designers.

Chapter Four looks at the traditional instructor-centred education models generally referred to in academia as "pedagogy" and discusses the need for a goal-centred curriculum. It also points

out how good curriculum design can make the difference between a dull, mind-numbing learning experience and a fun, confidence-building journey.

The thesis was influenced by my previous experiences. My undergraduate education started in the mid eighties when I enrolled at the University of New Delhi for a first degree in Chemistry. My secondary education had prepared me for this scientific approach to study and I was adept at statistical analysis and a range of procedural scientific activities. I then taught science and mathematics to secondary schools pupils for eight years to all ages - and currently in a further education college.

I applied to Middlesex to undertake a research degree and assumed that I would be able to use my background in scientific studies. My supervisors were Steve Torrance, a psychologist, and John Lansdown, an extraordinary polymath who had worked for years as an architect and planner but was also a choreographer and an internationally reputed pioneer in computer aided design. This experience was both stimulating and disorienting and I began to take into account forms of knowledge that were not amenable to quantitative research.

After John Lansdown's untimely death my present supervisors took over the project. Throughout this period I continued to approach the issue of teamwork in design in a primarily empirical way. Following a scientific approach, I devised a questionnaire that was intended to investigate the perceived advantages and disadvantages of teamwork.

The questions were intended to provide information as a basis for achieving a better understanding of the advantages of teamwork. Although the results of the survey proved dissatisfying in answering the targeted questions, it did however pave the path in taking my readers to another stage where I grew in strength by working on more complex issues.

I realised that in order to investigate the area further I needed to develop new kinds of hypothesis and was confronted with the difficulty of explaining some of the key terms and components of the design process. I was aware that the term 'design' is used in an expansive way incorporating simple craftwork as well as complex environmental planning. During the course of the work on this thesis my conception of design changed where I realized that it is a term used both to describe the conceptual stages that precede the various processes involved and to provide a way of talking about the objects that are the outcomes of those processes. The emphasis shifted from a concern with design as the object of enquiry to the content

of design practice and therefore, social processes that assist (or hinder) its development. Hence creativity had to be also considered as a result of social exchanges (evident in humour, for example) and the dynamics of group interaction.

Towards the end of the study, the focus of the project shifted to pedagogy, which is an area where I already had experience. I realized that although these issues such as creativity, humour and intuition are not openly taught, they are however encountered by both students and professionals through example, experience, the social culture of design and through social skills. Therefore it seemed appropriate that any change incorporated into the curriculum of design teaching would reinforce the characteristic I value in design practice. I recognize that my approach has been hybrid, moving between a need to quantify and the desire to provide a qualitative understanding.

Designing is considered both by clients and consumers to be a significant intellectual activity because of its complexities and the effects its results have on society. For developed and developing countries alike, high-quality design is a highly cost-effective resource available to improve trade balances.

A few good designers using advanced design processes can have dramatic impact on the success of products and services. But *who does better in design, loners or teams?*

1.0 Goldschmidt's work:

Gabriela Goldschmidt is currently an associate professor of architecture at the Technion-Israel Institute of Technology. She has published numerous papers in architectural and design journals and books on the subject of design thinking and cognition. In 1986-88 she was a visiting scholar at MIT, and in 1991 she served as a senior research fellow at the Delft University of Technology.

I became interested in Goldschmidt's work after reading her article "The designer as a team of one"[1], around which my study is significantly centered. Although Goldschmidt believes that team design is desirable, she claims that there is little research to support the claim that team work in design is superior to that of an individual designer. In an attempt to analyse this claim, Goldschmidt approaches the question from the perspective of cognitive science and asks whether the processes of design thinking can be accessed so as to be able to compare the behaviour and performance of the individual to that of a team. She believes that she has the tools with which to study design thinking. Parameters of comparison between a team and an individual were defined and a methodology presented based on protocol analysis. Protocol analysis studies are based on "think aloud" experiments in which the individuals engage in the investigated activity while they continuously verbalise their thoughts. Protocols of these verbalisations are then parsed into small units and encoded using a category scheme that reflects the research objectives.

[1] Goldschmidt G.,(1995a) "The designer as a team of one," *Design Studies* 16:2 p189-210

1.1 Individual and team problem solving

There are design situations in which it is not clear which mode of practice is desirable for the front edge of the design process: a team effort or an individual's endeavour? For example in the engineering-oriented design professions it is common practice to initiate work on a new task with a collective ideation session. The task is assigned to a team and the team members are thus jointly involved from the early stages of conceptual design. This does not appear to be the case in the more art-oriented design fields, where an individual designer is often responsible for the conceptual design phase. Although he or she may consult with colleagues and peers, the responsibility is however personal and a team steps into the picture at a later stage.

Is the contribution of several minds to the conceptual phase an asset in terms of the breadth of issues that can be expected to surface and the number of alternative candidate solutions that may be proposed? Or does teamwork contribute, inversely? Do conflicting views and the tendency towards conformity and compromise dilute the creative solutions of an individual author? Is the single mind less constrained because it is free to explore unpopular directions or is it more constrained by personal biases and limited expertise?

1.1.1 The problem

The above questions are not unique to design and have been asked in the context of research on problem solving and on scientific investigation. In general team work is considered to be more fruitful and more capable of resolving complex problems and collaborative work is more and more widely used. Collaborative undertakings however do not necessarily mean more satisfactory work. Motivation of team members tends to decrease where there is no personal penalty for slacking or no reward for successful performance.

A comparative study between individuals and teams in design particularly 'in the thick' edge of design seems rather relevant. The protocol was generated by the faculty of Industrial Design Engineering, Delft University of Technology, for a workshop[2] on Analysing

[2] The 1994 Delft Protocols Workshop: The aim of the workshop was to bring together a group of design researchers (all well versed in protocol analysis) to compare analyses of the same data and to discuss the state of the art in protocol analysis

Design Activity held in delft in September 1994. Industrial design protocols of a team and an individual at work on the design of a bicycle carrier provide a good opportunity for such a comparison for the reasons:

- industrial design lies somewhere between engineering and artistic design disciplines;
- protocol analysis is well suited for the comparison of processes;
- the equal settings of the two design sessions in question provide a considerable methodological advantage.

1.1.2 The Solo designer: Dan

Dan is an experienced mechanical engineer, who looks at the design of the bicycle rack mostly from a functional point of view. He produces five sheets of sketches, the first of which appears only 45 minutes into the exercise. Around 40% of the total time is spent studying the problem and getting himself informed about it before he starts sketching. His exploration leads him to decide on a tubular design for his rack and this decision is never questioned nor rated against alternative options. He takes a lot of time to decide on the location of the rack.
Having decided on a tubular design and a central rear position for the rack, he spends most of the design time on joints between the rack and the bicycle.
Connecting the given backpack to the rack is secondary issue in terms of the time he spends dealing with it, and he finds a rapid solution to it which he considers a major feature of the design. Protocols of these verbalisations are parsed into small units. Parsing is carried out simply on the basis of time-units.
Dan's protocol was divided into 28 units in accordance with the subject matter they deal with, ranging in length from one to eight minutes, plus one unit which lasts for 12 minutes. Omitting the longest unit in which he conducted a telephone conversation, we arrive at an average of four minutes per unit.

1.1.3 The Team effort: Kerry, Ivan and John

The design team comprises of three product design engineers who work together in practice. They have a moderate amount of experience, Kerry is somewhat more experienced than her colleagues. They work in a systematic manner which requires little discussion among them

on procedure. Fifteen minutes into the session they produce a timetable in which they divide their time into well defined design phases and Ivan is asked to be the time keeper.
They then enter into a brain storming session in which they bring up issues and concepts and list them in order of process on a white board. They list the functional requirements, desired features and alternative options for the positions of the rack, concepts of joining the rack to the bike and the pack to the rack and materials. The process is iterative and they discuss the different items on their list several times. The rack's position on the bike is determined easily at an early stage. Many alternative solutions are explored especially for the way the backpack can be attached to the rack. Questions of appearance come up and the team looks for 'cool' ideas. They produce four sheets of drawings, of which only two contain actual design sketches, mostly three dimensional, starting approximately half an hour into the process.
In the last minutes of the session the team calculates manufacturing costs and arrives at a fairly complete preliminary specification for the designed product. Although no division of labour is planned apart from Ivan's role of timekeeping, careful analysis can point to group dynamics that produces social roles in the team, and it appears that each member contributes different dimensions to the joint effort.

The team protocol was divided into 45 units by subject matter ranging in length from one to nine minutes and averaging to 2.66 minutes per unit. For the proposed comparison, productivity was chosen as the yardstick for commentary and analysis however there is the need to be sure that the two protocols are of a kind and that protocol analysis can be applied to them on equal grounds.

1.2 Design thinking and verbalisation

Can thinking aloud and conversing with others be seen as similar reflections of cognitive processes under investigation in this study? Adopting Vygotsky's view on the relation between thought and speech the answer is in the affirmative. Vygotsky distinguishes between two planes of speech: the inner and the external. Inner speech is the semantic aspect of speech in that it centres on predication and tends to omit the subject of a sentence and words connected to it. Inner speech is a function in itself, not an aspect of external speech but together inner and

external speech form a unity of speech. Thinking aloud can be seen as being close to inner speech whereas conversing is certainly a sample of external speech.

Both inner and external speech are more than representations of thought. In Vygotsky's words: 'Thought is not merely expressed in words; it comes into existence through them.'

1.3 Design productivity

The term productivity bring to mind issues of cost effectiveness and profitability. Performance, motivation, efficiency, effectiveness, production, quality, etc. are also related issues of productivity. According to Pritchard and Watson, efficiency and effectiveness such as producing a better range of ideas, reducing development time, and so costs, and speeding the process of bringing better products to the market are the most important issues to look at. It is not easy to measure group productivity: interdependence among group members is necessary to achieve the group's goals. The patterns of such interdependence may be rather complex and therefore the productivity of a group is not a simple sum of the performance of its member. Finding ways to assess effectiveness and efficiency in design thinking, as carried out by both individuals and teams are therefore needed. Efficiency is relevant to design thinking because it bears on creativity and expertise, among other things. The amount of mental resources that must be invested to obtain innovative ideas is directly related to creativity. Expertise has an even closer association to efficiency. Creativity will figure in this discussion on protocols however expertise will not feature. Effectiveness shall be more or less equate to productivity and will be a major concern.

1.4 Critical design moves

Goldschmidt's analysis of the design protocol is structural, aiming to facilitate access to cognitive aspects of the design process, particularly those related to productivity. The protocol is parsed into design moves and the design process is looked at in terms of the relationships created by the links among moves.

1.4.1 Linkography

Parsing and coding of protocols are of major importance to fruitful analyses. Parsing is often based on time units and provides a rough division into phases of the investigated process. While it is useful to look at time dependencies of sets of variables, however by changing the base of parsing, protocols may be analysed in additional ways, yielding rich and potentially illuminating information.

Linkography is the system developed to notate moves and the links among them and is vital in order to comprehend structural patterns of design reasoning. Linkography[3] is a system that parses protocols into individual design moves, independent of any time units. Linkography calls for the division of a protocol into units which are then parsed into design moves. The meaning of 'move' in designing is a step, an act, an operation, which transforms the design situation relative to the state in which it was prior to that move. Moves are normally small steps and it is not always easy to delimit a move in the think aloud protocol of a single designer.

A move in Dan's unconscious protocol is defined by the beginnings and endings of coherent utterances. The team's protocol is easier to parse, and each utterance by one of the designer is defined as one move. Within each unit of the design process each move is numbered chronologically by the researcher. For each move, the question of whether it is linked to every one of the moves that precede it in a given sequence is asked by the researcher. Two kinds of links are established and they are very different conceptually; backlinks record that path that led to a move's generation, while forelinks bear evidence to its contribution to the production of further moves. The number of links relative to the number of moves in a given sequence is an indicator of the strength of the design process, or of its productivity.

Effective design process is characterised by a high ratio of interlinking among its moves. The proportion of links/ moves is termed the Link Index (LI). If a high number of links is indicative of productivity then special attention should be given to moves rich in links. Link-intensive moves are termed Critical Moves (CM), and all the Critical Moves of a sequence together describe a critical path. Critical Move rich in forelinks is notated CM> and Critical

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[3] Goldschmidt,G. and Weil M., (1998) "Contents and Structure in Design Reasoning", *Design Issues*:Vol.14 No 3 Autumn 1998

Moves rich in backlinks <CM and a Critical Move rich in links in both directions is notated<CM>. In this present study, a move is referred to as critical if it generates seven links or more in one direction.

1.4.2 Productive designers: Dan and the team

Compatible portions of the protocols are selected for analysis and comparison. Compatibility is judged by content, or subject matters that are as close as possible to one another. Matching portions were found and the mean Link Indexes for these portions calculated. The team LI = 2.75 and Dan LI = 2.67. The difference is not significant. Likewise the CM percentage of the total number of moves is 12.42% for the team and 10.14% for Dan which is not significant. Moves made by Dan are slower than those made by the team, however similar values obtained for the LI and CM lead to the conclusion that processes are basically equally productive. This conclusion does not reflect reality for the majority of projects which are in practice undertaken by teams. The management of design project in my view has not taken on board Goldschmidt's conclusions - why is that? Companies are increasingly using forms of multidisciplinary team working, in addition to reducing development time and costs, there are indications of other benefits such as attitudes improvement, growth of personal self improvement and tolerance to learn new skills from team working within companies. In view of the fact that there seems to be an increase in teamworking and Goldschmidt recognises this tendency can we regard this as a mistake on the part of the management or is it evidence that Goldschmidt's conclusions are not appropriate to current thinking and practice.

1.5 The Issues

My issues with Goldschmidt's work are taken up in more details in the next section.

My reservations with Goldschmidt's work are based on the following:

- who does 'better' in design – loners or teams? 'Better' does not account for user satisfaction
- she does not take into account creativity
- bicycle racks do not reflect current day design challenges
- she is not taking into account the importance of team design or team building

- problems with her analysis tool
- the experiment was conducted only once.

1.5.1 Who does 'better' in design – loners or teams?

'Better' does not account for user satisfaction.

The term productivity brings to mind issues of cost-effectiveness and profitability. However function is a key concept in design because ideally design is a process in which an object is realised from its functionality. After all function is used to evaluate objects to assess how well their purpose is satisfied, and this can only be accounted for and measured through user satisfaction. The functionality the bicycle rack intended is not the function given by requirements but the function it serves to its intended users.

The subjects do not seem to be familiar with bicycle rack design although they are bikers. They do not have expertise about the specific design problem they are trying to solve. They are using general design heuristics and identifying and accessing relevant information figures very strongly in their design behaviours. An expert doing the same job may require less information management. Design is an information design process, over the course of a design process designers handle large amounts of information. Therefore the quality of designs and the overall productivity of the design process depend heavily on the information management skills of designers. Information management is the process of capturing and organising design information in such a manner that it can be retrieved and reused at a later time. Information management therefore lies primarily on the designers, which often results in reduced productivity (when designers lose some of their time doing information management) or loss of valuable information (when little information is captured and organised).

1.5.2 She does not take into account creativity

A laboratory environment restricts the number of influences on the design process and thus the variables in a study. Although it is suitable for comparative research, it also implies that it is less suitable for analyses of how design actually takes place. The designers had to work in a room not familiar to them, where every action and utterance were observed and recorded.

They were not surrounded by their own tools and had to work with the information provided. They could not let the problem settle overnight or while doing some work (due to time constraint and thus lacking in creativity). The individual in addition, could not communicate with other designers, which might have affected the ability to design and thus the result of the analysis.

1.5.3 Bicycle racks do not reflect current day design challenges

In choosing an assignment for this type of experiment, a trade-off has to be sought between time (for both subject and researcher), reality of the problem, and suitability for an individual and group of designers. Designing bicycle racks is a relatively small assignment which does not require specialist knowledge and which can be solved within a few hours by an individual. More complex problems or projects more in pace with recent technology and current design problems might show differences especially in group work. There might be more need to collaborate, and specialist knowledge might force group members into different roles. However, in order to compare individuals and groups, the problem should be solvable by an individual. This problem is without doubt inherent to this type of comparative analysis. The fixed, relatively short time available must have surely influenced the design process.

One of the reasons given by Goldschmidt[1] for choosing the design of a bicycle carrier is:'*industrial design lies somewhere in comparison between engineering and the more artistically oriented design disciplines*'. Instead of a bicycle rack, what would happen if a different product was chosen, one that shifted the scale more towards art and or technology.

1.5.4 She is not taking into account the importance of team design or team building

The subjects were all experienced designers, but their level and type of experience varied. The individual designer, Dan, had more than 20 years of experience with an emphasis on electro-mechanical work. Two of the group members had five years of experience, the third group member eight years of experience. Their emphasis was on mechanical design.
The subjects were all experienced designers, but their level and type of experience varied.

Several studies showed that the years of experience can have a considerable effect on the time needed to fulfil the assignment and on the way in which people work. This could have affected the findings found by Goldschmidt's[1] work. Another subject –related limitation of this type of study is what Denzin (1978) calls the demand-characteristic effect. Subjects are not passive objects. They do not have to obey the role set for them in the experiment. However, 'subjects will persist in their assignment' because 'the norm of the role of subject is to be a good subject; to be a good subject demands that one interprets ambiguous meanings and assignments in a context that values participation'. This does not prevent problems, as the interpretation might cause subjects to proceed in a way that was not intended by the experimenter. In the experiment this might has resulted in the designers working more systematically than usual. However as this will apply to all designers in the experiment, this is assumed not to have caused differences.

Another limitation is that the subjects had to work either alone or in a group throughout the design process. In practice, design consists of a combination of individual and group work. One could argue that it restricts both the individual and the group. However, the effect of having no one to work with and the effect of having to work in a group all the time might be different.

1.5.5 Problems with her analysis tool

The individual designer was asked to think aloud to be able to record his process. Though considered to be easy to learn, and not very distracting, thinking aloud might have changed the individual's way of working. For example, it might have increased his awareness of his own design process. Group work on the contrary, requires the communication of thoughts. Therefore there is no need to ask the designers to think aloud to record the design process, i.e. to change their way of working in this respect.

[1] Goldschmidt G., (1995a) "The designer as a team of one", *Design Studies* 16:2 p189-210

1.5.6 Limitations of the analysis method

The analysis of protocols has its specific limitations both related to 'parallel' events and the difference between individual and group data. Video recordings and their protocols can be analysed in a variety of ways. One of the basic activities involved in protocol analysis is the division of the protocol into units that are coded according to a classification scheme. Various schemes can be applied, depending on the aim of the study, and the sources used to develop the scheme can differ. Another clear difference is the way in which the protocol has been divided: event-based; category-based; and time-based. Which approach is most suitable depends on the level of detail required to achieve the aim of the study.

The use of protocol analysis for group work introduces several difficulties and thereby, limitations compared to its use for individual work. Often the different group members are involved in different activities or talk at the same time, and they do talk more than individuals. Apart from posing problems on transcribing the video recordings, one has to be careful with the analysis. When people are talking at the same time, and the time for each event is recorded, this will affect calculations based on the time event. Often utterances are repeated for confirmation. This might distort the results when counting specific events is important.

One also has to be careful in interpreting the sequence of events in a group as the design process or approach, as is common for analyses of individual processes. Activities take place in parallel and the individual thought processes continue independent of the group process. The sequence of events in a protocol is, therefore, likely to consist of events of sometimes different processes existing in parallel and related to each group member. It seems difficult to untangle these processes. A detailed comparative analysis requires the same data collection and analysis methods to be used for all cases involved. Therefore the same methods were used to study the individual and the group. However, collected data are likely to be different, which implies that any similarities or differences that are found in an analysis of these data, might be the result of differences in collected data rather than differences or similarities between individuals and groups. I can therefore conclude that also the analysis method is detailed but however limited as it looks at the process from only one point of view. Therefore observed similarities or differences might have been coincidental and not caused by

factors such as group size. More work has to be undertaken to understand fully the differences between group and individual design processes to be able to divide tasks and develop tools and methods in a way that takes into account the strengths and weaknesses of each type of process.

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1.5.7 The experiment was conducted only once

The number of protocols that has been analysed is limited to two. Therefore I believe that this study can only give a first indication of differences and similarities that needs to be investigating further. Comparing the results of this study with those of other protocol studies using the same analysis method may be worth considering. In analysing this case study, it is necessary to keep in mind that the focus is on the design process, without knowing the individual abilities of the designers completely and also without knowing how this influences the design process. For a general understanding of design, the question why certain events happen in the process. What are the reasons for all the observed phenomena?

Questions such as:

- why does Dan take a lot of time to clarify the task and to deal with the bike and the backpack? It may be that this behaviour is a result of his large design experience
- is the short time for clarifying the task in the team typical for team processes or a result of the time pressure in the experiment?
- is Kerry's strong involvement in decisions a result of her experience in mountain biking and backpacking and her design experience with bike equipment?
- why John mainly creates the ideas and Ivan concentrates on organising the process? Perhaps these are the jobs they are trained in and like to do most.
- are the observed processes successful design processes under the experimental conditions?

We do not have other processes under the same conditions to compare with.

I think it is fair to say that further research is needed in the following directions:

1. Detailed information about the individual prerequisites and abilities could be a basis to explain some of the observations in the design process. Further research could help to understand the relations between individual prerequisites and design behaviour.

2. The comparison of several case studies in teams (or with single designers) under the same external conditions and an evaluation of the resulting designs should lead to a better knowledge of successful and unsuccessful design processes.

2.0 My Work

The decision to do a questionnaire came right at the beginning of the project – the aim was to find out the extent to which Goldschmidt's[1] views are relevant among designers working on current-day projects. A questionnaire was the most direct method of obtaining information and, therefore, I attempted to do a survey with U.K. based designers but had had very poor response. I decided to shift to other sources and use my existing contacts in Mauritius and in India instead.

The participants were mainly civil and mechanical engineering students from the University of Mauritius and design students from various disciplines from the Indian Institute of Crafts & Design in Jaipur, Rajasthan. It could be argued that this may have led to different results due to cultural differences, although I believe that the participant views on teamwork as opposed to individual 'authors' would be based on many factors – personal experience, professional ideology and cultural differences. The attitude of a group to teamwork influences the efficiency of the process and therefore the outcome. The usual assumptions in the west are that 'easterners' (notably the Japanese) are more capable of collaborative work as they have been less subject to various religions and political emphases on individualism. Western ideologies, Protestantism, capitalism, consumerism have laid heavy emphasis on the 'self' and autonomy. Also western design ideology, particularly since the impact on modernism has placed heavy emphasis on the individual designer.

I thought it was important to get a wider cross section of views and design problems and thus responses from the survey covers several design fields, namely textile design, craft design, interior design, graphic design, architecture and urban design, civil engineering and mechanical engineering.

Following a statistical analysis on the responses obtained from the survey, it soon became clear that the questionnaire was not delivering any significant result. This alerted me to the fact that I needed to shift focus and initiate a more qualitative approach in order to deal and

[1]Goldschmidt G. (1995a) 'The designer as a team of one', *Design Studies* 16:2; pp189-210

discuss with more complex issues that have an impact or connection with the subject such as creativity and humour. I realized that these diversions were necessary to put me back on track, to sharpen my focus and to satisfy my curiosity, and they will be detailed in the next chapter.

2.1 My Questionnaire

The questionnaire consisted of 13 questions and the participants were asked to tick the option that they felt was the most appropriate with regard to their own experience. After a few preliminary questions which aimed to establish the background of the participant, the questions were aimed to tease out (1) the importance of team work as opposed to individual work and (2) the importance of intuition as opposed to a methodology in designing - a sample of this questionnaire along with samples of responses can be found in appendix 1.

Along with the survey mentioned above, I also carried out an intensive literature search which looked at the work of other researchers and writers relevant to the field ofGoldschmidt's work. The outputs to this search will be discussed in Chapter 3.

2.2 Survey results

The data obtained from the survey which studied teamwork designing as opposed to solo designing are tabulated in two contingency tables, table 2.1 and table 2.2 respectively.

Table 2.1 displayed data with respect to the following 3 attributes:

- gender (2 levels – Female or male)
- results obtained as a consequence of working in a team (3 levels – worse, same and better)
- design technique applied if working in a team as opposed to working alone (2 levels – same, different)

Out of the 125 people surveyed, 116 responded to this question.

Table 2.1: Data relating Gender, Teamwork result & Technique Applied

Gender	**Male**		**Female**		**Total**
Technique Applied	Same	Different	Same	Different	
Teamwork result					
Worse	1	3	0	3	7
Same	3	5	5	10	23
Better	22	23	11	30	86
Total	26	31	16	43	116

Table 2.2 displayed data with respect to the following 3 attributes:

- results obtained as a consequence of working in a team (3 levels – worse, same and better)
- importance of a methodology while designing (3 levels – very, little, none)
- importance of intuition while designing (3 levels – very, little, none).

Out of the 125 people surveyed, 119 responded to this question.

Table 2.2: Data relating importance of Methodology and Intuition with Teamwork result

Importance of Methodology		Very	Little	None	Total
Teamwork result	Importance of Intuition				
Worse	Very	2	0	1	3
	Little	3	0	0	3
	None	1	0	0	1
Same	Very	15	5	1	21
	Little	2	2	0	4
	None	0	0	0	0
Better	Very	53	7	0	60
	Little	21	4	0	25
	None	1	0	1	2
Total		98	18	3	119

In order to analyse the responses on my questionnaire survey, I have decided to take a statistical approach. Statistical analysis can be classified according to the types of variables observed. Variables are called discrete if they can assume either a finite or countable number of values; they are continuous if they can assume any value in some interval. For example, the response "shoe size" is discrete while the response "daily temperature" is continuous. Discrete variables can either be quantitative or qualitative; continuous variables are quantitative.

It is important to differentiate between (i) responses and (ii) explanatory variables (which affect the responses). Making a distinction depends on the design study and scientific goals of the investigations. Variables can also be distinguished according to their scale of measurement. Four measurement scales are described below.

2.3 Different measurement scales

2.3.1 Nominal Scale

A nominal scale categorises the data into distinct groups. Examples of variables measured on nominal scales are: (Yes/No) and (Team/Own).

2.3.2 Ordinal Scale

An ordinal scale both categorises into groups and orders the groups. Example of variables measured using ordinal scales are: importance (Very / little / None) and work results (Worse / Same / Better).

2.3.3 Interval Scale

Interval scales categorise, order and quantify comparisons between pairs of measurements. Responses to question 7 of my questionnaire make use of such a scale. (0 – 25%, 25 – 50%, 50 – 75% & 75 – 100%). Comparisons between individual measurements cannot be performed with an interval scale.

2.3.4 Ratio Scale

A ratio scale categorises, orders, quantifies comparisons between pairs of measurements, and quantifies comparisons between individual measurements. An example is length of time, it is true that one year is twice as long as 6 months. Measurement scales are used to classify variables in the following way. Variables measured on either nominal or ordinal scales are called qualitative, while those measured on either interval or ratio scales are called quantitative. The data discussed below is a multivariate problem meaning that all the variables are qualitative. Discrete multivariate data are displayed in contingency table

as those above. One or more of the variables are responses and the remainder (if any) are explanatory variables.

2.4 Goodness of Fit

The Chi Square (X^2) statistic can be used to compare observed frequency distributions with distributions that we might expect according to theory or assumptions. We refer to such a comparison as a test of **goodness of fit**[4]. These r x c tables as those above are referred to as contingency tables. The observed frequencies listed are referred to as the observed cell frequencies. Before I analyse the contingency tables, let's examine what hypotheses I want to test. In the first case I want to test whether there is a relationship between teamwork result and technique applied. In the second case, I want to test whether there is a relationship between teamwork result and methodology / intuition.

[4]We use the Chi-square distribution as a test statistic to determine how well a set of observations fits atheoretical, or expected, set of observations. In other words, the objective is to find how well an observed set of frequencies fits an expected set of frequencies. The test is called the goodness of fit test.

Formally,

H_0: The two variables under consideration are independent

H_1: The two variables are not independent

Referring to the first example, I start the analysis by calculating the expected cell frequency.

Table 2.3: Observed & Expected frequencies of Teamwork result versus Technique applied

Teamwork result	Technique applied	
	Same	Different
Worse	1 (2.534)	6 (4.466)
Same	8 (8.328)	15 (14.672)
Better	33 (31.138)	53 (54.862)

Under the assumption of independence, the probability of randomly choosing a subject whose teamwork result is worse and whose technique applied is the same is given by the product of the probability of choosing a subject whose teamwork result is worse and whose technique applied is the same. Using the totals of the first row and the first column to estimate these two probabilities, I get

$$(1 + 6) / 116 = 7 / 116$$

for the probability of choosing a subject whose teamwork result is worse and

$$(1 + 8 + 33) / 116 = 42 / 116$$

for the probability of choosing a subject whose technique applied is the same.

Hence, I estimate the probability of choosing a subject whose teamwork result is worse and whose technique applied is the same as (7 /116) * (42 / 116), and in a sample of size 116,

I would expect to find

$$(7/116 * 42 / 116 * 116) = 2.534$$

subjects who fit this description.

> *The expected frequency for any cell of a contingency table may be obtained by multiplying the total of the row to which it belongs by the total of the column to which it belongs and then dividing the grand total for the entire table.*

With this rule all the expected frequencies are calculated and the results are summarised in the above table 2.3, where the expected frequencies are shown in the parentheses below the corresponding observed frequencies. To test whether the discrepancies between the observed frequencies and the expected frequencies can be attributed to chance, I use the X^2 statistic according to the formula

$$X^2 = \text{sum of } ((o - e)^2 / e)$$

The solution

Hypotheses H_0: The two variables under consideration are independent

H_1: The two variables are not independent

Level of significance = 0.05

Criterion Reject the null hypothesis if X^2 > or = 5.991, the value of X^2 @ 5% significance Level for k – m – 1 = 3 – 0 –1 =2 degrees of freedom. Otherwise accept the null hypothesis or reserve judgement. Substituting these values into the formula, I get

$$X^2 = 1.6511$$

Decision: Since X^2 = 1.6511 is less than 5.991, the null hypothesis is accepted and therefore conclude that teamwork result and technique applied are independent.

2.5 Critical assessment

While the majority of the respondents were student designers, a substantial proportion (around 75%) were mature students with previous practical work experience of working on design projects. Therefore the result of this survey is a representation of current day designers' perceptions. A weakness of application is the narrow cultural sample – respondents were from India and Mauritius respectively. Further work should be undertaken with a cross section of respondents, to minimize the cultural bias such as the different perceptions of and beliefs in authority and community, to be found in eastern and western practitioners. However, the results of this survey seem to reinforce my belief that Goldschmidt's[1] findings do not correspond to the subjective experience of those who teach in the field of design nor to the informal views of those who study on the designing field.

While the survey is inconclusive on whether there are differences in working practice, it is clear that there are strong perceptions among designers that there are differences between individual designing techniques and team designing techniques. There are similar perceptions that the differences will have an effect on the final design of the product. This effect, whether better or worse, require further investigation and I therefore should now widen my research to see what other researchers with similar interests thought. This is taken up in the next chapter.

It may be relevant to the outcome to consider that the training of designers involves some contradictory elements. Although there is often a strong emphasis on an ability to work in teams (particularly with regard to employability) there is usually little specific training in or simulation of, teamwork. The assessment of student and trainee designers is normally based on individual achievement and the models of successful practitioners often emphasize individuality as an aspect of originality.

[1] Goldschmidt G., (1995a), 16:2 pp189-210

There has been other research in areas relevant to Goldschmidt's[1] research and conclusion. This chapter looks at and evaluates different views and analyses other major areas of research in design such as what is teamwork? What is design? Who can judge what good design is? What is creativity and how do we think creatively? How can we evaluate design methodology and intuition. These are discussed following a comprehensive literature search.

3.0 Research on teams; teamwork and team building

In industrial environments, several experts may work together to investigate appropriate solutions for a design or usability issue. A critical problem is to derive an acceptable consensus from a group of experts who share neither the same background nor the same objectives. It is not uncommon to find that experts do not understand each other. Strong personalities may dominate a meeting even if they do not contribute much to content.

In addition, power differences exist between management and labour. It often follows that group decision making is not always democratic. Despite these criticisms, UK design firms have shown increasing interest in promoting teamwork in building design. Attempts to incorporate teamwork practices in the design process have led some of these larger firms actively to seek out commissions and contracts where teamwork is a specified goal. In order to understand the intricacies of teamwork processes that are leading to the increasing popularity of design teams, researchers have carried out a series of controlled laboratory design sessions in an attempt to isolate and test the importance of several variables. These variables are thought to be related to effective teamworking and team performance.

3.0.1 Team Performance

Peacock (1989)[5] stated that there was evidence that team performance can be more effective than individual. Gokhale (1995a), an associate professor at Western Illinois University in the department of Industrial Education & Technology, considered that collaborative learning

[1] Goldschmidt G., 1995a) "The designer as a team of one", *Design Studies* 16:2 p189-210
[5] Peacock,R. (1989) "An industrialist's view", Second National Conference IDATER, Loughborough, U.K.

fosters development of critical thinking through discussion, clarification of ideas and the evaluation of others' ideas.

At the most basic level, team work brings several minds together to bear on a problem. Hackman[6] (1983) used the term 'synergy' as referring to group phenomena which emerge from interaction and affect how well a group is able to deal with a situation. The popular idea is that the team can generate more than the sum of its individual parts. In 1965 Tuckman published his famous 'Forming, Storming, Norming, and Performing' model. This model identifies four distinct phases within a group's life.

Any team appears to go through stages of: forming, storming, norming and performing. Only in the last stage is productive work done on the task itself. The earlier stages are important in establishing team identity and preparing for further work.

Team working can improve the range of ideas generated as the process of working with others means that the individuals gain differing perspectives, helping them to examine their own values and preconceptions.

Homogeneous teams such as those typically generated by peer selection tend to be harmonious in the initial phases of the project. However they may lack a range of perspectives which may assist in error cancellation and the development of the type of active discussion which can promote innovative ideas. The selection of teams with a heterogeneous background can promote a wider range of perspectives and active discussion but means that the team tends to go more slowing through the forming, storming and norming stages. Experience of forming groups appear to help the individuals go through the initial forming stages more quickly and become productive sooner.

Design usually deals with levels of ambiguity and unpredictability. It can be argued that teams are better equipped for dealing with this because of the range of perspectives available. By managing ambiguity, the design team can smooth negotiation and preserve design latitude by tolerating variety of action or opinion.

Gokhale[7] reported that collaborative learning in teams fosters the development of critical thinking via the clarification of ideas and the evaluation of other members' ideas.

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[6] Hackmann,J.R. (1983)"A normative model of work team effectiveness", *Technical Report No.2*, Naval Research, Yale School of Organisational Management

[7]Gokhale A.A.(1995) "Collaborative learning enhances critical thinking", *Journal of Technology Education 7:1*

Team working can enable individuals with a range of knowledge and skills to work together and solve problems or realise opportunities that an individual specialist could not. More substantial and multidisciplinary tasks may be set.

Teamwork is a multi-faceted concept – a rich and deceptively complex term which in my opinion its complexity is reducible to simpler terms. It has been defined as 'a small number of people with complementary skills who are committed to a common purpose, performance goals and approach, for which they hold themselves mutually accountable' (Katzenbach & Smith 1993). *The Wisdom of Team*[8] presents lessons learned from the success and failure of actual teams. The authors base their wisdom on personal experience along with extensive interviews conducted with 50 different businesses. Katzenbach and Smith's lessons are supported by case studies. "Real" teams are the focus of the book. According to Katzenbach and Smith a "real" team is *a small number of people with complementary skills who are committed to a common purpose, performance goals and approach for which they hold themselves mutually accountable (p 45).* These elements of a team -- purpose, performance goals, common approach to work and mutual accountability -- define what teams are and how they should be managed. Teams are distinguished from work groups in that the work they perform is collective as opposed to the sum of individual contributions, leadership roles are shared and the team does real work together that results in a specific end product or service being delivered. This distinction is important, because the focus of the book is on what teams are, what it takes to become a team and how to exploit the potential of successful teams. The authors also present useful guidelines for determining when to use a team and when to use a work group. Teams are not presented as an organisational ideal. In fact, Katzenbach and Smith encourage looking at the organisation's goals and policies to determine if a team or work group is the best choice. Their thesis is that teams are worth the trouble where they support organisational goals. In their view, the potential of teams is unlimited and cultivating real teams is one of the best ways of upgrading the overall performance of an organisation. Katzenbach and Smith's advice is simple, straightforward, and practical. They look at teams in an organisational context.
Certain elements are critical to team success.

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[8] Katzenbach, J. and Smith, D. (1993) *Wisdom of Teams*, Boston: Harvard Business School Press

The organisation needs to have or develop a strong "performance ethic". In other words, compelling clear purposes and performance standards need to be an important part of the organisation's culture. According to Katzenbach and Smith,[8] performance, not chemistry, shapes teams. "Real" teams emerge when the individuals in them take risks involving conflict, trust, interdependence and hard work. Making conflict constructive by developing ways to handle differences and concerns and moulding them into common goals is when real teams emerge. The authors suggest achieving this by establishing urgency and clear direction in teams, selecting members based on skill balance, not personality, and with opportunities to learn from each other. Establishing clear start-up rules for behaviour and seizing upon a few immediate performance-oriented tasks that are challenging but achievable also help teams develop. Spending lots of time together and giving positive feedback are key.

Katzenbach and Smith are pragmatists. While they describe the senior management team as the hardest to establish, they present this as a fact of organisational life that can be addressed. Their solution: start by creating a strong senior management work group and go from there. Many successful organisations using teams have them. The authors are also realists. The difficulties teams may face such as lack of management direction are described with suggestions for addressing them. Finally, and maybe most importantly, Katzenbach and Smith are optimists. They believe that most people are able to lead. Leaders need to provide guidance and give up control and most importantly believe in the team and put them first.
It is that attitude, belief in the team, that is the most important characteristic of a leader. They conclude that a strong performance ethic leads to the pursuit of common performance results that benefit customers, shareholders, and employees. An overemphasis on any one area creates distortions that lead to turf battles and politics. Managers must demand and then relentlessly support pursuit of performance by teams. This is a clear simple model that can easily be applied to any type of organisation. All of this advice is offered while keeping jargon to a minimum. In fact, the book starts by acknowledging what we all know, creating change in an organisation can be difficult. Yet *The Wisdom of Teams* provides simple strategies, questionnaires to analyse organisational readiness, and alternatives that will get your organisation closer to a real team environment. It outlines the basics elements of team and then offers techniques for sticking to

[8] Katzenbach and Smith (1993) *Wisdom of Teams*, Boston: Harvard Business School Press

them to achieve success. You do not need to be a process consultant to make teams work in Katzenbach and Smith's world. And this is their thesis greatest strength. Teamwork is also said to be characterised by helpfulness, coordinated effort, a shared approach to working, open communication, and friendliness. Attempt has been made to provide a link between effective team work and the learning organisation. The main lessons from successful companies are ones of open and free dialogue between all levels in the organisation and the recognition that employees wish to have more responsibilities in their jobs.

"the idea of employee empowerment may also explain the high level of employee satisfaction"[8]

In this project, the more recent concepts of changes in leadership styles, the employees role and overall interaction in modern organisation environment are also considered. Achieving results through teams will also be discussed, as well as the essentials elements in the formation of teams, team development, team behaviour, individual roles and the power of teamwork. The concept of action-centred leadership is explored to manage the needs of a project, the individual and the work group as a whole. Of particular importance in forming a team is to allow individuals to develop within them a perceived identity. Motivation and satisfaction are closely related to work structure and both influenced by individual values and needs. Self-esteem is a predominant driving motivator for the team, further supported by a strong community need and perhaps an indication that the individuals wish to have certain amount of control over themselves. Opportunities should therefore be created to take advantage of this. We hear a lot about people being turned off by their jobs. Friends tell us that their work is boring or their boss treats them like an idiot. Frequently we see interviews on television with employees who are grumbling about pressures to increase productivity while, at the same time, pushing employees to take wage cuts. The good news is that managers in a number of organisations are learning that there are ways to cut costs, improve productivity, and *increase* employee commitment. Take, for instance, the management at the Lion Nathan brewery in Auckland, New Zealand, Packaging manager David Alcock - an Australian who has worked at Toohey's brewery which is also owned by Lion Nathan - is very enthusiastic about the workplace reforms and empowerment initiatives his company has taken. These changes,

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[8] Katzenbach, J. and Smith, D. (1993) *Wisdom of Teams*, Boston: Harvard Business School Press

according to him, have been of great benefit to both the company and the employees. And most of the current employees would agree that the changes have been for the better.

The production side of the brewery is now organised around a number of teams which report directly to management. This is very different from the previous hierarchical reporting structure with its department area managers, supervisors and leading hands. Instead the teams are now multi-skilled and look after the bigger aspects of production. Team members have been trained to do most jobs on their teams, which allows for job variety for each individual as well as increased flexibility for the organisation. The teams, consisting of 1214 individuals, take responsibility for their own production, wastage, continuous improvement, quality assurance, training and a range of safety measures. In the past, many of these activities were assigned to various managers, sometimes resulting in 'passing the buck' and demarcation either between different departments or between employees and managers.

Today's situation is characterised by ownership, empowerment, flexibility and increased skill variety for team members. While each team has a team leader, the whole team has a major say in who this person is. The team is also actively involved in recruiting team members. Lion Nathan's change to a team-oriented working structure was gradually introduced over three years. It was not always easy or without opposition. Most of the resistance on both sides was based on fear. Some of the managers feared losing their job and their power. Some of the employees felt that the change was forced on them; others were simply reluctant to take on the additional responsibilities that come with the team structure. So gaining the acceptance of, and commitment to, the new working structure from all parties took a bit of time. But what stands out is that the team approach at Lion Nathan has proved beneficial for both management and workers. Productivity has increased and is predicted to increase further as the organisation learns to take advantage of the changes. The number of management layers has been reduced, and communication between management and employees has improved as a result.

Most noticeable is the family feeling which exists at the plant. Gone are the days of 'us and them', of not working for the same goals, and of managers and employees having separate cafeterias. The new working structure has fostered good morale and more enthusiasm, making

the workplace better for everyone.(Source: Adapted from Robbins, Bergman & Stagg (1997):506)

The workers at Lion Nathan initially felt bored, made to feel 'like idiots' with their skills not being used, and under pressure to increase productivity. The new working structure has fostered good morale and more enthusiasm, making the workplace better for everyone. Most noticeable is the family feeling which exists at the plant: gone are the days of 'us and them', of not working for the same goals. To succeed make work interesting, make it motivating, create enthusiasm, but without communication teamwork cannot exist. By doing this a better understanding of each other opinions and attitudes are gained. The role of the manager becomes the business leader providing the 'vision'. As such, they champion the team by being its coach to create self-managed work units. The role of the manager becomes a service organisation for the people, a world turned around from one where the manager is responsible and staff responsive to one where the team become appropriately responsible with the manager responsive to their needs as clearly illustrated by the Lion Nathan's brewery example.

The creative element of leadership underpins the ability to envision, inspire, empower and align where all the essential elements to the success of the team will be to the Company as a whole. There is a growing acceptance of radical change for example with business process reengineering. To operate effectively as a consequence of the changing political, social, economic and technological arena organisations will have to utilise all of their assets. In particular teams will become the main performance factor for most organisations. By harnessing their thinking power, gaining their full commitment and accepting that they do know what needs to be achieved.

Ralph Stacey[9] is Professor of Management and Director of the Complexity and Management Centre at the Business School of the University of Hertfordshire in the UK. His current research has been focused on Group dynamics and Human agency in complex responsive networks.

In 1992 he states

It is through the journey itself that a route and a destination are discovered: You have

[9] Stacey, R. (1992) *Managing Chaos, Dynamic Business Strategies in an unpredictable World.* London: Kogan Page

continually to make new maps as you travel if you wish to discover new lands. The key to success lies in creative activity for making new maps, not in imitative refining and following of already existing ones. And this in perspective brings with its major changes in the way managers act.

Creativity is the future for organisations. Management theories are the past experiences, we are now in an era of the unknown. Although uncomfortable it may be but people who are visionaries, such as Charles Handy, hold the key to the future.

Charles Handy has written some of the most influential articles and books of the past decade, including *The Age of Unreason*[10] and *The Age of Paradox*. After working for Shell International as a marketing executive, economist, and management educator, Handy helped to start the London Business School in 1967. He has worked closely with leaders of business, non-profit, and government organisations. Charles Handy is an influential voice worldwide. One of the first to predict the massive downsizing of organisations and the emergence of self-employed professionals, Handy has a gift for looking 20 years ahead at ways society and its institutions are changing.

Handy [11](1994) argues that we are in a time of discontinuous change, " *a time when the only prediction that will hold true is that no prediction will hold true*". Similarly, Ralph Stacey (1992) in the preface talks about the future direction of organisations being unknowable, *'this means that no one can be in control of that future direction because unknowable directions emerge from the spontaneous, self-organising interaction between people'*

Argyris (1960) stressed the importance of an individual in organisational life or behaviour, linking this to psychological growth and the need for individual goal setting. More recently Handy [12](1993) lists over sixty different influences affecting organisational effectiveness, split primarily into individuals and environmental. That is why when organisational theorists focus on a core of motivation the line manager responds 'but in practice it is not like that'. Handy groups these relationships between people, power and practicalities.

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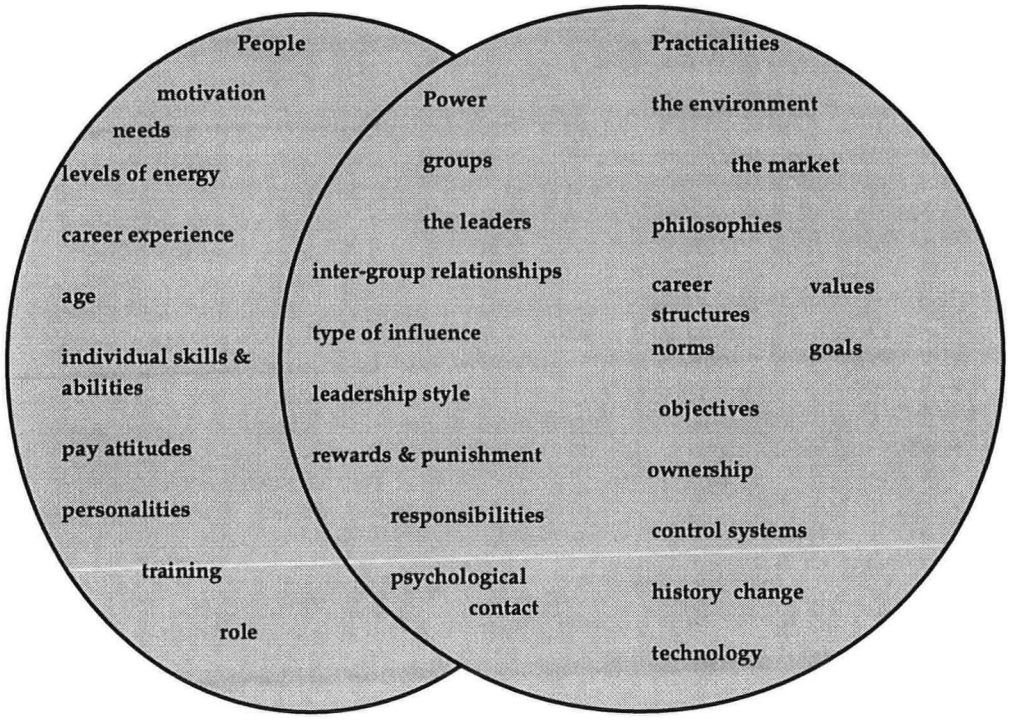
[10] Handy (1989) *The age of the unreason*, London: Arrow
[11] Handy (1994) *The empty raincoat* , London: Hutchinson
[12] Handy (1993) *Understanding Organisations*, Harmondsworth: Penguin

Figure 3.1: Relationships between People, Power & Practicalities



Charles Handy (1993)

Teams form the basis for today's complex organisations and are as basis and necessary as are the families to society.

No organisation will be strong and competitive without effective teams

Doyle [13](1992)

The key to the future then appears to lie in the ability to enable inspirational performance at all levels in the organisation through individuals in teams. The key will be to move from the rational ordered phase of organisational management to an integrated approach, building on existing strengths, along with a quest to adapt and restore our focus by creating a new vision. This will be a learning sphere of self –management, self-awareness and self-control. Success in such new structures can only come about by commitment of all employees to shared values of the organisation that will guide them to 'form and reform collaborative inter and intra

[13] Doyle, R.J. (1992), "Caution: Self-directed work teams", *HR Magazine* : Vol. 37 p153-155

departmental teams and networks that will achieve the aims of the organisation'. To create the ability to respond and adapt quickly to change, a network of alliances, end of "compartmentalised" working and individualism by the beginning of mutual dependence.

3.0.2 A Change in Leadership style

Harnessing such collective capability of an organisation needs vision, leadership, communication and coaching. To achieve excellent performance from a team of ordinary individuals the managers role will no longer be to control and command the behaviour of individuals or groups, but to facilitate to ensure employees are equipped to carry out their tasks. To empower, energise and support the team. They will shape the project teams to explore and exploit any emergent opportunities. Effective managers understand and know when to intervene and confront, when to encourage and reward, when to coach and counsel, but also when to leave things alone. Leadership will remain important in that it defines the vision, the strategy and the tactical or operational framework.

Leaders are social architects to enable teams to operate, not empire builders to protect themselves.

Lessem[14] (1994)

This "developmental manager" is something of a new breed. His emphasis is social rather than technical or economic, with human relations becoming a central theme to organisation growth (Charles Handy (1991)). To align the team behind the ideas and obtain the group's wholehearted commitment to the overall plan. This process must be allowed to permeate the whole organisation if it is to succeed. Coaching will become more critical, not everyone can be a leader but everyone can be a coach. It is to know where you are going and not going where you know, that is just doing what you did in the past which will not promote better performance in either the team or individual. Coaches do not need to be experts or to be more skilled than the person they are coaching, but they must be able to add value to the person's development, personal or professional, by way of observation, explanation or practical demonstration. To provide direction rather than directives helping the individual to learn on the job, as often in the rapid changing climate the new skills have to be developed and cannot be learnt as again

[14] Lessem, R. (1994) *The Management of Organisations*. Oxford: Blackwell

this would only be doing what the individual did in the past which may not be sufficient. Coaching is about how to empower philosophy to promote a self belief, to say it's within yourself. People can achieve great things due to the right state of mind. For example giant killers in the FA cup, teams who play beyond their perceived capabilities
(Most recent example is the South Korean Team in the World Cup 2002).

3.0.3 A Change in the Employees Role

The traditional pyramid structure will need to be turned upside down, so that instead of the workers supporting management, the management is there to enable the workers. Crucial to this will be the empowered employees, who takes charge of their own destiny, their day to day roles and responsibilities and are entrusted with the destiny of the company. To date we have chosen to ignore that the vast bulk of "latent " potential value in an organisation was simply not accessible. If one consider starting from the concept that followers make leaders powerful and as such, followers are at least as important as leaders and will become more so as organisations flatten and layers of management are removed. The time has gone when a single person does the thinking while all the others do the actions. All the organisation's skill, knowledge and power needs to be fully engaged.

3.0.4 A Change to the interaction within organisations

Traditional organisations are set up to undertake two actions.

1. Monitor and supervise, to ensure employees do what they are employed for.
2. Provide co-ordination across activities.

Even with the empowered organisation there will be the need for some discipline and monitoring and the role of the co-ordinator will still exist. Organisations must have a purpose but a true empowered work force does not mean they can do whatever they decide to do when they decide to do it. Teams provide an alternative to the traditional hierarchical need for total control, the fact that teams revolve around social interaction and as such the group by nature will exert considerable influence on individuals. Pfeffer[15] (1994) suggests that

[15] Pfeffer (1994) *Competitive advantage through people*, Boston: Harvard Business School Press

[...] groups provide social information and certainty about how to evaluate the conditions of the work setting and what the critical dimensions of work really are. Both conformity pressures and informational social influence mean that groups have enormous effects on individual behaviours.

Management has typically seen these influences as perverse leading to restriction in output, formation of unions, and resistance to management control [...] However, positive results from group influences are more likely when there are rewards for group efforts, when groups have some autonomy and control over the work environment, and when groups are taken seriously and become the fabric of the organisation .Organisations that have tapped the power of teams have often experienced excellent results.

But this organisational co-operation will also be subject to other influences beyond normal constraints. Organisations do not just have divisions, departments and teams. They also have in-groups, out-groups, social conspiracies and arrangements, all of which will have to be addressed. Alongside teams there will be cliques, and with information sharing rumours, gossip and the grapevine all exist within the shadows of the organisation. Effective managers will both build teams and also manage these shadow side realities. The time is ripe to eliminate "street-wise" teams by forming "smart-wise" teams with mutual dependence that will steer their organisation to success by acting creatively and who are allowed to penetrate every corner of the business.

3.0.5 Attitudes in a team

The team's attitude is fundamental to its likely effectiveness and come from the individuals involved. But as with personality traits, attitudes themselves are the most difficult to change. It is important that there is an overall commitment to the team with individuals being supportive and positive. The social aspects of a team need to be addressed by team building to gain the spirit and commitment, individuals develop a common understanding and tend to revolve issues through discussion before conflicts arise. But what creates the attitude towards work in the first instance?

3.0.6 The inheritance of a work Ethic

We could take work as just a mundane or unpleasant task that has to be performed so that we are able to do the things that are really important. But a work ethic is much more positive in its outlook, viewing work as valuable both to society and the individual. The motive behind this activity remains unclear, is it simply to make money or is there more than just materialistic values?

I view my generation as a hard working one, becoming in many instances workaholics. But a work ethic should view work in a much more positive way. Surely humans were not just created to make money. There is a need sometimes to work hard, but also a need for time to reflect and sometimes space purely for leisure. Only a balanced combination of all three elements will give true quality to life. Nowadays individuals, due to external constraints, need to structure their pattern of work and life. Is this balance more about working more cleverly, more flexibly, which is the basis of Charles Handy's 'Empty Raincoat' philosophy? It would appear that to allow this to happen individuals need a freedom to pursue their own aspirations but within the context of an organisation's aims. People are more directed by their interests than by values so, paradoxically, it would appear that an individual is motivated by work ethic not by the values that it portrays but more by personal interests.

3.0.7 Motivating the group

Motivation itself is the personal incentive an individual has to perform a job well. The management of motivation is about understanding what causes an individual to be motivated and subsequently creating and maintaining the environment, both physically and psychologically, that encourages the individual to improve work performance, human and animal actions are directed. Human don't simply walk, reach, shrink or flee; they walk and reach toward some objects, shrink and flee away from others. Often however, the object exists in as yet unrealised future. In such a case, an inner motive (a purpose or desire) apparently leads to actions that bring the subject to their goal.

3.0.8 Human Behaviour influences

Why should we care about these theories of human behaviour? Because, as Robert Frank (1988) noted

> *Views about human nature have important practical consequences [...] They dictate corporate strategies for preventing workers from shirking, for bargaining with unions, and for setting prices...Our beliefs about human nature help shape human nature itself [...] Our ideas about the limits of human potential mould what we aspire to become.*

Images created become self fulfilling i.e. perception of ability is very strong to the individual, people who believe that they are high fliers, average performers or low ability achievers will take on the roles projected. Virtually all economic models of behaviour view workers as effort-averse.

James Baron[16] (1988) has perceptively noted

> *The image of the worker in these models is somewhat akin to Newton's first law of motion: employees remain in a state of rest unless compelled to change by a stronger force impressed upon them – namely, an optimal labour contract. Various incentive features of internal labour markets are claimed to provide forms of insurance that overcome workers reluctance to work.*

These perspectives on human behaviour are incorporated in numerous policies and practices of the work place, in which an emphasis on control, discipline, limited individual incentives, and monitoring are evident.

3.0.9 Motivators of today

It is clear from the above that a great deal of work has been carried out on the subject of motivation, however there are no definite set of rules although there will be a range of opinions supported by perceptions of evidence. Motivation for individuals is a personal thing and can change. All must work towards finding a productive balance between the needs and desires of the individual and the demands of the organisation.

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[16] Baron,J., (1988) "The employment relation as a social relation", *Journal of Japanese & international Economies, vol. 2, 492-525*

Helene Denis[17] (1986), summarise this all by this description

> *Satisfaction and motivation are different realities, a person can be satisfied with his task, but unmotivated nonetheless, and the opposite is equally possible. Motivation is a complex process, originating from a lack of satisfaction and a need to be fulfilled. Behaviour or action is dependent on the value of the individual, objective and his probability of reaching it.*
>
> *Satisfaction only comes at the end, even if it also could be the source of action, because it is an attitude, i.e. a predisposition to react favourably, or not to, a certain situation. Motivation and satisfaction are thus closely related to work structure, and both share the fact that they are influenced by values.*

3.1 Achieving results

Teams form the basis for today's complex organisations, this is evident from the fact that in the last decade or so great emphasis has been laid on the positive outcomes of teamwork and of teambuilding. To a project manager, it is through a project team that objectives are achieved, without a team nothing would happen. Achieving results are mostly through other professionals where it is necessary for independence and autonomy to flourish. Superior-subordinate relations, unilateral decisions, dogmatic attitudes and the simple use of authority will simply not work. Here leadership is about explaining as well as organising, planning and control. An approach of looking at situations is to step back and reflect, searching for areas of agreement and then make decisions. This is the basis of an approach known to management as action-centred leadership, Adair[18] (1983).

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[17] Denis, H. (1986) "Matrix Structure, quality of working life, and engineering productivity," *IEEE Transactions on Engineering Management* Vol.33 Aug.1986 Pages 148-156

[18] Adair (1983) *Effective Leadership*, London: Pan

Figure 3.2: Action-centred Leadership

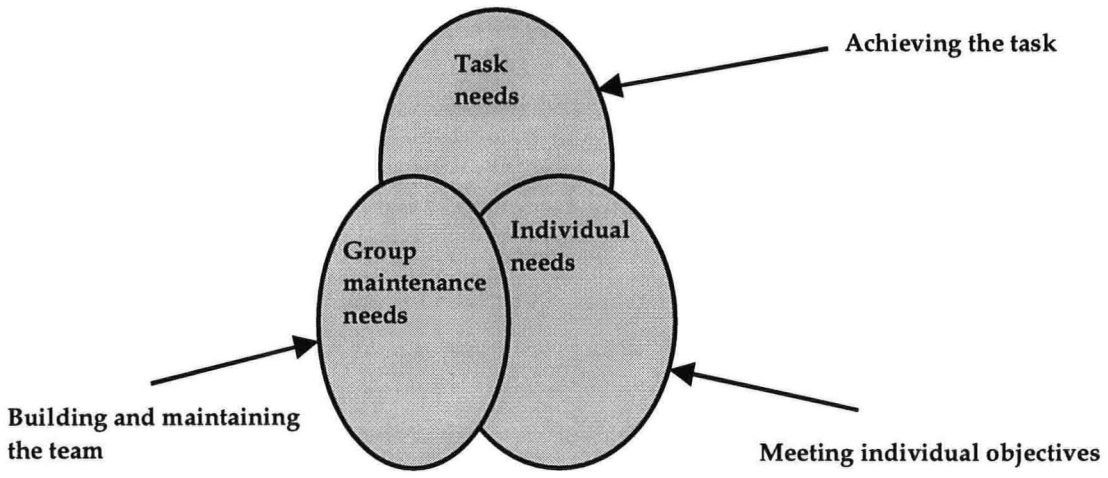
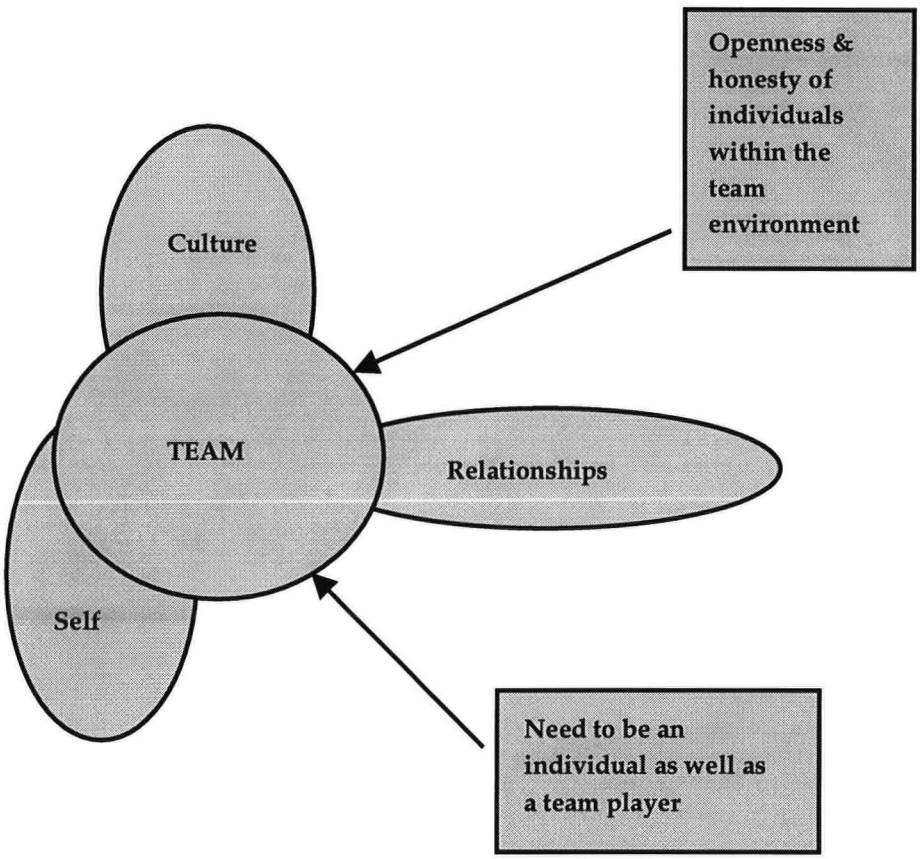


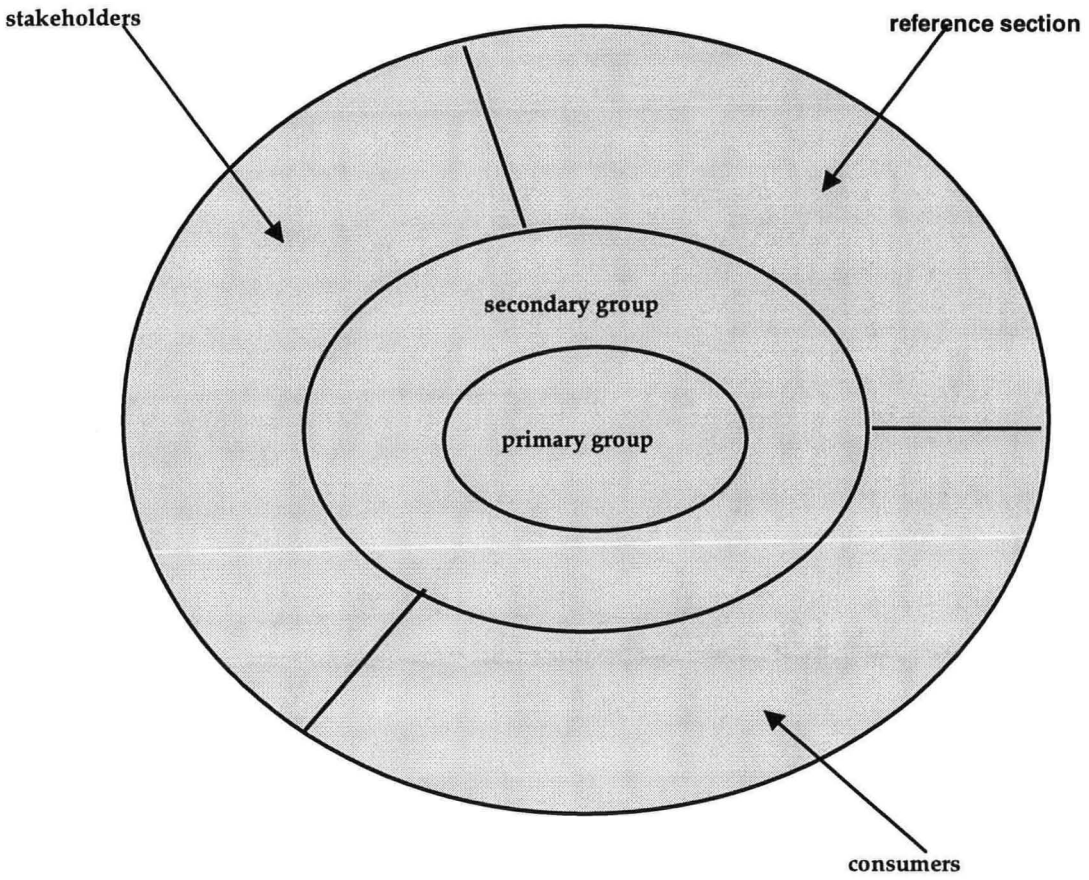
Figure 3.3: Influences on individuals in a team



But what does a team comprise of? Rodney Turner[19] (1993) describes 3 sets, these being

[19] Turner, R., (1993) *The handbook of project based management: Improving the Process for Achieving Strategic Objectives. London: McGraw-Hill*

Figure 3.4: Components of a team



The primary group are the main team who work together. The secondary group; consisting of people who interact with the primary group, and contribute directly to their work, but not part of that group. The tertiary group are people who have influence over the others, or who are affected by the work of the team, but have no direct contribution to the work. This comprises of three sub-groups, people who have an effect on the members of the primary and secondary groups, people whose lives may be changed by any actions, and lastly the consumers. The expectations of all the people in these sections must be managed if the team is to effective, as they have a powerful ability to disrupt.

3.2 Formation of a Working Team

In forming a team, a group of individuals are brought together who must be allowed to develop within them a perceived identity, so that they can work together effectively using common, and acceptable values. Handy[20] (1989) states that this concept of perceived identity is critical to team formation, without it the group just remains a collection of random individuals.

This process of forming a team identity and a set of values takes time. Teams go through stages in their development. During these stages, the team's motivation and effectiveness goes through a cycle in which it first decreases, before increasing, and then possibly decreasing towards the end. In forming the team members come together with a sense of anticipation and commitment. Their motivation is high at being selected but their effectiveness is moderate because they are unsure of each other. As the team members begin to work together storming begins, they find they have differences, which initially causes both the motivation and the effectiveness of the team to fall. Eventually the team members will start to reach agreement (Norming) over the various issues. This will be a process of compromise and acceptance. As a result of this the team begins to develop a sense of identity and a set of values. These form a basis on which the team members can work together, and effectiveness and motivation begin to rise again. Once performing, the team work together effectively for the duration of the project. As the team reaches the end of its task, the effectiveness could rise as the members make concerted effort to complete the task, or it can fall, as the team members mourn the end of the task. The manager's role of course is to ensure that the former rather than the latter happens.

3.2.1 Team effectiveness

Effectiveness is not just a measure of target achievement, but also whether the individual and team motivation needs are being satisfied. Good indicators are:

- a clear understanding of the role of the team
- high commitment to goal achievement
- strong group cohesion of openness and trust.

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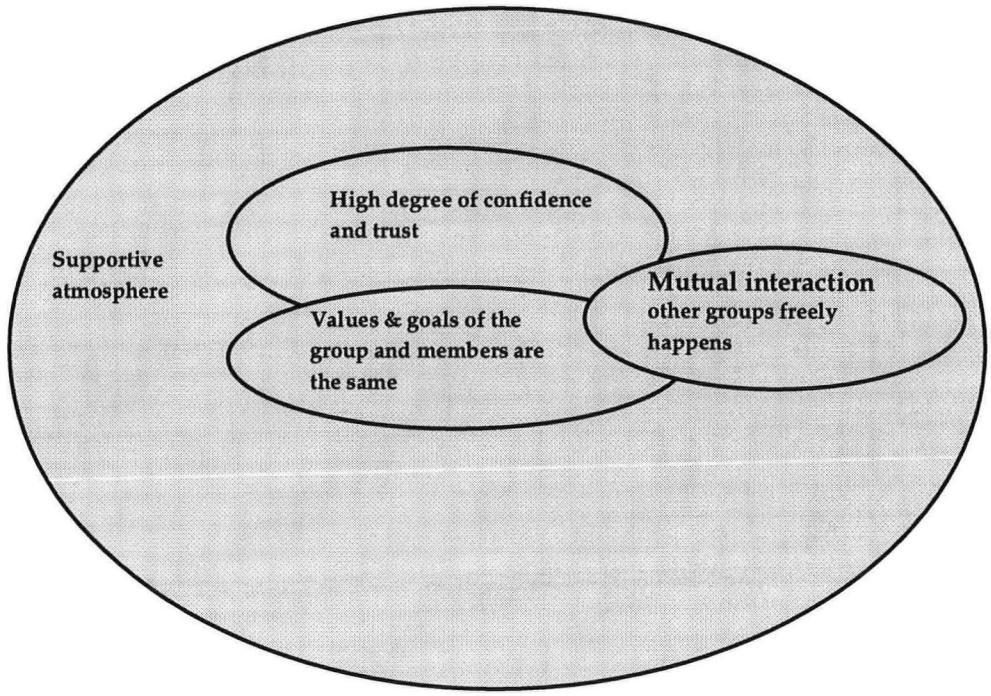
[20] Handy, C. (1989) *The age of the unreason,* London: Arrow

Rensis Likert[21] (1961) defines group effectiveness by four inter-linking issues

Figure 3.5: The four interlinking issues of group effectiveness



3.2.2 Behaviour of the team

Although the organisation's systems can often be more complex than any one individual can understand, the individual still contributes a major influence to the outcome, often far in excess of what they can foresee. It is important that co-operation exists between the individuals. The individual can make a big difference and this is the first point to recognise and is fundamental to teamwork. Group interaction is important to the team's performance and learning. This depends on the contribution of the individual, their ability to observe, question and contribute their understanding.

The team's effectiveness is however, frequently determined by how individuals relate to each other. A combination of personalities in the group and group dynamics, and the organisations culture. This culture will have developed over a period of time; its influence is very powerful, having been created by the history of how things have been done and what the

[21] Likert , R. (1961) *New Patterns of Management*, New York: McGraw Hill

past effects were. Uncertainty, insecurity, fear and disorganisation will impede the group's will and capacity to perform. Here again, communication will form the key for everybody to understand each other's perspective. Frank, open discussion must be encouraged so that mutual goals are identified which override individual interests.

Learning styles will vary within the team and this variation will influence the manner in which they attempt to deal with issues as a group. These styles are dependent on the individual, their personality and their own previous experience. The need for some to be more analytical and others being more intuitive, the reliance on facts or more on feelings.
The manner in which these issues combine is vital to the effectiveness of the team. Any slight change in personality or the group dynamics can have a traumatic effect. Most significant would be going into a 'change situation'. People cling to old ways, so they need a process to help them disengage from the past; go through the transition during which they are unhappy with the past, but not yet emotionally committed to the future; and finally replace old routines with new. Teams provide a basis for that process as teams can assist people to change and to manage change. Teams bring together complementary skills and experiences that by definition exceed those of any individual on the team. Because of their collective nature and commitment, teams are not as threatened by change as are individuals left to fend for themselves. Most resistance to change comes about from the fear of the unknown. What is planned for me? This can lead to a feeling of isolation for the individual, and ultimately stress. Yet this can be avoided by involvement and effective communication. This means talking to, and persuading the right people to take action or accept the planned changes. But what is effective? It had been recognised that in any change situation there are the early adopters who encourage the majority to become followers, but there will always be a number of 'laggards' who will act as terrorists causing much disruption. Therefore, taking advantage of the early adopters throughout the organisations layers, these can influence a broader spectrum of followers and generate the necessary momentum.

3.2.3 The Concept of Empowerment

> *" Today's workers demand greater participation, flexibility and autonomy... The organisations that have positioned themselves for success are those that focus on empowering their workforce"*
>
> Wellins[22] (1992)

The power of teamwork has always been recognised, from the sporting arena to the flight deck of the Starship Enterprise. The high-performance teams are characterised by enthusiasm and passion, where team members support each other; they communicate openly and freely with the other members. Where people just seem to know what is required and, no matter what, the job gets done and done well. Quite often these high performing teams are small teams or where the company exists in a single office. The challenge is to create that small team feel in the large organisation environment. This needs is further reinforced by Peters (1987) when he states:

"Take all the evidence together, and a clear picture of the successful firm in the 1990's and beyond emerges. It will be:

- *flatter*
- *populated by more autonomous units*
- *quality-conscious*
- *service-conscious*
- *more responsive*
- *much faster at innovation*
- *a user of highly trained, flexible people.*

3.2.4 Developing a Team Understanding

Armstrong[23] (1992) from a review of literature produced a check list of things to do to achieve good team work.

- establish urgency and direction

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[22] Wellins, R.S. (1992)., "Building a self directed work team Training & Development," Vol.46 pages 24-28
[23] Armstrong,D.(1992).Managing by Storying Around. New York: Doubleday Books

- select members based on sills and skill potential, not personalities. They should be good at working with others but still capable of taking their own line when necessary
- pay particular attention to first meetings and actions
- set overlapping and interlocking objectives for people who have to work together. These will take the form of targets to be achieved or projects to be completed by joint action
- assess people's performance, not only results they achieve, but also on the degree to which they are good team members. Recognise and reward people who have worked well in teams
- encourage people to build networks. Things get done in organisations as in the outside world, on the basis of whom you know as well as you know
- set up interdepartmental project teams with a brief to get on with it
- describe and think of the organisation as a system of interlocking teams united by a common purpose. Don't emphasise hierarchies. Abolish departmental boundaries if they are getting in the way, but do not be alarmed if there is disagreement- remember the value of constructive conflict
- hold special "off the job" meetings for work teams so that they can get together and explore issues without the pressures of their day to day job
- use training programmes to build relationships. This can often be a far more beneficial result of a course than the increase in skills or knowledge which was its ostensible purpose
- use team building and interactive sessions to supplement the other approaches.

3.3 A Way Forward

In today's increasingly competitive environment, teams are being recognised as capable of achieving more than the output from a collection of individuals. Jeffrey Pfeiffer (1994) takes the main theme that people and their management is now more important because the other sources of competitive advantage are much less powerful for sustained success.

Traditional sources of success – product and process technology, protected or regulated

markets, access to financial resources, and economies of scale- can still provide competitive leverage, but to a lesser degree now than in the past, leaving organisational culture and capabilities, derived from how people are managed, as comparatively more vital.

This he refers to as unleashing the power of the work force.

Deming noted:

Industry desperately needs to foster teamwork. The only training or education on team work our people receive in school is on the athletic field. Teamwork in the classroom is called cheating

Gabor[24] (1990)

Some call teamwork purely "synergy" but it is more important to have a true understanding of what constitutes a team. One definition could be: *A team is a group of people with complimentary skills who are equally committed to a common purpose and set goals for which they hold themselves mutually accountable.*

There are many qualities of a good team, some of which are captured by the definition, however there are other attributes which take more time to develop. There are core threads that weave themselves through any successful team.

These include

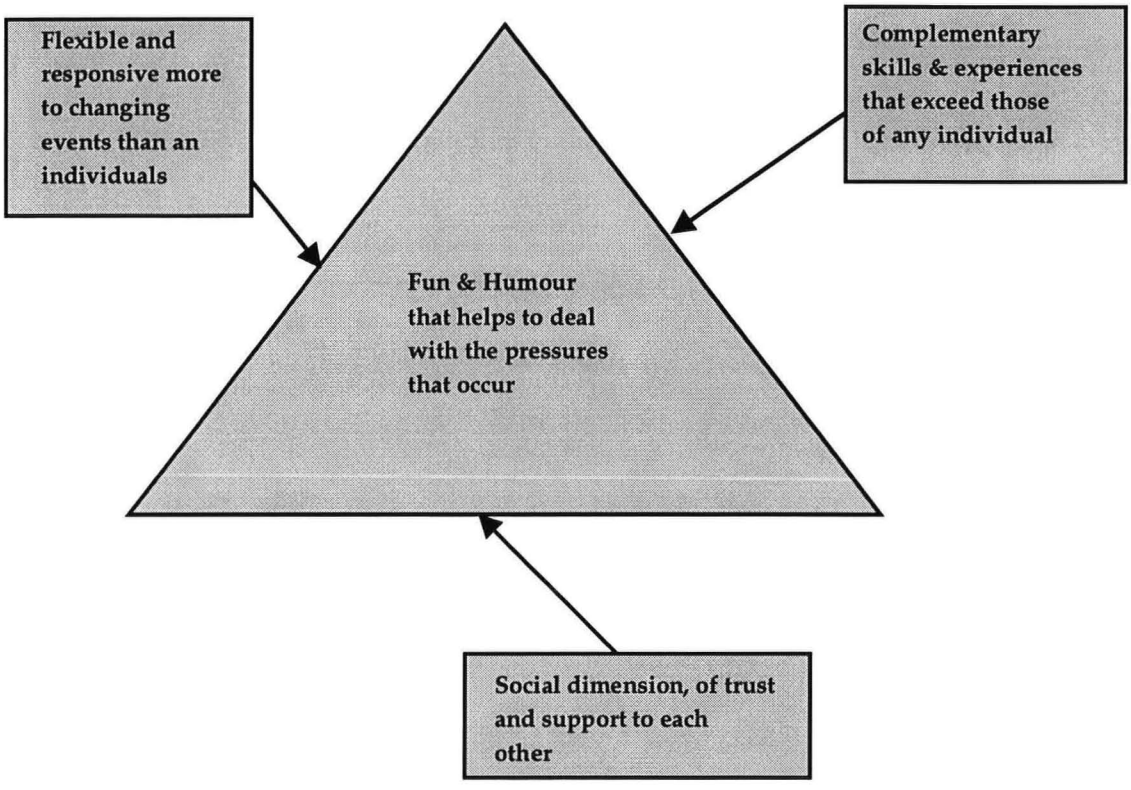
- pride
- humour
- commitment
- recognise and respect individual differences
- enthusiasm.

These form the building blocks of effective team performance.

[24] Gabor (1990) *The man who discovered quality* , New York: Times Books

Why do teams perform well?

Figure 3.6: Building Block of Effective Team Performance



Katzenbach and Smith [25](1992) suggest that the number of members for a successful team must be kept small. They suggest between two and twenty-five. This being due to the support, trust and just knowing what others are doing that develops within small groups. Whereas larger groups tend to be more restrictive on the sharing that is needed to build a team, and even have difficulty to find the basic time to meet together which is essential for development.

3.4 Humour in the team

One of the most powerful but often the least understood, techniques available is humour. Managers all over the world use humour to get things done, to influence and persuade, to motivate and unite, to often say the unspeakable and to aid change by defusing tension.

[25] Katzenbach & Smith (1992) *Wisdom of Teams*, Boston: Harvard Business School Press

In western culture teasing is routinely used as a means of social control, for saving face and for establishing intimacy. Besides helping to explore differences, humour also helps teams to achieve a sense of community and joint purpose.

My understanding is that humour generally serves one of the three purposes at any time – it can be a shield (making fun of ourselves before others do it), a weapon (hurting others, either offensively or defensively) or a bridge (the people that laugh together feel connected). If there is no humour, there is no outlet for bonding with others or coping with frustration.Paying attention to the humour in a team is an easy way to see what some underlying dynamics are, which I believe benefits us all. Now managing it is trickier, properly managed humour is not a risky thing to tackle when building teams, humour at the expense of others is always risky. A team without humour would be a bleak environment to contemplate working in or with. When a team can joke, laugh and question while they are completing the task, they are doing well. It shows a high level of emotional security and the level of shared humour can act as an indication of the well being of the group.

Humour in the workplace works like a thermostat, controlling the climate within the environment. It is a key component of the ambiance that greets and surrounds everyone who enters the workplace. Simply put, positive humour fosters a warm and inviting feeling. Negative, divisive humour makes a place seem cold and aloof. Humour, or lack thereof, defines the emotional state of a workplace in the same way lighting sets the tone in a theatre production, where changing lights indicate a shift in mood. In the theatre, the illumination fills in the holes and occupies the spaces between characters, events and sets. In organisations, which consist of sets of human relationships, humour illuminates the dynamics of the group. It is a language by which people join and identify a common universe. They consciously and unconsciously make statements through humour about themselves, their relationships, their groups, and their company, which they find difficult to say otherwise. Humour in the workplace is rarely neutral, trivial or random. It is deployed for the achievement of quite specific purposes to do with self-preservation, getting things done or getting one's way.

Managers use humour to influence and persuade, to motivate and unite, to say the unspeakable and to facilitate change. They also use humour to deflect criticism, to cope with failure, to defuse tension and to make their working lives more bearable.

Humour plays a wider role in business, reinforcing shared values at every level; bonding teams in organisations, shaping and perpetuating corporate cultures, underpinning national management styles and even help advertisers to segment consumers by the humorous cues to which they respond. Everyone who has worked in an organisation knows that humour plays a central role, not just in making work more bearable, spicing up office life and puncturing stress but also in getting things done through people, as a galvanising force, as a key to changing atmosphere and as a mean of getting your own way.

Humour feeds on the unexpected and business is nothing if not unpredictable. Management is about human factors, the actions, reactions and interactions of individual men and women are impossible to organise and predict with precision. People may be wayward and do illogical things for obscure or selfish reason. Individuals will find that being able to do the job is not enough, they are expected to play a role. That role is shaped by the expectations that people have of someone in that job, irrespective of who that person is. For instance, managers are expected to dress right; for men suits are expected. Behaviourally too, people have constraints placed on them. Certain traits like decisiveness, perseverance, initiative have to be played up while others such as cowardice, greed, dishonesty have to be muted. The contrast between the expectations that organisations have on people and what people are really like leads to a constant mismatch which is charged with comic tension. The idea that humour resides in the gap between an individual's outer persona and his or her real self is a long established one. Examples include Basil Fawlty (Fawlty Towers), who sees himself as the only sane, rational person around, when in truth he is the originator of all the chaos; or Jim Hacker (Yes, Prime Minister), who believes he is rather adept at getting his own way, when it is he who is the guileless victim of manipulation. Both central characters assume that everyone has been taken in, when in fact they have only succeeded in fooling themselves.

Humour is a way of mocking others and yourself to get the real discussion going.

(Sir John Harvey-Jones, former chairman, ICI)

However humour does not always work in different cultures where beliefs and assumptions can make humour inappropriate. In such circumstances, used prematurely or indiscriminately, it can alienate and create lasting damage to relationships. On the other hand, if used appropriately humour can put people at ease, paving the way to open and constructive discussion.

When we are trying to deal with the problem we have to distance ourselves from it. While we are totally absorbed by it there can be no possibility of finding a new attitude towards it. This is why consultants are often called in. They come along with a fresh eye and do not take things for granted. On a more mundane level we face the same predicament when we try to proof-read our own writing. We are so familiar with the words that we tend to see what we think is there rather than is actually there. This is why an outsider can come along and spot basic errors of spelling or grammar in what is supposed to be a final draft. Humour can provide that sense of detachment. It enables us to see things afresh, to play with situations rather than get stuck with them. Humour is the mechanism which gives up rapid access to the side of our character that is more fluid, relaxed and explanatory. Humour helps to prime spirit and mind for appropriate action.

Humour is also used to avoid having to name names and comic interlude is immediately followed by the re-entry into the serious mode. Humorous interaction is bracketed off from normal interaction. It makes a situation explicit without risk of reprisal. And this is particularly useful in team setting where the need to continually question and renew is vital to the team survival. The effective functioning of a team requires people to be told when they are under-performing, uncommunicative or unwilling to delegate and this has to be done without losing their goodwill. The 'joking mode' reconciles these disparate objectives. It can be used to deliver criticism and to stir people into action without alienating them or sapping their motivation.

Humour can be used to deliver unpalatable messages or potentially unpalatable messages with a softened impact. Most commonly, this takes the form of teasing. Teasing is something you do to others, it is never self administered. It is a way of censuring others by letting them know you have noticed, without actually telling them off. Teasing is particularly prevalent in meetings, where the continued contribution of all participants is important.

Teasing is a discrete way of sanctioning deviant behaviour. It requires the guilty party to laugh at the tease, thereby acknowledging the deviant action, but also allows him or her to rejoin the group without losing face. Typically when someone arrives late at a meeting, teasing is used to mark the violation while quickly returning to a state of consensus among those present.

For instance, one manager arrive late at a brainstorming session wit h some of his peers. The leader of the session commented, ' You realise we're going to have to punish you for this?' Another manager added enthusiastically, 'And I'll be the one to administer it.' There was no need for resentment or self-justification on the part of the wrongdoer. The only response expected of him was laughter. He obliged, thereby acknowledging the offence symbolically pledging renewed allegiance to the group. Cohesion was maintained and correction achieved without confrontation or loss of face. Thus humour can take the sting out of criticism, but it can lower individual resistance too. It helps to accelerate understanding and makes people more amenable to persuasion.

3.5 Creativity

The ability of any organisation to survive in these times, when you have to create the future, will be in the first instance be dependent on the creativity of the key policy makers. Creativity is dependent on the ability to break links with the past, to break out of the old mould. To be truly creative must be an ultimate goal for everybody. The best way to the future is to create it. What are creative ideas? How do we go about getting one? Is creative ability a matter of inspiration alone? What is inspiration? Are there any techniques for discovering creativity in the individual? Is there any training which develops it? What sort of environment encourages it?

In the past, practical men of science and business were apt to under-rate creativity. But of late, we have seen the emergence of a different point of view. Many people have come to recognise that whether it occurs in painting a picture, writing a poem or symphony, inventing a new jet propulsion system or a new marketing technique or a new wonder drug, the creative process is a manifestation of the same fundamental ability: namely, the ability to relate previously unrelated things. The arts and sciences are rediscovering the fact that they are siblings. And the world is discovering that creativity is important, it has become big business. Much has already

been discovered about the techniques of creativity, about its development by education and training, about the environmental factors that encourage it, but more remains to be discovered.

One of the facts that is emerging is that creativity in all fields seems to be the ability to relate two or more things that were not previously related. It is the ability to look at things with a fresh eye. It is the ability to look at a problem and to see a way of solving it that has not been seen before. Like Newton and the apple – or Archimedes on Saturday night. This ability in all fields seems to be interrelated. A definite pattern of the creative process is the knowledge which can definitely increase anybody's ability to perceive these vital relations between previously unrelated things. Many people are afraid to put two ideas together as they fear it might explode.

3.5.1 Creativity in Humour

There has been many attempts by critics, psychologists and philosophers to analyse humour. Humour is one of the most creative activities of which the human mind is capable. Humour, itself, is not a creation (Victor Borge)[26]. Humour is for a humorist, what a paint brush is to a painter, a piano for a pianist. Humour is a tool with which to create. Borge has been reported as saying *"humour is like truth: it is or it ain't"* and also *"humour begins with a smile and a smile is the straightest route to the heart"*. Borge emphasised the value of good will toward a product resulting from identification between the sponsor and a pleasant experience.

> *"I have tried often, in discussions with advertising agents, to convey to them the importance of co-ordination between the performer, in the case of the humorist, and the sponsor's product. To interrupt a pleasant performance with an idiotic three minutes of nonsense about an automobile that is just as good or just not different from any other automobile, for example, irritates the viewer and fails, psychologically, to create a pleasant relationship between public and product. In advertising you may, with humour, create a happy or at least friendly feeling toward the product or its producers, a mood, a situation, a demand, an economic result."*

However, the distance which separates the moods depends chiefly upon the ability of the

[26] Victor Borge was pronounced "the funniest man in the world" by the New York Times. Victor Borge invented the inflationary language – the one where numbers are hidden in the language (like *wonderful*) become inflated (*twoderful*)

person to recognise the humour contained in all situations in society.

The value of humour lies in the change of the mind set, creativity then follows humour as 'a new connection'. What you do with humour – good, bad, indifferent is the creation. The unexpected, irony, satire, slapstick, metaphor and cultural inappropriateness, therein lies creation in humour.

3.5.2 The Mystery of Creativity

Creativity itself is seemingly a mystery, for there is something paradoxical about it, something which makes it difficult to see how it is even possible. How it happens is indeed puzzling, but that it happens at all is deeply mysterious. From the dictionary definition of creativity, 'to bring into being a form out of nothing', creativity seems to be not only unintelligible but strictly impossible. No craftsman or engineer ever made an artefact from nothing. The problem does not concern only material creation. To define creativity psychologically, as 'the production of new ideas', does not help either. For how can novelty possibly be explained? Either what preceded it was similar, in which case there is no real novelty or it was not, in which case one cannot possibly understand how the novelty could arise from it.

There are many intriguing factual questions about creativity, above all, just how it happens. But many recalcitrant problems arise, at least in part, because of conceptual difficulties in saying what creativity is, what counts as creative. These factual questions cannot be answered however while the conceptual paradox is raging. Once the paradox is tamed and the mystery is eliminated, creativity can sensibly be regarded as a mental capacity to be understood in psychological terms, as other mental capacities are which leads to the sorts of thought-processes and mental structures in which creativity is grounded, thus suggesting a solution to the puzzle of how creativity happens.

Humour comes from hitching together unrelated ideas to form a completely new idea. The jolt of change from one mental set to another and the interpretation of the change although the data has not. The jolt produces momentary fear and then relief, which is expressed in laughter. Humour disorients and then reorients understanding and this points out to the

possibility of thinking new ideas with the same data, and is then considered from one mental set to another. Incidents and comments are only funny in a given context. A glance at the cartoons in business magazines reveals that much of the humour hinges on people making frivolous remarks in serious situations or vice versa. Why do we often fail to laugh at the clown who falls over? Because we expect clowns to do that. If on the other hand, we see an eminent figure, such as a politician, take the merest lurch, the incident provokes effortless laughter.

Humour help to change the atmosphere and dispel tension in difficult situations. Getting things done through other people means overcoming potential conflicts of interest, clashes of personality and resistance to change. It means instilling enthusiasm, encouraging openness, and fostering teamwork. All of these can be eased with the deliberate use of humour. In its most constructive form, humour can even buttress creativity. Humour and creativity have a lot in common. Both involve divergent rather than convergent thought processes; free wheeling associations, the discovery of hidden similarities, and leaps of imagination. Two separate domains of thought are linked by a common thread which is normally overlooked, but which seems glaring once expressed. Humour comes from surprise, what makes you laugh is something that is both surprising and yet logical or plausible. There is surprise followed by the realisation that the unexpected ending makes some sense after all (H. Gleitman[27] 1995).

Consider the following example, two men are out on a safari, filming a lion. As they get closer to the lion, it roars to register its displeasure. They try to get closer still, it roars again. Casually one of the men takes off his heavy desert boots and slips into a pair of running shoes. His colleague notices and says scornfully, 'I don't know why you are bothering with those you'll never outrun it.' The other replies: 'I don't have to outrun it, I just have to outrun you.' The joke involves a sudden switch of perspectives of the sort that characterises lateral thinking puzzles. We are amazed at our own myopia, and make the smiling admission, 'I have been fooled.' Seeing the joke can be equated to solving the problem. The above example demonstrates the close relationship between the haha and the aha. Humour can pave the way for innovation. This is not to say that a good idea needs a throw away line to kick start it; but an

[27] Gleitman,H., (1995) *Basic Psychology*, NY, W.W.Norton & Company

environment which is amenable to humour is also likely to be propitious to ideas, for several reasons.

Humour is vital in shaping the rhythms of work and the patterns of contact within the organisation. A sense of humour acts as a magnet, drawing others to see us. Funny signs or posters such as (you don't have to be crazy to work here) projects one's view of the world, and trigger certain assumptions about one's character and attitudes. They are like open invitations to kindred spirits. It encourages comment and banter and helps people connect. In short, it makes work ore sociable. Novices generally find themselves sidelined from all humorous activity. Since they are powerless they tend not to be joked about, nor are they allowed to make jokes at the expense of established group members. This exclusion period can be important for socialisation purposes. The novice has a chance to determine who wields the power and how. But not until others start to mock the novice will he or she feel like a real member of the group.

If novices are those with least impact on humorous proceedings, those who have the most are the corporate leaders. Leaders can have hefty influence on the nature and incidence of humour. They are custodians of corporate well-being and depending on their approach, may be the object of much humour. Leaders can therefore be seen as having a liberating effect on their entourage, who may be carried along in their humorous slip stream. Indeed their impact may be such that they leave humorous legacy behind them. Thus the humorous contribution of leaders may be accentuated by the fact that they tend to attract like –minded people to the team. An important consideration then in building a team may be a sense of humour. By laughing at imperfections in themselves, leaders open up the way to a more honest dialogue. Their readiness to admit their own limitations makes them seem more human and approachable. It conveys the leader's willingness to learn, fumble and persevere. Humour has the ability to establish emotional proximity between leader and followers.

It helps to break down barriers between people and promotes a climate that is conducive to open debate. Humour allows people to speak up, to broach delicate subjects, it promotes a healthy exchange of ideas. People will make more daring suggestions, safe in the knowledge that they will not be penalised for it. Humour makes a team more participative and responsive. Furthermore when leaders joke with others, they demonstrate that they look upon people as something more than just a resource to get things done. To arouse deeper commitment, leaders

have to show something of themselves. They have to provide the stimulus that turns a group of individuals into a team. The working environment is a consummate generator of paradox and inconsistency, and humour thrives on these. It could even be said that humour exists in order to compensate for the inability of our rational view of the world to accommodate disorder. The presence of humour serves as a constant reminder of our limited understanding of team processes and human behaviour. It is from the disparity between our expectations and reality that humour springs. In every plan gone wrong, in every principle disproved, in every fact caught in duplicity, there is a comic energy waiting to be unleashed.

While it is true that humour mocks existing organisational patterns and activities, that is the price to be paid for preserving them. Humour also helps to sustain team effort, energises and unites those who partake of it. It facilitates the co-ordination of effort and makes team pressures more bearable. It is the safety-valve that makes collective endeavours possible. For all these reasons humour is deemed a necessity and not a luxury. More surprisingly perhaps, the usage of humour and the practice of leadership turn out to be closely related. Both require that vital, yet intangible faculty, judgement. Hitting the right humorous chord demands sensitivity to other people, to their frame of mind and motivation, and to the image that one is projecting The effective use of humour therefore demands interpersonal sensitivity as well as comic insight. Humour then is but one skill, albeit a valuable one, in one's repertoire. Knowing when and how to use humour is just another facet of the leader's craft.

Humour has intrinsic value, it takes us out of ourselves, it enables us to reflect, it brings us closer together and makes us more humane. It makes us capable of understanding the range of values and the discrepancy between them and also the levels of human response.

3.5.3 Inspirational and Romantic views of Creativity

The inspirational approach sees creativity as essentially mysterious even superhuman or divine. Plato put it like this: *'A poet is holy, and never able to compose until he has become inspired, and is beside himself and reason is no longer in him...for not by art does he utter these, but by power divine.'*

The romantic view is less extreme, claiming that creativity – while not actually divine is at least exceptional. Creative artists and scientists are said to be people gifted with a specific talent which others lack: insight, or intuition. As for how intuitive insight actually functions,

romantics offer only the vaguest suggestions. They see creativity as fundamentally unanalysable and are deeply unsympathetic to the notion that a scientific account of it may one day be achieved. According to the romantic, intuitive talent is innate, a gift that can be squandered but cannot be acquired or taught. This view implies that the most we can do to encourage creativity is to identify the people with this special talent, and give them room to work.

Romanticism provides no understanding of creativity. This was recognised by Arthur Koestler, who was genuinely interested in how creativity happens, and whose account of creativity in terms of the juxtaposition of formerly unrelated ideas is also a popular view.

> *'The moment of truth, the sudden emergence of a new insight, is an act of intuition. Such intuitions give the appearance of miraculous flashes, or short circuits of reasoning. In fact they may be likened to an immersed chain, of which only the beginning and the end are visible above the surface of consciousness. The diver vanishes at one end of the chain and comes up at the other end, guided by invisible links'.*
>
> Koestler [28] (1975)

How intuition works? How is it possible for people to think new thoughts? These matters can be better understood with the help of ideas from Artificial Intelligence (AI).

AI is the study of how to build and/or program computers to do the sorts of things which human minds can do: using English, recognising faces, advising on problems in medical diagnosis. It provides many ideas about psychological processes, and so has given rise to a new approach in studying the mind: 'computational' psychology.

3.5.4 Creativity in research – Group creativity

It is usually the individual who makes a discovery. Scientific laws and principles usually carry an individual's name like Newton Laws of Motion or Le Chatelier's Principle and, inventions are made and patents are taken out in an individual's name like Sainsbury's. He is normally the man who observes a phenomenon, perhaps first able to interpret it but very, very few individuals perform all the creative processes involved in the development of a new device or a

[28] Koestler, Hungarian born British novelist, journalist, and critic was best known for his novel Darkness at Noon (1940). From 1956 he focused on questions in science and mysticism, especially telepathy and extrasensory perception.

new system. We heard a lot about the individual scientist, the individual genius, the lone worker. But more than one individual is required for the process of procreation and one is inclined to think that this will apply to creation as well.

3.5.5 The team approach

Some people are unusually endowed with great creative talent. There are very few people who are continually bubbling over with imaginative thoughts with suggestions on how to do things better. There are others who go about their daily work, who do it well and thoroughly but who seldom come up with a creative idea.

There are very few self-starters who are impelled to create. There are others who have within them the potential to create but who need the necessary stimuli, the necessary environment, to bring creativity into being. What are these stimuli? Brainstorming sessions, incentive bonuses, comfortable environment and the like have been proposed as systematic solutions but there is little evidence to support this. Creativity is stimulated less by gimmicks than it is by an inward motivation to do well and by a healthy level of challenges. By and large people endeavour to live up to the reputation you hold for them. If a man truly believes that you expect something of him, he tries very ,very hard to live up to these expectations. People need to feel that someone has confidence in them. A good leader evaluates his men and lets them know that he has confidence in them where he believes they can perform. He generates a sense of team work and an aura of enthusiasm and expectation which are vital to the success of a project. Along with these factors, there must be recognition, recognition can push a man onward to even a greater accomplishment.

In a team operation, we cannot get all perfect people. They are not all outstanding in creative ability, they are not all alike. It would be impossible to match them so that each did his job perfectly. One can apply in organisational operations some of the principles that one learned when dealing with components in electronics – applying the feedback mechanism, when controls are over-controlled, lighten up on them; when there is failure to give out enough communication, feed through more information.

3.6 Stimulating Creative thinking - Brainstorming

A brainstorming session is one in which a group of people try to pool their imagination, operating on all the facts they can summon up and, allow themselves to toy with any idea, in the hope that it may suggest something to someone else in the group and, in the end, snowball into a useful idea.

3.6.1 Limitations of Brainstorming

The most startling and weighty piece of evidence for the failure of brainstorming in terms of its own objectives, is the experimental study by Donald Taylor at Yale University. The conclusion of the study (using 96 people) was that brainstorming inhibits creative thinking.

In brainstorming, strong emphasis is placed upon avoiding criticism, both of one's own ideas and upon the ideas of others. Nevertheless it appears from that study that the individual working in a group feels less free from possible criticism by others, even when such criticism is not expressed at the time, than does the individual working alone. Further, that a given number of individuals working in a group appear more likely to pursue the same train of thought, to have the same approach to the problem, than do the same number of individuals working alone.

The greater the variety the train of thought or approach, the greater should be the number of different ideas produced. To the extent that group participation reduces such variety, it will inhibit the production of ideas.

The chief danger of brainstorming lies not in the question of whether or not it produces more or less ideas, or more or less varied ideas, but in fact that it distorts the creative process by dealing with it piecemeal and putting it on the production line as though creativity can be handled on a production basis. The brainstorming technique allows only the group to proliferate possibilities. The creative process doesn't end with an idea, it only starts with an idea.

Brainstorming obscures and confuses the real problem, which is that creativity is indivisible. Creativity is a total process, it cannot be isolated in the experience of individuals. It cannot operate from nine to five everyday and not at any other time.

3.7 Characterising thinking

Thinking is an activity that has long intrigued and puzzled psychologists and philosophers and continues to do so. Since all valuable innovations in the arts and sciences originate from fruitful thinking, it is a process of evident importance. The term 'thinking' is taken to refer to a set of processes whereby people assemble, use and revise internal symbolic models. These models may be intended to represent reality (as in science) or conceivable reality (as in fiction) or even be quite abstract with no particular interpretation intended (as in music or pure mathematics). Thinking directed toward problem-solving may be regarded as exploring a symbolic model of the task to determine a course of action that should be the best (or at least satisfactory) without overt and possibly costly trial and error. Given the strong emphasis on problem-solving in the general literature of thinking, the question arises 'what is a problem?'. Following Duncker, problems were defined as arising when an organism has a goal which it does not know how to reach. A variety of approaches have been taken to the topic of thinking in the history of psychology; one dominant information processing approach takes the computer as its key metaphor for the mind. In their cognitive aspects, this approach sees people as computer-like systems that code, store, retrieve and transform information. Most information processing models for various tasks accept certain limitations on cognitive capabilities.

3.7.1 Deductive and Inductive Reasoning

In deductive tasks, people are required to what conclusion, if any, necessarily follows when certain statements are assumed to be true. In the case of inductive reasoning, people are required to determine the implications, if any, of some particular observation(s) for the truth of possible generalisations or hypotheses.

3.7.2 Syllogistic Reasoning

A fairly common type of deductive problem in everyday thinking, is to determine what conclusion, if any, must follow from certain assumptions about category membership.
The main features of syllogistic arguments may be conveyed by a few examples.
Consider the following:

All mammals have backbones.

All dogs are mammals.

Therefore, all dogs have backbones.

Since the third statement (the conclusion) follows necessarily from the first two (the premises) this is a valid syllogistic argument and may be compared with:

All cats are mammals.

All dogs are mammals.

Therefore, all dogs are cats.

In this case the conclusion plainly does not follow from the premises and the argument is invalid. It should be noted that the validity of an argument is independent of the truth of the premises. A valid argument is simply one in which, if the premises are true, then the conclusion is also, necessarily, true. In addition to validity, syllogisms can be varied in many other ways for experimental purposes. For example they may be varied by changing the quantifiers (some, all) used in the argument; the terms may be abstract or concrete; the premises and conclusion may be negative or affirmative; the propositions in the argument may be empirically true or false and so on. Clearly, many features of the task can be readily manipulated. A number of variations are also possible in the response requirements. Subjects can be asked to produce valid inferences from given conclusions; to judge a possible conclusion as valid or not; or to select a valid conclusion from a set of possibilities.

Early studies (Wilkins 1928)[29] established some of the main factors associated with difficulty of syllogisms, such as correctness. There what answer can be given to the often raised question, "Do people think logically?" If the criterion of logical thinking is reaching conclusions consistent with those of the formal logic then one must answer that people are not always logical reasoners. They do make errors.

In deductive reasoning, inferences are made from statements (premises) that were to be taken as true. Somewhat different but related tasks arise when one has to test statements (hypotheses) for truth against external data. Detectives and scientists, for instance, constantly face the inductive problem of deciding whether certain hypotheses are true or false. A possible general approach is to follow the "hypothetico-deductive" method. In this technique, implications are

[29] Wilkins M.,(1928)., "The effect of changed material on the ability to do formal syllogistic reasoning," Archives of Psychology 16, 83. [68, 72]

deduced from the hypothesis and are then checked empirically for truth or falsity. If the implications of the hypothesis turn out to be true, then the hypothesis is supported, otherwise it can be rejected on the grounds that if validly drawn inferences from the hypothesis lead to empirically false conclusions then the hypothesis must be false.

3.8 Creativity in the design process

Creativity in the design process is often characterised by the occurrence of a significant event the so called 'creative leap'. Sometimes such an event occurs as a sudden insight which the designer immediately recognises as significant, but often it is also in retrospect that the designer is able to identify a point during the design process at which the key concept began to emerge. Retrospective accounts of creative events made by designers themselves may not be wholly reliable. However, some recent descriptive, empirical studies of the creative event have begun to shed more light on this mysterious aspect of design. More of these independent studies of creativity in design are necessary in order to develop a better understanding of how creative design occurs. Studying creative design is seen as problematic because there can be no guarantee that a 'creative' event will occur during a design process, and because of the difficulty of identifying a solution idea as 'creative'. However, in every design project creativity can be found - if not in the apparent form of a distinct creative event, then as the evolution of a unique solution possessing some degree of creativity.

The 'creative' aspect of design can be described by introducing the notions of 'default' and 'surprise' problem / solution spaces. Surprise is what keeps a designer from routine behaviour. The 'surprising' parts of a problem or solution drive the originality streak in a design project. The process of evolution in the natural world is nowadays seen as driven by a reaction to a surprise (change in environment), rather than a gradual changing of a phenotype and genotype in an ever closer approximation to an optimum in the fitness function. Creativity in the design process can therefore be validly compared to such 'bursts of development'.

3.8.1 Can anyone be creative?

Every living, breathing human being has the potential to be creative. Each of us is a unique individual capable of creating....it comes with the human territory. We are, simply, quite a

creative species. All people can be creative but those who are recognised as being creative have an awareness that others don't. However it is not productive to think of hard categories of the creative and uncreative. There is a qualitative and pragmatic element as not all creativity results in useable solutions. Children are endlessly creative in terms of inventing uses and recombining but little of what they create is producible or saleable. Creative people seen to be able to tune in more to their thought patterns and glean great ideas. People who do not use their creative potential don't know how to do this or aren't even aware it is possible. Creative people can start thinking about something , then forget it. Meanwhile, their brains are still thinking about it. Non-creative people don't know that their brains are working for them off-shift. There are many components that influence the creativity of individuals. This is not to say that people tremendously fluctuate in their creativity day to day and hour to hour; the opposite is often believed- that some individuals are generally more creative most of the time than others.
The reasons why some people are more creative, however are many.

- Without the abilities needed to do the creative act, it is highly unlikely the individual will do the act. Just because a person has the ability to do something, however, does not necessarily mean that the person will do it. This is why it is important to have motives.
- Without the motivation to do so, it is unlikely that a person would complete an act, regardless of the person's abilities.
- Opportunities in the environment can affect the creativeness of individuals and groups of individuals.

One aspect of a creative personality is the fluency with which they generates a number of new ideas. Not only does the creative person think of good ideas, but he/she can think of many ideas, explore them and record them. Creativity can be suppressed over the years or at an early age depending on circumstances, however it is important to recognise that creative ability can be learned, improved upon and increased over time.

3.8.2 Unfolding or Teaching

Two widely diverging views can be found on the optimal means for developing creative talents. One view might be termed the "unfolding" or "natural " perspective. This child is viewed as a seed, which , though small and fragile, contains within its husk all the necessary 'germs' for

eventual virtuosity. The role of the gardener who tends the seed is primarily preventive so that the seeds have the opportunity to unfold on their own. By analogy in the field of education every normal child is seen (at least potentially) a productive and imaginative individual. The teacher 's role is to shield the innocent and fragile young child from pernicious forces in the society so that this inborn talents can flower.

The opposite point of view is somewhat less favourable but however not less familiar. This perspective, which can be termed the "training," "directive," or "skills" approach, holds that at the very minimum unfolding is not enough. Like a young seedling abandoned on the shady side of the hill, a child left alone will never achieve his potential. A child even one displaying considerable promise, will come to nought without firm guidance and active intervention on the part of more knowledgeable adults. Proficiency is the attainment of many highly intricate skills, ones that can be acquired only under the direction of a gifted teacher or practising expert. It is wise to declare that both sides have a point and that the truth lies just about midway between equally untenable extremes. I will affirm that both these positions have factors in their favour. Yet I hope that a deeper understanding of both views – unfolding as well as training – may emerge from a developmental perspective and that, indeed questions in design creativity and design process in general benefit from such an examination.

3.9 The two halves of the brain

Superficially similar in appearance and functioning, the hemispheres of the brain have gradually revealed their individual identities.

Not only does each half control the movement of limbs and sensations on one side of the body, but the left and right hemispheres seem to play distinct roles in thinking, perception, feeling and memory. Moreover left-handedness seems integrally tied to an atypical relationship between the two halves of the brain. It has been known since classical times that the human brain is composed of two massive, physically equivalent halves. More recently (Brain, 1965; Springer and Deutsch, 1981),we have learned that each half controls movement in the opposite half of the body. Some of the most persuasive evidence from studies originated by Nobel laureate Roger Sperry using person with split brains. These are people whose two hemispheres are severed by cutting the corpus callosum and a few other connective tracts in order to control

epilepsy. Only in the latter part of the 19th century did physicians first conjecture that higher cognitive functions might be organised asymmetrically in the left and right cortices of the two hemispheres. Careful studies of patients who had lost language functions after their brains had been damaged, revealed that this condition (known as aphasia), predictably follows injury to the left cerebral cortex, but occurs rarely after equivalent damage to the right hemisphere. Complementary evidence has suggested that the right hemisphere also has its special genius. The precise nature of specialisation (dominance) remains a subject of heated dispute.

Evidence has also emerged that not all human brains are organised in the same way. Knowledge about the brain and hemisphere function has come principally from the study of once-normal individuals whose brains have been injured by a stroke, an accident or a tumour. When such patients lose the ability to perform a task, the inference is made that the injured region played an important role in he execution of that function, as when a patient with significant injury to the left becomes aphasic. Conversely, if a brain-injured patient retains the ability to perform a task, the crucial capabilities are thought to reside somewhere in the remaining intact portions of the brain. According to scientific literature, the left hemisphere has manifested a clear advantage in dealing with language, particularly with consonant sounds and rules of grammar. Processing of vowel sounds and access to the meaning of words seem to reside in both hemispheres. The right hemisphere has no cognitive superiority equivalent in strength to the left hemisphere's dominion over language. Nonetheless, the right hemisphere does seem relatively more important in spatial tasks. Frequently it seems that both hemispheres contribute to the task but in different ways. For example to draw an accurate representation of something, we seem to need the right hemisphere for the overall contour and the left hemisphere for identifying details and internal elements. I suspect that this picture of differing but complementary contributions by the two hemispheres will hold as well for other realms of thought and that there are more ways that the two hemispheres can interact.

3.10 Design and Culture

What is the relationship between cultural contexts and design processes, solutions and products?

> *'Now that 'Design ' is understood from Tokyo to Moscow, from Buenos Aires to Montreal, it is obvious that each country according to its politics, its economics, its sociology, its industry, uses 'Design' in a different way; but one must add that a universal language is being constructed daily'.*
>
> G.Patrix (1973)

In its most anthropological sense, the word 'culture' is used as a concept which embraces the ideas, values and practices constituting society as a whole, rather than one which only touches one level of human endeavour. In parallel, design is a phenomenon which affects everybody.

This definition of culture has to be considered within a broad context which subsumes economics, politics and technology as these are the forces which have determined the dominant cultural patterns in modern society. Design is also formed and sustained by these forces and. As a result, designed artefacts act as cultural ciphers. Since 1900 design and culture, in the wide sense, have become recognised as increasingly interdependent.

Design looks in two directions at the same time: as a silent quality of all mass-produced goods it plays a generally unacknowledged but vital roles in all our lives; as a named concept within the mass media it is, however much more visible and generally recognised. In the latter guise design becomes an extension of marketing and advertising usually associated with named designers and brands.

The 'designer-jeans' phenomenon, which persuades us to buy a product because it has been designed, is, culturally speaking, totally distinct from the activity of the anonymous designers within industry who resolve the problems of cost, appearance and use in consumer products. The way in which design as an adjunct of marketing has grown out of design as an aspect of mass production is a major theme of recent design. It is a change which directly mirrors the way in which the model of mass-production industry, as presented by Henry Ford, which dominated American ideas about industrial organisation in the early twentieth century, has been challenged by an alternative model which stresses batch production,

a smaller scale of operations, and, at times, a fair amount of hand or skilled work or computerised 'mass customisation'. The latter model puts the demands of the marketplace above those of the logic of mechanised mass production and tends, as a result, to value the diversification of products rather than, or as well as, standardisation. These two models of industry coexist in the 20th century and has different implication for the meaning of design. An important sub-theme is the way in which the aesthetic of designed artefacts has swung repeatedly backwards and forwards from production to consumption as sources of metaphorical inspiration.

Although design has come to be defined and understood since the advent of mechanisation, it is important to remember that the concept has an earlier history which is largely responsible for the way we comprehend it today. Design has always been one aspect of a larger process, whether of manufacturing, in the craft or mechanised sense, or, from the consumer's point of view, of participation in social or economic life and its definition has been in a state of constant flux due primarily, to the changes in the socio-economic framework which have sustained it. Thus the difference between a seventeenth-century pattern-maker and a modern industrial designer is less one of the nature of their respective creative activities than of the economic, technological and social constraints and potentialities within which the activity is performed. What have remained constant are the visualising and humanising aspects of the design process as even today the designer's input into the manufacture of an electronic calculator, for example, focuses on the aesthetic and ergonomic aspects of the product. The most significant and powerful constraining factor on design in the last two centuries has, however, been its growing alliance with mass production and mass consumption. In recent decades, manufacturing industry has removed design from its original, humble and largely anonymous backstage position as an element in the production process and pushed it in the limelight as an important aspect of the saleability and desirability of consumer products thus creating cultural meaning.

Design, in the 'old' sense, has not disappeared, it remains as central to the process of production as it ever did but tends, at least in terms of its cultural image, to be over-shadowed by the more sales-oriented concept.

The ambiguity created by the co-existence of these two faces of design has been the greatest stumbling block in a satisfactory analysis of it. It has become increasingly difficult to extricate the propaganda of design from its real manifestations and to separate sales talk from fact. One way of avoiding this impasse is to consider design within the context of social life. From this perspective, design simply becomes one of the forms of mass communication in modern society inasmuch as it plays a fundamental role, both practical and psychological, within daily life. In understanding many of the changes in the meaning of modern design it is important to grasp the modifications that have been affected by changing social patterns to which the designer, like everybody else, can only respond although in some ways design helps to find forms for them or even determine them not just problem solving but also desire creation. The changing role of women in the 20th century for example has influenced the appearance and image of the so-called labour-saving devices in the home needed to minimise housework. Conversely, design initiatives can modify social behaviour, as in the case, for example of the Sony Walkman, the miniature tape-cassette player which has encouraged a new attitude towards such solitary activities as jogging and travelling on the underground.

The social and psychological necessity for design is easily justified by the fact that we only need to buy, for example one set of plastic crockery which would last us a life-time. That we continue to buy expendable products made of fragile materials, and often, indeed, to invest in duplicate examples which only vary stylistically, because of the demands of social status or ritual emphasises the fundamentally symbolic role that design plays in our consumption and use of objects. While this tendency may be minimised at the more technical end of the spectrum (most of us do not for example, need more than one microwave oven) even in goods of this nature there are signs that pluralism is increasingly the norm. The socio-cultural argument is reinforced by the economic demands of industrial capitalism which depends on the constant consumption of goods. Together they locate design in the centre of the picture as it is design that provides the variation and the markers of identity or status that are so essential to modern society.

Design decisions are constantly being made everywhere, whether by designers or consumers. They all focus on the aesthetic of the product whether, in the designer's case, defined as a creative resolution of the joint demands of technology, price, function and social

symbolism or, in the case of the buying public, as the fulfilment of the requirements of taste, practicality and social and economic needs.

Design is, more often then not, therefore, manifested in tangible and visible form and objects are, therefore an important point of entry for the design critic or historian. Design is ultimately, a cultural phenomenon whose effects are as abstract as they are physical.

As Patrix implies, it is the nature of design in the modern world to be international as it depends increasingly on the structure of the world market for its very existence. The English word 'design' is currently used widely in countries such as Japan, France, Italy ..., a fact which indicates that its meaning in contemporary society has moved away from its definition in previous centuries when it was interchangeable with the Italian *il disegno* and the French *le dessin* meaning drawing. The fact that these countries have abandoned these native terms in favour of 'design' suggests that more than a mere shift in design has taken placed and that what has occurred is, in fact, the emergence of an entirely new concept.

The relationship between design and culture has taken many twists and turns throughout the 20th century, as design is both a mirror of, and an agent of change within twentieth century culture. Thus modifications in the former's evolution both reflect and determine developments in the latter. All kinds and levels of cultural values, whether those manifested in, for example, political ideology, in various social and cultural activities, or in the economic status quo, find their way into the designed artefact by one means or another and those artefacts communicate those values in tangible and visual form.

A few designers (like Adolf Loos, Robert Venturi) have realised the significance of design's umbilical link with culture in this century and have tried to make that recognition explicit in their work. Most practising designers have however pursued the more passive path of sustaining rather than challenging the cultural status quo.

Design inevitably perpetuates the ideology of the system that it serves. In the 20th century that system has been represented in industrial society almost wholly by the capitalist economic framework of mass production and mass consumption. In its basic state, design is simply the creative act which determines the nature, appearance and the social function of useful objects. As such, like painting, sculpture, poetry, dance and music, it has the potential to improve the quality of life by rendering the material world both more 'beautiful' and more

efficient. Where design diverges from the areas of cultural activity is the moment at which it enters the realms of mass production and mass consumption. From that point onwards, it becomes harder for self-expression, whether that of the designer or of the consumer, to assert itself within the economic determination of the framework which defines their actions. Mass cultural values, reflected in mass taste and symbolised by mass-produced artefacts, are perpetrated by the mass manufactures and absorbed wholesale by the mass consumer. Design is therefore an important medium of communication which expresses the values of the system within which it functions.

The way forward for design remains difficult but exciting. Today's most dominant stylistic and philosophical tendency is an interest in pluralism and differentiation. Within pluralism the weight of responsibility hangs increasingly on the shoulders of the designer. While still fulfilling manufacturing industries' needs for ever-increasing production and consumption, the designer is still in a unique position of being able to improve the quality of life in a number of ways, whether in terms of influencing the ergonomic and aesthetic quality of products, or of social and psychological fulfilment and cultural richness.

3.11 Research on analysis tool – Protocol Analysis

Studies of functional behaviour in industry such as designing are of value since they offer the opportunity for training and enhancement of skilled performance. Analysis of methodologies available identifies limitations in their ability to account for the extensive variation in skilled behaviour.

Despite the pleasurable aspect of watching other people working, this watchdog activity has a value beyond feeding idle curiosity. Interest in what people do has always been high, primarily because it offers opportunities for improving performance, particularly of skilled tasks. Arguably, it is this watching, learning and improving pattern which is the dominant element in the evolution of sophisticated technological capability.

Judging from the number of publications, there is a growing body of information on design as a separate specialist activity viewed from a number of standpoints. Whatever the focus of the study, there has been a move away from prescribing what people should do and towards what they actually do. Clearly such a shift towards less prescriptive thinking requires

methodological approaches towards the study and modelling of functional behaviour. Understanding design activity will depend to a large extent on how clearly we can describe what designers do. This will also contribute to improved performance by identifying optimal strategies and determinants of successful behaviour.

3.12 Methodological Options

How do we go about studying behaviour? There are a large number of options listed in Table 3.1 below. These classify into direct and indirect methods: to each of these advantages and disadvantages are attached. Indirect methods are essentially based on asking specialists what they do, rather than watching them actually doing it. They are often used in conjunction with analytical techniques aimed at eliciting relevant dimensions of behaviour. A major disadvantage here is that such techniques impose hypothetical constructs on the observed situation because of analysis needs: these may only loosely relate to what is actually happening. Such 'filtered perceptions' obtained from indirect methods have been shown to deviate considerably from information obtained from direct methods
(McCall et al).

In the case of direct observation, both self-observation and other-observation suffer from the major disadvantage of being expensive in research effort. A second limitation is that they are specific to the individuals studied. The resulting lack of anonymity is a restriction on research in some cases. However leaving aside observational validity and bias for the moment, these methods have the advantage of producing rich data about events as they happen. Table 3.2 indicates the benefits from using this methodology in terms of restrictions on observation, recall and reporting. Table 3.3 redresses the balance somewhat by considering the disadvantages.

Table 3.1: Activity centred studies relating to individuals (Bessant 1979)

Activity Area	Typical studies
Information processing and decision-making	Newell, Shaw, Simon
Cognitive psychology	Parnes; Rickards & Freedman
Communication Behaviour	Allen; Shilling & Bernard
Leadership style	Fiedler
Problem-solving style and coping strategies	Johnson
Group processes	Bales
Group roles	Benne & Sheats
Group influence and group political behaviour	Witte
Organisation size, structure, technology, etc	Pugh et al
Organisation environment	Lawrence and Lorsch
Organisation climate	Pelz and Andrews
Company management style	Burns and Stalker
Innovation adoption characteristics	Rogers and Shoemaker
Learning style and environments	Carlsson et al
Design studies	Broadbent and Ward
Identification of group related to alienation etc	Shephard
Motivation of different specialist groups	Hackman
Comparisons of white & blue collar workers	Goldthope et al
Development of psychology	Argyris
Individual ways of seeing the world	Kelly

Table 3.2: Constraints on methodology (Bessant 1979)

Observation – the work of specialists tend to high variety, the extent to this variety, allied to their involvement in their jobs, limits the specialists' ability to memorise and categorise his activities for later reporting. This is worsened by 'decay' in remembering, the longer the time interval between recording the data, the less clearly it will be recalled. The fallibility of such retrospective data argues for more direct methods.

A limitation of all methods lies in the fact that many activities are non-observable: planning, thinking etc. Whether this is in the form of answering a telephone, writing a letter or thinking about a design, it is obvious that simply recording these facts as events will be of little value. We need to get closer to what is actually taking place. The best route around this problem would seem to be based on getting background information via protocols, interviews etc.

Recording – The problem of variety in task content and pressure of work means that much of the briefer activity may well be lost at the recording stage. There is also the problem of consistent recording: whilst researchers may have this discipline it is unlikely that the subjects carrying out self observation can maintain it for long.

Recall – As indicated earlier, there is a tendency to forget over time and this influences the availability of data. 'Memory decay' is greater with (1) more elapsed time since the event, (2) lesser occurrence of the event, (3) relative unimportance of the event, (4) stronger personal connection of the equation to a person's self-esteem, and (5) less accessibility to relevant data. Thus, much data is inaccessible to the researcher since respondents often cannot recall events, or misrecall various events. This too argues for direct as opposed to indirect methods.

Bias and censorship – Inevitably people wish to show themselves in a favourable light and thus activities which may not be construed as 'good' tend to be played down. This defensiveness will mainly associate with self reports but it is difficult to assess how far 'being researched' actually alters behaviour patterns.

Table 3.3: Disadvantages of direct techniques (Bessant 1979)

- Co-operation and commitment are sometimes difficult to obtain and maintain over extended periods.
- It is difficult to ensure anonymity.
- Relatively expensive in time and personnel.
- Tend to be feasible only with small samples.
- Produce voluminous data that is unwieldy to analyse
- Determine a representative period for observation may be difficult due to various cyclical patterns in work activities.

3.12.1 Design Activity

Design activity encompasses some of the highest cognitive abilities of human beings, including creativity, synthesis and problem solving. Every normal person is capable of exercising such abilities, but it is in design activity that they are most frequently stretched to their limits. The study and analysis of design activity offers significant intellectual challenges. Nonetheless design activity is a growing research field, stimulated both by the challenge and by the increasingly wide recognition of the value of design activity.

A substantial and varied range of research methods have been developed and adopted for the analysis of design activity. However this section will focus on one particular research method, that of protocol analysis. Of all the empirical, observational research methods for the analysis of design activity, protocol analysis is the one that has received the most use and attention in recent years (Ericsson & Simon 1993)[30]. It has become regarded as the most likely method (perhaps the only method) to bring out into the open the somewhat mysterious cognitive abilities of designers. In essence, protocol analysis relies on the verbal accounts given by subjects of their own cognitive activities. It is difficult to imagine how else to examine what is going on inside people's heads other than asking them to tell what they are thinking.

Of course this is fraught with difficulties. People do not necessarily know what is going on

[30] Ericsson & Simon., (1993) Protocol Analysis; Verbal Reports as Data, Cambridge, MA:MIT Press

inside their heads, let alone have the ability to verbalise it and what is going on inside their heads might not originate there. Nevertheless, people do normally find it relatively straightforward to give a verbal account of what they believe they are thinking, or what they are thinking recently. Retrospective verbal accounts (i.e. recalling what one was thinking recently) offer one means of getting at cognitive activity which is frequently used not only in research but also in everyday interchanges: 'What were you thinking when you were doing that?'. Concurrent verbal accounts (i.e. 'thinking aloud') offer the researcher the hope that they really do externalise or allow an insight into at least some of the subjects' cognitive activities. Ericsson and Simon (1993):

> *'There is a dramatic increase in the amount of behaviour that can be observed when a subject is performing a task while thinking aloud compared to the same subject working under silent conditions. A brief instruction to think aloud usually suffices to bring about this major change in observable behaviour'.*

However there are some significant disadvantages of think aloud protocol. Firstly, there may well be side effects of the verbalisation, such as it actually changes the subject's behaviour and their cognitive performance. Secondly, what the subject reports may well be incomplete accounts of what their cognitive activity actually is. Thirdly, the subject may, quite unintentionally, give irrelevant accounts, reporting parallel but independent thoughts to those who are actually being employed in the task.

All these disadvantages weigh particularly heavily on the validity of protocol analysis in design, where 'non-verbal thinking' is believed to be a significant feature of the relevant cognitive activities, and where the use of sketches and similar externalisation of thought processes seems to be fundamental.

3.13 History of Protocol Analysis

The analysis of think-aloud protocols emerged as a method of psychological research in the 1920s. From the beginning it was a method of seeking insight into problem solving. The early studies were limited by the researcher's ability to take accurate notes of the subject's verbalisations. When tape recorders became available in 1945, more accurate methods of verbal data collection allowed more precise, and less selective, studies to be undertaken.
The availability of video recording in the 1970s added a new dimension, in which the non-verbal behaviour of subjects could be studied alongside their verbal reports. The number and variety of protocol studies of design activity have grown significantly in recent years. As well as the conventional, single-subject, think aloud protocol studies, the use of dialogue exchanges between two or more collaborating subjects has also been employed (Schon 1983)[31].

In the late 1980s, protocol studies of engineering design began to appear but the studies in that domain have increased rapidly since. A significant feature of several of these engineering design studies has been their further extension of the method of analysis of team design activity. The classical protocol study relies on an individual subject thinking aloud; this is not possible in teamwork, of course, but the verbal exchanges of members of a team engaged in a joint task do seem to provide data indicative of the cognitive activities that are being undertaken by the team members.

A rapidly growing field of study which has also begun to use protocol analysis is that of software design, where teamwork has also begun to figure significantly, particularly related to the design of computer-based support systems. Most researchers using protocol analysis have studied design activity within one domain, but there are a few who have attempted to make comparisons across several domains.

The industrial (product) design domain has been studied relatively little through protocol analysis until very recently. The last decade has seen a major growth in the use of protocol studies as a method of analysing design activities. It has not been easy however to draw general comparisons or to agree general procedures for such studies because of their scattered and independent nature. The 1994 Delft Protocols Workshop was designed in order to

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[31] Schon, D.A., (1983) *The reflective practitioner*. New York : Basic Books

concentrate on this research methodology itself and to encourage more co-ordinated progress in analysing design activity in the future.

3.14 The 1994 Delft Protocols Workshop

The aim of the workshop was to bring together a group of design researchers (all well versed in protocol analysis) to compare analyses of the same data and to discuss the state of the art in protocol analysis. Although the number of protocol studies in design has been growing steadily, an intensified and broad discussion around protocol analysis was lacking. Most of the studies have been relatively isolated projects of research groups trying out the method by themselves. Furthermore protocol analysis happens to be so labour-intensive that single research projects just cannot yield statistically significant stand-alone data. The participants of the workshop were provided with a set of 'standard' data to analyse by all of them. The common set of data make it easier to compare and criticise each other's work.

The aims of the workshop were

- to get an overview of the accumulated knowledge on design of the participating researchers
- to seek a common language in discussing protocol analysis and detailed design processes
- to 'validate' protocol analysis as a research technique
- to stimulate discussion on the properties and limitations of protocol analysis research in design
- to discuss possible ways of using protocol analysis in the future, alone or in combination with other research techniques
- to form the basis of an international research network, a platform to discuss these matters.

3.14.1 Results of the workshop

Although protocol analysis is not a universal cure for design research problems, it has nevertheless been 'validated' as a research technique for design with respect to the following:

- Protocol analysis has severe limitations in capturing the non-verbal thought processes in the design work. 'Completeness' of protocol data is an illusion. Protocol analysis is a very specific research technique, capturing a few aspects of design activity in great detail.

- Even within these restrictions we have to be very careful. The experimental set-up heavily influence the protocol data, and the amount of interpretation needed to wrench conclusions from protocol data is also comparatively large. It is impossible to claim to have all these factors under control. In the end, conclusions and generalisations drawn on the basis of protocol research will only be valid if and when we have a coherent picture of the influence of the experimental technique and situation. In the meantime, we can do little more than identify the sources of bias in protocol research, and be very explicit on the way the experiment was set up, the background of the researchers, the aim of the project, etc.
- The adoption of protocol analysis as a research technique in design is an effort on the part of design methodologists to find a rigorous form for their empirical research. Protocol analysis is somewhere in the middle ground between the 'hard' experimental methods of the natural sciences and the 'weaker' purely observational methods of the social sciences. The whole of empirical design research can be seen balancing between these, perhaps trying to lean both ways. The general feeling in the discussions at the Workshop was that the balance has tipped too much to the side of rigour and 'safe' research techniques, at the expense of 'relevance' of results for design practice and education.

3.14.2 Limitations arising in comparing group and individual work

The results of a comparison between group and individual work have to be viewed in the light of the limitations that are inherent to the experiment and to the analysis method.
The experimental limitations are related to the request to think aloud, the number of cases, the type of assignment, the type of environment, and the subjects.

3.15 Investigation of Individual and Team Design Processes

In industry, engineering designers are collaborating more and more in teams crossing department and even company borders. The work of a single designers is part of a complex technical and social process. It is therefore necessary to understand the interrelation of different factors determining design processes. What are these factors? Every design process starts with a design task. The way in which the design task is solved depends on whether a designer has expert knowledge about a field or not. This brings up the *individual prerequisites* of each single

designer such as his or her skills and knowledge. Working in a group gives another dimension to the use of the designer's abilities. The way in which a group discusses, solves conflicts, and makes decisions may increase or decrease the performance of its members. Thus the *prerequisites of the group* are of great influence on the process and its result.

Experiments with designers in standardised situations in a laboratory are approaches to get hold of the variety of individual procedures in design. This allows one to explain observed differences in behaviour in the 'same' external situation relative to the individual's prerequisites of the subjects. Some previous empirical research in this field has been conducted together with psychologists and thus provided an insight into the cognitive processes, the strategies and the tactics employed by the subjects during problem solving in design.

The design process can be reflected from different points of view, the phases, the problems and the sub-problems. Also by observing the actions of designers and their steps of analysing and making decisions in their work. But how can we comprehend all these simultaneous actions? One way is to record the design process as accurately as possible. However, the conditions of the experiment and the record-keeping process have a few limitations for the validity of any conclusions.

The requirement to think aloud interferes with the process of thought and action in the individual experiment. The single designer, Dan, (Goldschmidt 1995) is forced to formulate thoughts and ideas verbally which may differ in form and significance from what they would have been in a process without thinking aloud. The team members are not thinking aloud, they are just communicating while designing. Any conclusions on the comparison of the team and individual process should consider this difference. Additionally, the external conditions were not absolutely the same: Dan used a telephone to consult an external expert, whereas the team did not consult externally. Therefore care should be taken when comparing the individual and the team design process. Recording category classes can possibly allocate observations to given categories without any doubt and without the need to interpret their meaning. The recordings of sub-functions, phases and product characteristics sometimes requires a decision on the part of the record keeper as to the emphasis of the action or spoken thoughts. This, of course, leads to a lack of precision. This lack of precision is also influenced by the possible incompleteness of thoughts while 'thinking aloud'.

3.15.1 Design Strategies

The subjects do not seem to be familiar with bicycle rack design although they are bicycle users. They do not have expertise about the specific design problem they are trying to solve. They are using general design heuristics and identifying and accessing relevant information figures very strongly in their design behaviours. An expert doing the same job may require less information management. The main parts of the problem, such as, deciding on the position of the backpack, designing a mount, and designing a backpack to rack connection, may be determined by the given task. Thus we see that both subjects attend to the same issues. The group follows a brainstorming strategy; they try to make analogies, defer judgement and try to generate many alternatives. They go through these issues twice, once during what they call 'ideation' phase, and then again during what they call the design phase. The individual designer focuses on each issue once, but during this time he goes through what can be called 'ideation' design.

The individual uses existing designs more extensively, and by making a telephone call finds expert opinion about the positioning of the backpack on the bike. He also reasons from first principles, his comments indicate that his preferred strategy is to use expert knowledge, failing that to use simulation and scenarios and then search. This is what he does when determining the location of the backpack. In other subtasks such as when mounting the rack to the bike, he starts with search. It would appear that he has more knowledge about this or that it will be too time consuming to seek expert knowledge.The constraints used for defining the design problem differ between group and individual. The design group designs a tray with straps instead of taking advantage of the external frame. The individual designer, on the other hand, attaches the backpack to the rack with clips so that it can be taken off easily,
but the clips are expected to carry a pack weighing less than 15lb. According to available information, the pack can weigh up to 50lb, but this information was not seen by the individual. It can therefore be concluded that the most important differences between group and individual are in information management.

3.16 Information Management

Design is an information design process, over the course of a design process designers handle large amounts of information. Therefore the quality of designs and the overall productivity of

the design process depend heavily on the information management skills of designers. Information management is the process of capturing and organising design information in such a manner that it can be retrieved and reused at a later time. In recent years there has been an increasing deployment of computer-aided tools to support the design process in areas such as CAD (Computer-Aided Design), CAE (Computer-Aided Engineering) and CAM (Computer-Aided Manufacturing). However these tools are very domain specific and provide limited or no support for information management. Information management therefore lies primarily on the designers, which often results in reduced productivity (when designers lose some of their time doing information management) or loss of valuable information (when little information is captured and organised).

3.17 Two Paradigms for Describing Design Activity

Over the years, many systems for describing design processes have been developed. Problem solving theories introduced by Simon[32] (1992) provided a framework in the scope of design studies by allowing the study of designers and design problems within the paradigm of technical rationality. Simon also provided a sound, rigorous basis for much of the existing knowledge in design methodology. This paradigm, in which design is seen as a rational problem solving process, has been the dominant influence shaping prescriptive and descriptive design methodology ever since.

A radically different paradigm was proposed by Schon (1983), describing design as a process of reflection-in-action. This theory can be seen as a reaction to the problem solving approach, specifically made to address some of the blind spots and shortcomings Schon perceived in mainstream methodology. The two paradigms for design methodology represent two fundamentally different ways of looking at the world, positivism and constructionism.

3.17.1 Design as a Rational Problem Solving Process

Seeing design as the rational problem solving process means staying within the logic-positivistic framework of science, taking 'classical sciences' like physics as the model for a

[32] Simon, H.A. (1992) "*Artificial Intelligence*", vol. 4, 181-200

science of design. There is much stress on the rigour of the analysis of design processes, 'objective' observation and direct generalisability of the findings. Logical analysis and contemplation of design are the main ways of producing knowledge about the design process. Simon quotes optimisation theory as a prime example of what he believes a science of design could and should be.

The problem solving approach means looking at design as a search process, in which the scope of the steps taken towards a solution is limited by the information processing capacity of the acting subject. The view of design as a rational problem solving process has helped to give a much needed stable analysis to design methodology, and has informed much of our knowledge about design today.

3.17.2 Design as a Process of Reflection in Action

In *The Reflective Practitioner*, Schon has developed what he calls a 'primer' for a 'new theory of design'. He argues that the prevailing positivist paradigm is hampering the training of practitioners in the professions. He sees the training programmes as being defined in terms of generalities about the design problems and design processes, without any attention to the crucial and difficult problems of the linking of these two in a concrete instance. Any design problem is unique, a 'universe of one', and a core skill of designers lies in determining how every single problem should be tackled. This has always been left to the 'professional knowledge' of experienced designers, and not considered describable or generalisable in any meaningful way.

Schon calls this the essence, 'the artistry' of design practice. Thus he finds it unacceptable that these problems cannot be described in the prevalent analytical framework, and that their solving therefore cannot really be taught in the professional schools. To describe the tackling of fundamentally unique problems, Schon proposes an alternative epistemology of practice, based on a constructionist view of human perception and thought processes. He sees design as a 'reflective conversation with the situation'. Problems are actively set or 'framed' by designers, who take actions (make 'moves') improving the current situation.

Table 3.4: The rational problem solving paradigm and the reflection-in-action paradigm summarised

Item	'Simon'	'Schon'
designer	information processor (in an Objective reality)	person constructing his/her reality
design problem	ill defined, unstructured	Essentially unique
design process	a rational search process	a reflective conversation
design knowledge	knowledge of design procedures and 'scientific' laws	the artistry of design: when to apply which procedure/piece of knowledge
Example/model	optimisation theory, the natural sciences	art/the social sciences

Dorst and Dijkhuis (1996)

3.17.3 Teamwork and social processes in design

Most of what is know about design activity and the design process comes from studies of individual designers (Cross 1992). Teamwork in design has been studied relatively little. However teamwork is of considerable importance in normal professional design activity and is becoming of even greater importance in product design as it becomes a more integrated activity. There has been a growing number of studies of teamwork, particularly in the context of CSCW – computer supported co-operative work.

Working as a member of a team introduces different problems and possibilities for the designer, in comparison with working alone. Perhaps this particular group of designers (Kerry, Ivan & John) worked productively as a team and reached a relatively successful conclusion to the set task, within the prescribed task. They reported that they are reasonably happy with what they had achieved in the available time. Despite some of the observations made about the roles, relationships and social interactions within the team, there were no overt signs of frustration or dissatisfaction within individual members of the team.

However, it is clear that teamwork is a social process, and therefore social interactions, roles and relationships cannot be ignored in the analysis of design activity performed by teams. Many aspects of team design activity are influenced by social process factors and these are relevant to the analysis of design activity, and important to the design methodology of teamwork.

Design methodology, particularly in the engineering domain, has tended to treat the design process as a technical process – as a sequence of activities based on a rationalised approach to a purely technical problem. More recently, and more particularly in the architecture, product design and software design domains, attention has also been directed to designing as a cognitive process to the cognitive skills and limitations of the individual designer. Design methodology is now addressing the design process as an integration of all three of these – the technical process, the cognitive process and the social process.

3.17.4 Collaboration in Design Teams

Modern interdisciplinary design demands that designers learn to work well in teams. Teamwork requires individuals to express ideas and misgivings, listen, negotiate, etc., that is to collaborate. Designers need to be aware of various characteristics of collaboration so that they can identify successful and poor strategies within their own work of practice.

The content of an evolving design depends heavily upon negotiation strategies and other more subtle and ubiquitous social processes that shape design work. Design emerges through social interactions. Team members' orientation to a solution or process is demonstrated by levels of commitment in utterances and gestures. Depending on their level of commitment and other team members' alignment they adopt appropriate strategies of persuasion. They carefully moderate their commitment to their ideas to remain amenable to negotiation. They appeal to common sense, design theories, standard practices, expert practices, user preference and demonstrations with physical hardware in order to persuade.

Many solution proposals and interpretations of requirements can clearly arise from designers' interacting with available hardware. They also emerge as part of the ongoing activity.

Design usually progresses as the group focuses and transitions from topic to topic. Still there is evidence that team members are continuously engaged in monitoring multiple issues at multiple levels of attention. Transitions occur when

- team members seek to shift the debate to another topic
- team members seek to change the process
- prompted by related topics
- topics lose steam
- processes lose steam
- team members stop to seek information.

Collaboration is only successful when a group is well balanced in their roles and manages their negotiation well. Watching, discussing and reflecting upon videotapes of a group of designers working together can provide a means for design students and designers alike to become aware of the variety of productive and counterproductive strategies and processes available to them. With this awareness it becomes easier to identify when oneself or members of one's team are following counterproductive strategies and to gain a fuller appreciation of the strategies that work well in design.

3.18 Can concurrent verbalisation reveal design cognition

The theory behind classical protocol analysis (Ericsson & Simon 1993) is that by asking a person simultaneously to perform a certain task and to 'think' aloud one can gain direct access to the person's thought and hence the patterns and sequences of the thought required for the task. It is not clear how a disability such as dyslexia, primarily a disorder of language, would affect an analysis dependent on language ability. The example may be atypical but suffices to highlight the problem of using concurrent verbal reports as a means of obtaining cognitive information. If aphasia could be considered as a filter between thought and speech, then one might hypothesise that such a filter, to a greater or lesser extent, exists in everyone. That is to say, thought is always mediated, and sometimes offset, by channels of communication formed by constitution and experience. A central problem for protocol analysis as a research tool is to determine just how much these channels of communication affect the thought preceding the communication.

Designing is a way of thinking incorporating many separate modes of thought in much the same way as talking is a way of thinking incorporating many modes of thought. Sometimes a mode of 'design' thinking and a mode of 'talking' thinking may be concomitant, in which case one may elicit designing behaviour using concurrent verbalisation. At other times, though, 'design' thinking and 'talking' thinking may be unrelated to one another, in which case prompting a subject to 'think aloud' will result in verbalisation that is not a reflection of designing behaviour and additionally the verbalisation will affect the task.

3.18.1 The elicitation of design thinking

Concurrent verbalisation seems in some way to be attempting to elicit fragments of propositional knowledge, which may, in actual fact, not exist. It is a common notion amongst designers (and artists) that if they could say what they are attempting to do they wouldn't have to design/ draw/ compose it. An interview with Richard MacCormac, a well-known British architect whose recent projects include the Wellcome Wing at the Science Museum, the award winning Ruskin Library at Lancaster University and Southwark Underground Station, one of the acclaimed new stations on the Jubilee Line Extension, touched on the problem of talking while designing:

> *Architecture is a medium of thought which is very powerful and that in the same way, as say, mathematics and music are media of thinking, we have our medium of thinking and the difficulty with it of course is, like music, that is a medium that's extremely difficult to talk about.*

What does concurrent verbalisation actually represent if not design activity? What aspects of design thinking that are not effectively revealed by concurrent verbalisation? These types of thinking fall into two categories: (1) whether words 'thought aloud' are an adequate representation of thought, and (2) whether an experimental design situation actually affects the design thinking it seeks to analyse.

The problem of what words and language actually represent is a problem that occupies a central position in the twentieth century philosophy, the interaction between knowledge and language being a central question within this problem. One has to be therefore cautious about

accepting a direct link between words and thoughts in a commentary provided by concurrent verbalisation during designing.

The standard text of protocol analysis (Ericsson and Simon 1993) summarises its application by saying that there are strict limits for reports on thought processes. Concurrent verbal reports, however, do seem a fair reflection of a certain type of thought – thought appearing in short term memory. It thus seems valid to use protocol analysis to elicit short term thought processes. Design, though, is a task that involves many other types of thinking, and it is these other mechanisms that are not amenable to concurrent verbalisation. As an example the interview with the architect Richard MacCormac revealed how using different drawing instruments mediates different ways of thinking: *'There are different frames of mind which involve different instruments actually producing and representing what you are doing.'*

It is these 'frames of mind' which concurrent verbalisation does not adequately convey. An extremely persuasive view in psychology and creativity literature is that creative process consists of two distinct modes of thinking. This view is indeed supported by neurological evidence suggesting that the left and the right hemispheres of the brain provide different aspects of human thought. The left is concerned with temporal activities including verbal memory and speech articulation; the right is concerned with perceptual and spatial activity.

Such a theory might suggest that activities in design such as sketching and understanding a brief would be difficult to verbalise. The constraint of time within a design process is an important factor. Too much time and a designer has the chance to change their mind over and over again. Too little time and mistakes are made and ill-considered solutions are thrown together. In a description of a 'normal' design process one would expect a design brief to arrive some time before a designer might begin to work on that brief. Client and designer together would like to think that they are getting the best possible solution for a particular problem. In achieving this end there must be a period where a designer weighs up alternatives, critiques their solution, or just simply leaves the problem for a few days.

The time when a designer sits down and focuses on a design task takes place some time after they have received a brief. There is still much valuable information to be gained at such a point, initial thoughts still need to be worked out. A far more accurate experimental methodology would be one that didn't force the designer into working any faster that they felt

happy doing. A misconception that remain implicit in using protocol analysis in design is what is termed as 'the unitary notion of design', that is the idea that designing is one 'thing'. The premise of protocol analysis is that by putting a designer into a laboratory and asking them to design while thinking aloud we are able to capture much information about this 'thing'. Design is not a unitary thing, the time to put a designer into a laboratory is when an aspect of design can be isolated and studied either separately or in context.

Allied with the view of design as a unitary 'thing' is the idea that every designer must be following a valid design process and that the study of any designer, no matter how inexperienced, must tell something about designing. Clearly the incarnations of design vary considerably and this seems to imply that perhaps better questions to ask are what it is that distinguishes a good designer from a bad one, a novice from an expert, an architect from an engineer. The final point is if we cannot use protocol analysis to elicit the design thinking of people who are dyslexic, then we must use other methods of analysis.

3.19 Research on methodology / intuition

My general perception is that people working on a team are more likely to follow a methodology, a procedural path often based on previous experience whereas solo worker may or may not use a method. I believe that Goldschmidt's conclusion is more valid on a project which is based on intuition. In her experiment she is not taking into account a method. Most technological projects these days will have one or more prescribed method of approach and it would be interesting to repeat this experiment within this kind of environment.

3.19.1 Design Methodology

Design methodology is the study of the principles, practices and procedures of design in a rather broad and general sense. Its central concern is with how designing both is and might be conducted. This concern therefore includes the study of how designers work and think; the establishment of appropriate structures for the design process; the development and application of new design methods, techniques, and procedures; and reflection on the nature and extent of design knowledge and its application to design problems.

3.19.2 The History of Design Methodology

From the early 1960s to the early 1980s, the study of design methodology was pursued by a loosely connected international network of scholars and researchers such as Christopher Alexander and Bruce Archer leading methodologists representing what has often been regarded as the 'design methods movement'. As well as making their own contributions to the development of design methodology, some members of this movement have also commented from time to time on the progress of the 'movement' in general, and on their own changing attitudes towards design methods.

Christopher Alexander, a powerful and original stimulus to the initial emergence of 'the design methods movement' had apparently become totally disillusioned with design methods and especially design methodology by the time he did an interview with the DMG newsletter (Design Methods Group) in 1971. He felt that the development and study of design methods has failed to contribute to better design.

Alexander claims that his original motive for getting involved with design methods was because he wanted to design beautiful buildings- buildings as good as traditional, vernacular architecture. Influenced also by his background in mathematics, he wanted to be able to describe a logical, step-by-step process for design because that will ensure that he really knew what he was doing: 'the definition of a process, or a method, was just a way of being precise, a way of being sure I wasn't just waffling'. In applying his early work , however, he found that he was able to go fairly directly to his schematic design diagrams without the exhaustive prior analysis of problem requirements. This realisation has led him into his work on 'patterns'. In that interview with the DMG newsletter in 1971, Alexander is frequently scathing in his remarks on design methods and methodology, suggesting that the methods had become irrelevant to real design and that the study of methodology had become a pointless preoccupation and excuse for people with a fear of engaging in real design activity.

A year later, Horst Rittel, another leading figure in the design methods movement, which was kept alive by conferences and small publications accepts that much of the early design methods work seems to have been fruitless, and proposes a concept of 'generations' of design methods. According to Rittel, the first-generation methods were based on the wrong premises to be really useful in design. They had been drawn from the systems engineering

techniques of military space missions, and therefore were not wholly adequate to the problems of planning and design. Rittel proposes a number of principles for second-generation methods. Perhaps the most important of these is that the design process is based on an 'argumentative' structure, and that expertise and relevant knowledge are assumed to be distributed amongst a wide range of participants. Thus second-generation methods are intended especially for a more participatory approach, in which the role of the designer 'is that of a midwife or teacher rather than the role of one who plans for others'.

This new emphasis was a reflection of the extensive moves towards opening up the processes of planning and design so as to include the participation of lay people. Both Rittel and Alexander suggest greater participation in design as a key reason for their changed perspectives on design methods.

Another leading figure in the design methods movement was J. Christopher Jones, he also rejected much of the early work in design methods, but seemed prepared to go much further in a search for new approaches not only to planning and designing but also to living in general. He argued that a new flexibility is wanted in designing as in living. In the search for this flexibility, Jones turned to the arts and particularly to works (such as those of the musician John Cage) which relied on chance or random processes for their composition. Jones began composing essays (about design, planning, technology and life) which incorporated several sources in a randomised format. What emerged was a continuing concern with trying to resolve the apparent conflicts between rationality and intuition, logic and imagination, order and chance. Jones reacted strongly against the direction he perceived the design methods movement taking in the early 1970s, against 'the machine language, the behaviourism, the continual attempt to fix the whole of life into a logical framework'. His contribution to the movement has been difficult for many to accept; after all chance, or accident, are usually regarded as the antithesis of design. However the use of randomisation procedures is simply a technique which embodies a rational decision to let chance play a major role in the process of composition. By the end of the 1970s it was time for someone to suggest the need for a third generation.

In his paper on 'The development of design methods'[33] Geoffrey Broadbent chronicled the rise and fall of both first- and second-generation design methods, and went on to propose the new premises. He suggested that the role of the designer is to make expert design conjectures, but that these must be open to refutation and rejection by the people for whom they were made. This suggestion was meant to draw upon, and to synthesise, the better aspects of both first- and second-generation methods. By the end of the 1970s it became clear that design methodology had passed through its crisis of confidence.

Bruce Archer's question, 'Whatever became of design methodology?'[34] was largely rhetorical. For him too, the interest in design methods had been to create better designs, however he took a very positive attitude towards the current state of the art. He believes 'that there exists a designerly way of thinking and communicating that is both different from scientific and scholarly ways of thinking and communicating, and as powerful as scientific and scholarly methods of enquiry when applied to its own kinds of problems'.
So for Archer, what was wrong with some of the mathematical and logical design methods is that they are 'the product of an alien mode of reasoning'. Designerly way of thinking are quite different but quite appropriate to the kinds of ill-defined problems designers tackle. Archer claimed that ill-defined, untamed problems are real problems of everyday life, and so the methods for tackling these problems are deeply rooted in human nature. This means that design methodology must be based on the study of fundamental, innate human capabilities, that design methods must not try to ape the methods of the sciences or the humanities but must be based on the ways of thinking and acting that are natural to design. It is from this viewpoint that design methodology can be seen to have a valid role to play in the development of design research, design education and design practice.

3.19.3 The Nature of Design Activity

Research in design methodology has been the investigation of what it is that designers actually do when they are designing. In general, the intention has been to try to develop an objective understanding of how designers design, which might then in turn lead to the development of

[33] Broadbent, G. (1979). 'The Development of Design Methods', Design Methods & Theories, 13:1, 41-45
[34] Archer, B. (1979). 'Whatever Became of Design Methodology?', *Design Studies*, 1:1, 17–18

improved design procedures. There are obvious limitations to studying what goes on inside someone's head, and researchers have to construct inferences from the behaviour and the reported thoughts and mental operations of their subjects.

The simplest way of studying designers' behaviour is to ask them to recall what they did when they are designing. Whilst this lacks the controlled experimental precision of the laboratory observations, it does produce very rich data which carry the intrinsic interest of reflections on real-world designing. Darke[35], in her paper on 'The primary generator and the design process', went further and suggested that it is undesirable to confine the analysis of human behaviour to strictly 'scientific' methods. Her own research was based on interviews with architects who had designed various housing schemes. She noted that there are severe problems with this approach too as her respondents might have faulty memories, might post-rationalise on their activities, and almost certainly would have difficulties in describing non-verbal design processes in words. Darke's starting point was a dissatisfaction with the early systematic design procedures which presumed an objective analysis-synthesis approach to designing. She used the evidence from her interviews to support an alternative approach of 'conjecture-analysis' and to suggest that , in addition, designers rely firstly on the formulation of a 'primary generator'. Very early in the design process the designer imposes or identifies a particular generating concept or limited set of objectives. 'These objectives form a starting point for the architect, a way in to the problem; he did not start by listing all the constraints.' This primary generator helped the designer (to make the 'creative leap'?) across the 'rationality gap' between the problem information and a solution concept.

The use of a primary generator was characteristic of all the architects Darke interviewed. She concluded that this is a necessary feature of the design process, because designers 'have to find a way of reducing the variety of potential solutions to the as yet imperfectly understood problem, to a small class of solution that is cognitively manageable'. The solution class was further narrowed by proposing one particular solution concept (the 'conjecture') which was then tested against the requirements and constraints of the problem, thus contributing to a fuller understanding, or analysis of the problem. Darke therefore

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[35] Darke Jane, (1979) "The Primary Generator & the Design Process",: *Design Studies*1 (1), 36-44

concluded that 'the analysis-synthesis model would seem to be refuted as a method which can readily be used in practice'.

A more objective method of studying problem-solving behaviour is protocol analysis. It was the method used to study design behaviour by Akin in his 'An exploration of the design process'[4]. His purpose was to study 'intuitive design' i.e. the natural behaviour of human designers which he distinguishes from the more systematic procedures of 'design methods' and the computer aided techniques of 'machine design'. He suggested that a better understanding of intuitive design will not only enable appropriate design methods and machine design procedures to be formulated but also could inform normal design practice and improve design education.

The main goal of Akin's[36] research was to 'disaggregate' the design process, i.e. to break it down into its component parts, and he chose protocol analysis as the most appropriate technique for this. Protocol studies rely on the subject reporting aloud what he or she is thinking or doing whilst tackling the given experimental task.

Akin's empirical study of the design process involved setting up quasi-laboratory conditions for recording the behaviour and the spoken thoughts of a designer performing a design task. On completion of the task the designer's behaviour is analysed by the experimenter and transformed into formalised statements of recurring behaviour patterns (Plans or Schemata) in terms used by Akin. From his analysis Akin identified a hierarchy of design strategies, beginning with 'setting-up' the design context and then searching for sub-solutions. Akin likes the designer's general solution search strategy to 'hill-climbing', i.e. the designer starts more or less at any point in the solution space and then tries to move from there towards a more local optimum by pursuing a sequence of small improvements.

Akin concluded that some long-held views of the design process do not reflect normal design behaviour. Like Darke, he suggested that the systematic procedure of analysis-synthesis evaluation seems inappropriate: 'One of the unique aspects of design behaviour is the constant generation of new task goals and redefinition of task constraints. Hence 'analysis' is a part of virtually all phases of design. Similarly 'synthesis', or solution development, occurs as early as

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[36] Akin Omer., (1979) "An Exploration of the Design Process," *Design Methods & Theories*, 13:3, 115-119

in the first page of the protocol. Akin suggested that normal design behaviour is to start with a broad, top down approach to the task, and that designers realistically attempt to 'satisfice' rather than to optimise solutions.

Akin's view is that the development of design methods must be based on a recognition of designers' normal ways of working if these methods are to integrate successfully. A more controlled experimental approach to studying designers' problem-solving behaviour was taken by Lawson in his investigation of 'Cognitive strategies in architectural design'[37]. In his main experiments Lawson compared the performances of fifth-year architectural students and fifth-year science students with the coloured blocks. The task was based on selecting and arranging coloured blocks of different shapes so as to try to maximise the amount of one certain colour showing around the outside faces, with an undisclosed rule requiring certain blocks to be present.

Lawson identified two types of error which would prevent a subject achieving the maximum possible score: planning errors in which there was simply a non-optimal arrangement of the blocks, and structural errors, in which there was an assumption of a more constraining rule than actually did apply. The architects made fewer planning errors but more structural errors than the scientists. The more interesting aspect of Lawson's results is in the analysis of the differences in problem-solving strategies between the two groups.
He discovered that in general the scientists were selecting blocks in procedures which were aimed at uncovering the problem structure (i.e. the hidden rule), whereas the architects' procedures were aimed at generating a sequence of high-scoring solution attempts until one proved acceptable. Lawson calls these two different problem-solving strategies 'problem-focused' (scientists) and 'solution-focused' (architects). Designers problem-solve by methods of synthesis, whereas scientists problem-solve by methods of analysis.

Several different experimental and observational methods of studying designer behaviour are reported by Thomas and Carroll in their paper, ' The psychological study of design'. They used a variety of methods to study designing, ranging from reflections on their own experiences to observations of others.

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[37] Lawson, B. (1983). How designers think. London: Butterworth Architecture

They view the design process as a 'dialectic interaction between the information in the client's head and that in the designer's head'.

What distinguishes the designer's contribution is his knowledge about the relationships between partial goals and partial solutions. However they also found from software design studies, radically different designs being proposed by different designers who were making different goal assumptions. Thomas and Carroll[37] concluded from their wide range of studies that designing is a generalisable form of problem-solving which can be applied in a wide variety of contexts, which was one of the original assumptions underlying design methodology. It seems clear that architects have a 'solution-focused' approach to design and that they begin to generate solution concepts very early in the design process. An ill-defined problem is never going to be completely understood without relating it to a potential solution. Another conclusion is that most systematic procedures are ill-matched to the conventional design process. Systematic procedures tend to assume or require an extensive phase of problem analysis, which seems an unrealistic approach to ill-defined problems. Darke, Akin, and Lawson all criticise the systematic analysis-synthesis procedure, in the light of their observations of how designers design. However, it would be tautological simply to argue that conventional designing is unlike systematic designing; the systematic procedures were developed specifically to be a change from conventional design practices, which were seen to be inadequate for the complexity of the tasks facing modern designers. Criticism of systematic procedures, therefore should not be taken as arguments justifying the conventional behaviour of designers.

3.20 Comparing paradigms for describing design activity

There are many ways of describing design processes. Based on a unique choice of assumptions and goals, every researcher will have attacked the design process in his or her own way. However the following discussion will looked at two basic and fundamentally different ways of approaching the design process.

[37] Thomas & Carroll., (1979) "The Psychological Study of Design,"1 (1), p5-11

3.20.1 Two paradigms for describing design activity

Over the years, many systems for describing design processes have been developed. The 'first generation' methods of design methodology in the early 1960s were heavily influenced by the theories of technical systems. The positivist background of these theories made for design being seen as a rational or rationalisable process. Criticism of these models raised interest in the fundamentals of design theory, the logical form and status of design. It also fostered a need for more detailed descriptions of the design activity, leading to more attention for designers and design problems, rather than just for the design process. Problem solving theories introduced by Simon (*The sciences of the artificial*, 1992) provided a framework for this extension in the scope of design studies by allowing the study of designers and design problems within the paradigm of technical rationality. Simon also provided a sound, rigorous basis for much of the existing knowledge in design methodology. This paradigm, in which design is seen as a rational problem solving process, has been the dominant influence shaping prescriptive and descriptive design methodology ever since. Most of the work done in design methodology today still follows the assumptions , view of science and goals of this school of thought.

A radically different paradigm was only proposed some years later, by Schon (the reflective practitioner 1983), describing design as a process of reflection-in-action. This constructionist theory can be seen as a reaction to the problem solving approach, specifically made to address some of the blind spots and shortcomings Schon perceived in mainstream methodology. The two paradigms for design methodology represent two fundamentally different ways of looking at the world, positivism and constructionism. These two ways have been with us literally since Plato disagreed with Aristotle.

3.20.2 Design as rational problem solving process

Seeing design as a rational problem solving process means staying within the logic-positivistic framework of science, taking 'classical sciences' like physics as the model for a science of design. There is much stress on the rigour of the analysis of design processes, 'objective' observation and direct generalisability of the findings. Logical analysis and contemplation of design are the main ways of producing knowledge about the design process. Simon quotes optimisation theory as a prime example of what he believe as science of design could and

should be. The problem solving approach means looking at design as a search process, in which the scope of the steps taken towards a solution is limited by the information processing capacity of the acting subject. The problem definition is supposed to be stable and defines the 'solution space' that has to be surveyed. The view of design as a rational problem solving process has helped to give a much-needed stable basis to design methodology, and has informed much of our knowledge about design today.

3.20.3 Design as a process of reflection in action

In the reflective practitioner, Schon has developed what he calls a 'primer' for a 'new theory of design'. He argued that the prevailing positivist paradigm is hampering the training of practitioners in the professions. He sees the training programmes as being defined in terms of generalities about the design problems and design processes, without any attention to the crucial and difficult problems of the linking of these two in a concrete instance. Any design problem is unique, a 'universe of one', and a core skill of designers lies in determining how every single problem should be tackled. This has been left to the 'professional knowledge' of experienced designers, and not considered describable or generalisable in any meaningful way. Schon calls this the essence, 'the artistry' of design practice. Thus he finds it unacceptable that these problems cannot be described in the prevalent analytical framework, and that their solving therefore cannot really be taught in the professional schools. To describe the tackling of fundamentally unique problems, Schon proposed an alternative epistemology of practice, based on a constructionist view of human perception and thought-processes. He sees design as a 'reflective conversation with the situation'. Problems are actively set or 'framed' by designers, who take action (make 'moves') improving the (perceived) current situation. (Refer to Table 3.4)

Until now design methodology has failed to take into account the situational aspect of design. But if the academic field of design methodology wants to influence design practice and education, it should address the problems designers have, and do that in a way that designers recognise (experience them).A more fundamental reason for dwelling on the designer's experience of design situations is that the multi-step process of designing is 'controlled' by the designer's decisions. These decisions are based on the perceptions of the designer at work in his or her situation. This makes the understanding of (at least this perceptual aspect of) the design

experience a prerequisite for any real understanding of the design activity itself. But what kinds of things do designers experience whilst in the design situation?
A situation is defined by the subjects' perception of the current state, goals and possibilities for action.

As a designer one is in a situation in which one is continually faced with the very concrete challenge of one's perceived design problem, and you have to decide on the kind and content of the action to take in this situation. 'What does this situation mean?' and 'What action can or should I take in this situation?' are eternally recurring questions. In most cases, considerations, linked to the content of the design situation (the perceived design problem, the designer's goals and the perceived possibilities for the next step) will determine the 'kind of action' (process-component).

Designers also make process-driven decisions, in particular when they are making a planning or checking their progress. But this requires them to 'step out of their design situation'. These 'jumps' into a wholly different way of thinking can easily be seen in any protocol of a designer at work. The conclusion must be that these process-driven decisions – the object of much current design methodology are not really part of the core design activity itself.

3.20.4 The limits of design methodology

In studying design as a process, one is looking at the process component of largely content-based decisions. This severely limits the power of a process-oriented methodology to understand what is going on in the design activity, and to help designers that are trying to work their way through the design situation towards a solution. Because of this process-focus very little knowledge and hardly any theory has been built up about the kinds and content of design problems, or the kinds of goals designers have (such as coherence and integration). One is strongly convinced that in order to get a deeper understanding of the design activity, design methodology should now start to address at least some more aspects of the design situation.

3.20.5 Descriptive value of seeing design as a process of rational problem solving

The 'topics' category, combined with the acts and goals, give some idea of the reasons for the different steps and the eventual course of the design process. But this way of looking at the

design process has no way of dealing with the logical links of the one to the other. Links can be reconstructed, but textual analysis remains necessary to forge them solidly. The paradigm of rational problem solving does not provide a basis for the study of design problems and their structures, and is very much focused on the process component of design decisions. That limits the understanding one can get from analyses like these of the design situation. The lack of theory on design problems makes this way of looking at the protocols little more a 'bookkeeping' of the design process. The rational problem solving paradigm does not provide us with some detailed theory on what would be a 'good' or 'healthy' design process.

3.20.6 Descriptive value of seeing design as a process of reflection in action

Although the link this paradigm provides between design process and the content of the design problem is valuable, however the treatment of design as a reflective conversation lacks the clarity and rigour achieved by the rational problem solving paradigm. This paradigms gets us closer to describing design as experienced than looking at design as rational problem process does. The process-content link in design decisions is preserved, and so is the perception of the design problem.

The weakness of the underlying theory makes it very hard to draw any general conclusions from the description of design. For example, because there is no theory on the structure of design problems, there is no basis for judging the appropriateness of a certain frame. This limits the usefulness of this theory of design as reflection in action to providing a very structured way of making case-studies (for the time being that is). Describing design as a rational problem solving process is particularly apt in situations where the problem is fairly clear-cut, and the designer has strategies that he or she can follow while solving them. Describing design as a process of reflection in action works particularly well in the conceptual stage of the design process, where the designer has no standard strategies to follow and is proposing and trying out problem-solution structures. Seeing design as reflection-in-action manages to describe the design activity without totally severing the close link between the content and process components of design decisions. Taking the action (move) as the 'unit for studying design' also gets us much closer to the activity of design as experienced by designers. This would put a very extended and systematised version of Schon's theory in a very good

position for possible application in design practice and education. The theoretical base of this theory should be developed further (e.g. through building a taxonomy of design problems, and of frames) so that more rigorous and generalisable conclusions can be drawn from this. There is no theoretical reason why this could not be done, and it has to some extent already been done by some builders of expert systems.

3.21 The reflective practice of design teams

For team designing to be effective we rely on team members to support each other in answering questions that arise and in picking lines of thought from each other to build on. This should give an added value compared to individual designing, where the designer creates his/her own private understanding of the design problem and the design solution. However by introducing several designers we also introduce the difficulties of team designing. These lie in synchronising the thoughts and activities of the team members. Judging from team observations this can cause substantial problems for team members in interactions and conversations (Valkenburg 1998)[39] and lead to misunderstanding and uncoordinated actions. Schon has constructed a theory in which the role of the designers, the design task and the design process are integrated. Schon's theory has already proved itself as a useful approach to describing individual design activities but its properties in describing team designing have never been explored.

3.21.1 Schon's paradigm of reflective practice

In his work Schon criticises technical rationality, the paradigm that is the basis of basis of mainstream design methodology, arguing that design methodologists that work within this paradigm restrict themselves to terms of generalities about design processes. In Schon's opinion, too little attention is paid to the structure of design tasks and the crucial problem of linking process and task in a concrete design situation. To him every design task is unique, a 'universe of one'. Therefore, one of the basic problems for designers is to determine how each single task should be approached. This problem has always been relegated to the 'professional

[39] Valkenburg A.C., (1998) "*Shared Understanding as a condition for team design*", The Journal of Automation & Construction, 7:2/3, 111-121

knowledge' of experienced designers, and was not considered describable or generalisable in any meaningful way. However, this does not satisfy Schon; he calls his tackling of unique design tasks the essence, the artistry of design practice. He finds fault with the prevalent analytical framework for failing to describe these activities, and regrets that the solving of unique design problems therefore cannot be taught in the professional schools.

To describe the undertaking of fundamentally unique tasks, Schon proposes an alternative view of design practice based on the idea that 'a kind of knowing is inherent in intelligent action' (Schon 1983). This action-oriented, often implicit knowledge cannot be described within the prevalent methodological paradigm of technical rationality. But Schon insists that this kind of knowledge is vital for action-oriented professions like design. He does recognise however that this implicit 'knowing-in-action' is difficult to describe and convey to students. What can be thought about and taught is the explicit reflection that guides the development of one's knowing-in-action habits. This he calls reflection-in-action.
Schon's theory is based on a constructionist view of human perception and thought processes; through the execution of 'move-testing experiments' (involving action and reflection), a designer is actively constructing a view of the world based on his/her experiences. In this paradigm, the basic elements of design activities are actions, and the kernel of the design ability is to make intelligent decisions about those actions. The results of these experimental actions are scrutinised by the designer, who reacts to this new state of his/her own making. The final design is a result of this interaction. In this 'reflective conversation with the situation', designers work by naming the relevant factors in the situation, framing a problem in a certain way, making moves towards a solution and evaluating these moves.

3.21.2 'Reflective practice' as an observation method

Although Schon never intended it as such, he describes design as being controlled locally, without dealing with higher level strategies, the description of team designing in episodes and categorising them into different activities provides a good insight of the team design on a project level. Identifying the teams episodes and activities is however easier if the team itself works in a structured way. Obviously, when describing design practice, researchers rely more or less on the structure in the ways of working of their research objects. In describing the

activities the researcher has to make a decision about the level of detail he/she wants to obtain. Dividing protocol into episodes in which the same activity occurs provides a good framework for discussion on team designing. In education it can be very useful to either illustrate design professionals-in-action or to confront design teams with their own practice. As a research method, describing design-teams-in-action with Schon's reflective practice is useful and clarifying, because the description provides a good survey of the course of the project. Going from this 'global' description we can start analysing the different activities in more detail, analysing the teams' behaviour.

3.22 Use of Episodic Knowledge and Information in Design Problem Solving

Problem solving based on 'reuse' of problem-solving elements, i.e. particular solutions to particular problems, rather than the reuse of general problem solving knowledge is considered to play an important role in design (cf. Case-Based Reasoning). This often made statement is generally based on introspection by authors who are design methodologists, A.I. researchers or designers themselves. The conclusion is that designers may have good reasons to proceed to design reuse but a question which may be asked, however, is: do designers indeed proceed to reuse and, if they do, why, and how do they proceed?

Knowledge, i.e. data collected, processed and/or elaborated in the past, and integrated into memory, always plays an important role in problem solving. The knowledge used in problem solving which has been studied most is abstract knowledge (problem solving schemas or rules) referring to types, or categories, of problems and solutions. Recently, researchers have started to discover the importance of problem solving reuse: the use of 'episodic', i.e. particular, experience-linked sources which are at the same abstraction level as the target problem, rather than general knowledge structures at a more abstract level.

The use of other problem-solving linked data but not its absolute contribution to the solution process. And if the use of episodic data indeed plays an important role in design problem solving, do designers need support in this use? One may suppose that the difficulties involved are similar to those problem-solving elements reuse, but they are perhaps greater, or more complex, because of the 'private' character of episodic data. Educators worry about the difficulty of providing students with 'reference information': how can they manage to

familiarise beginning designers with the enormous richness of experience in their field? Even if they possess 'libraries of past designs', these are not documented with respect to important questions for novices in a domain, such as solution procedures and alternatives which have been taken into consideration, and choices made and their underlying justifications.
The present state of knowledge on use of episodic data, design-reuse assistance specification remains a difficult question. The main way to advance on this point is to analyse empirical data collected on actual reuse activities, in experimental contexts, but definitely also in real, professional work situations.

3.23 Cognition and Design

A growing awareness has developed among design researchers of the potential significance of the relationship between design, cognition and computational modelling. Cognitive studies and computational modelling are among important ingredients of what is becoming a dominant paradigm in the research, modelling and understanding of mental processes in design. Design is considered to be one of the most significant of intelligent behaviours in humans. As such, it has a strong affinity to the field of cognition. Cognition is the study of human intelligence in all its forms, among them perception, action, vision, language, memory and reasoning. These cognitive processes are essential to all human intelligent activities. Among the classical subjects in human cognitive studies have been the communication of ideas and thoughts; visual perception which guides us, provides much of our knowledge about the world; visual metaphors; and of course thought which is itself among the most complex and distinctive of intelligent human capabilities. Thought is construed to involve mental representations and the manipulation of those representations in the accomplishment of goals. Thus thought is the diverse phenomena which involves multiple subjects such as concepts, reasoning, memory and problem solving.

In order to understand human intelligence and to endow machines and tools with similar capabilities, researchers in this field are exploring the mechanisms and structures which appear to underlie intelligent processes. If we wish to understand the nature of mind, and ultimately the nature of design thinking, we must expand our knowledge of human

cognitive processes. Cognitive processes in design are directly dependent upon various mechanisms such as those which constitute human vision and perception; on thought processes and how they are supported in operating on concepts; and on to her human cognitive attributes such as: categorisation, concept formation, analogical thinking, experimental reasoning and memory.

3.23.1 Cognition and Computation

The field of cognition drew new impetus in the 1950s from theoretical innovations in linguistics (Chomsky), computer science and artificial intelligence (Newell and Simon, Minsky). Developments in these fields provided new insight into the structure of human cognition and new orientations for disciplines concerned with intelligence, both human and artificial. More recently, and as a result of the scientific reorientation provided by the growth of experimentation and knowledge in the cognitive sciences, design has emerged as an important area for cognitive studies, providing a unique body of phenomena such as visual reasoning and creativity. One of the results of the growth of research significance found in design cognition has been an increased development of computational models in artificial intelligence that are founded upon cognitive processes. The essence of the connection between cognition and computation and the potential research significance of this connection was already apparent in Simon and Newell's research of the 1950s. As we know today these developments have now contributed to what may be considered a new tradition of design research methodology (Gero).

3.23.2 Design cognition and computation

Due to the significant economic implications of design, it is now among the primary research fields in academic and industrial research. The comprehension and modelling of design and the developments of a new generation of intelligent tools now acquire a significant research effort. The new multidisciplinary model of design theory, cognitive science and computation is becoming a dominant model for a conception of the 'design discipline', for design research, and for the formation of research groups and institutes.

Conversely, this amalgamation is providing a new impetus to expand the list of relevant topics in design cognition. Cognition and computation are providing a new orientation

for design research, and design itself is contributing new research topics to scientists in cognitive science, artificial intelligence and computation. Empirical research in design psychology on behaviours in human designers is currently also providing foundation studies which are essential to computational design research. This new integration is now resulting in a dialogue among scientists working within diverse disciplines employing various theories and methodologies and starting from different assumptions. The various approaches are complementary and our research community should benefit from the establishment of this new research field of design cognition and computation.

4.0 Art and Design Education

During the past few decades there has been a gradually rising concern about education for art and design, and their role in society. Some see them both as central activities in human affairs – some as valueless; some regard them as academically based disciplines comparable with science – some as inexplicable puzzles; some see them as the only means of providing enlightenment and allowing young people to flourish; some just enjoy them as their contribution to trade, business and cultural exchange. Whatever the view it is clear that art and design are a fuller part of our everyday lives. Today many more pupils consider art, craft, design and technology as major components of their studies. But what is worth learning both about and through art and design, and what form should any related education take?

Should pupils and students be provided with skills or should the emphasis be placed upon allowing creative ability to grow? Should educational activities focus on the development of disciplinary skills and techniques or should it be more on a broadly based interdisciplinary exploration?

If Design Education is to become a viable component of the curriculum and form part of the process of education towards the preparation for a full engagement with culture and society, then such a body of knowledge and system of ideas must be subject to the same paradigms that exert an influence on the whole curriculum.

The input/output model in Design Education must be related to have a symbiotic relationship to, other essential components of a curriculum process.

In this perspective the social origins of the education system; theories of childhood and adolescence; models of curriculum and education; aesthetic theories of art, design, craft and technology; are inextricably interwoven with the repertoire of values, ideas, beliefs in a given culture and society. Attention must be drawn to the essential issue that a faulty and incomplete notion of "Design Education" will inevitably lead to a faulty and incomplete ideal of "design" in the curriculum.

4.1 Knowledge and research in art and design

The idea of research has tended to elicit two sorts of response from artists and designers. On the one end, it is perceived as the antithesis of art and design activity, something to do with questionnaires and statistics, test-tubes and laboratories, at one remove from the real world with which artists and designers seek to engage. On the other hand, it is argued, artists and designers have been doing research all along, dealing with issues of technology, materials, meaning and communication at a sophisticated level. Research is simply an integral part of all art and design activity. Although the latter has much to recommend itself, and I would argue constitutes a distinctive tradition of practical research, neither of these responses is entirely satisfactory. Indeed it could be suggested that the switch from the former to the latter is simply a pragmatic response to changes in the funding of higher education, an attempt to seek credit from existing practice, without wishing to change that practice in any way.

Recent trends in higher education in art and design have combined to make the question of research increasingly important. There is a growing recognition in art and design that in order to achieve parity of status with the more traditional academic disciplines, and, importantly, to attract sufficient funding to develop its potential , there will need to be a greater attentiveness to the needs of research. As Allison[40] (1994) predicts and was subsequently proved right:

> *Research activity, in terms of volume, quality and direction, will be a major issue in the funding of institutions, courses and programme areas. It would be a reasonable guess that quality 'league tables' of institutions will be devised and that both the allocation to 'leagues' and places in the 'leagues' will be related to institutional research profiles.*

However, as Allison also points out, the issue of funding follows from the ability of practitioners and academics within the fields of art and design to create an environment appropriate to the development of research, and not the other way around. And, of course,

[40] Allison B.(1994)"*Research in Art & Design in the United Kingdom,*"Higher Educational Review,26:2, 49-64

it is more than simply a question of ability: *'There must be an institutional, or pedagogical, or academic, or technical, or some reason for wanting to do* research. *Not just status, promotion and fund-raising.'* (Frayling 1993/4)[41]

4.2 Why research in art and design?

What becomes apparent is that it is characteristic of research in art and design that is motivated by the art and design practice. Whether it is research in industrial design or the fine art, the application of knowledge is often at the fore front of the research. To argue that research into art and design, and research through art and design, should remain institutionally separate from research for art and design is to cling to the Romantic view of the artist that has outlived its usefulness. The development of a research culture in art and design must clearly be a two-way process, leading both to a clearer understanding of art and design and to the development of art and design work. The current position of art and design within higher education, and the scope that exists for the development of art and design research offers an opportunity to foster an interesting range of connections between different disciplines, forms of knowledge and research traditions. The institutionalisation of the division between reflection in action, theory and practice, has always been dubious worth, and should be rejected in favour of a more interactive and interdisciplinary approach, which will be to the benefit of all.

If we were to accept that a well constructed, high-talented and motivated team is better than an individual, we also need to recognise that to find or build such a team is difficult. So in most cases, an individual is perhaps better because the difficulties of communication and interaction can be obstructive. However this individual must be a good 'all rounder' and this is why design education is crucial. If a student designer tends to be intuitive then formal design methodology add structure to his/her thoughts. On the other hand if he/she is more cognitive in his/her approach then formal design methods will help with situations where he/she is less experienced. If society is relying on individual designers, it is therefore important for us to establish what makes a good designer. Can judgement be a major factor?

[41] Frayling C., (1993/4)"Research into art & design," London *Research paper, 1:1* Royal College of Art

4.3 The designer's judgement

On 3 July 1988 a US missile cruiser shot down an Iranian civilian airliner killing 300 people. Later a US Navy was to explain this terrible event by claiming that the operator of the Aegis air defence system had misinterpreted incoming signals on his display and mistakenly identified the aircraft as hostile. The disaster was due to operator error. Ferguson (1992), however, asserts that 'it is a gross insult to the operators who have to deal with such a monstrous system to say, as the Navy did, that the Aegis system worked perfectly and that the tragedy was due to "operator error"'. Ferguson's explanation is different; he claims that the system itself was at fault because the designers had made a serious error of judgement in grossly underestimating the demands their designs placed on the operators. This is a calamitous design error due not to errors in mathematical analysis but to 'errors of engineering judgement, judgement that is not reducible to engineering science or to mathematics'. Ferguson went on to state the 'no matter how vigorously a "science" of design may be pushed, the successful design of real things in a contingent world will always be based more on art than on science. Unquantifiable judgement and choices are the elements that determine the way a design comes together.

Well, what is judgement? What constitutes 'good' judgement and how do we know when a good judgement has been made? Is good judgement just common sense? Can judgement be taught? Or can good judgement be developed only through experience? If that is so, how can we protect the public from the consequences of inevitable errors in judgement while the designer is learning?

4.3.1 The art of judgement

Vickers[42] used the word judgement in the sense of the concept of responsible choice, of decision which is personal yet made with a sense of obligation to discover the 'rules of rightness' applicable to a particular situation. He thought that decision, however, was a narrower term than judgement, for, while a decision may be taken on a certain issue at a particular time, the capacity of good judgement can only be revealed over a period of time. Judgement guides decisions. He also distinguished three separate elements to judgement or

[42] Vickers G.V., (1983)*The Art of Judgement*: , London Harper & Row

three broad types of judgement namely reality judgements about the current state of affairs 'out there', value judgements about what state is most desired, and action judgements about what, if anything, to do. The third element can to some extent de decoupled from the other two; for example the success of any action does not prove that it was well conceived. On the other hand, judgements about reality and its significance are inseparable, resulting from what Vickers called ' appreciation', or a readiness to see things in one way rather than another.

To Vickers, judgement is a personal, mental activity involving the peculiarly human qualities of intellect, sensibility, character and will.

4.3.2 Good judgement

Although Vickers was a lawyer by training before moving into management, and seems to have had scant respect for the way engineers think about the world, his phrase 'rules of rightness' in the context of judgement has particular relevance to engineering design.

Design is inherently contextual. As Ferguson has pointed out 'the limits of any design is culture-bound: all successful designs rest on specific precedents'. Good judgement in design at the formative level, when an idea first takes on a specific style and structure, rests in acknowledging this characteristic and in seeking to establish what the ground rules are. Engineers employ non verbal thinking in 'forming' ideas for change and again from Ferguson, 'their visual memories are particularly influential' when they are thinking out their preliminary plans. It is another characteristic of design that these preliminary ideas are remarkably resilient. They strongly direct further development of a design. The criterion for 'good' judgement will be goodness of fit to these perceptions. When a designer exercises judgement in the domain, it is not just a case of conforming to what is expected, there is an element of expanding the limits of acceptability but not by too much. Good judgement in fact may be demonstrated by the purposeful creation of an imperfect fit with the norm. But in an overall sense, a new design must still conform to some set of rules of rightness.

Progress in engineering is essentially evolutionary, even in fast moving areas such as Computers (although sometimes discovery happens which causes paradigm shifts in the design world). This is an eminently sensible approach, adopted to ensure that new designs are

given the best of chance of success. Any success in engineering is ultimately judged in the marketplace, not by the cleverness of a new idea. This reality defines a second design domain in which judgements must be made, that of commerce. The commercial design domain has its own set of rules of rightness. While a new idea might fit well in the formative domain, and while it might have great technical appeal to its design team, it is its commercial potential which will drive its realisation. Good judgement in this domain will become apparent after the product launch begins the successful penetration of the market. Failure to establish an economic share of the market will be deemed the result of an error of judgement. The rules of rightness in this case are perhaps the most difficult of all to establish.

A second area of judgement in the commercial design domain concerns design effort. Along the path from concept to market, the design stage is but one of the many functions in a business seeking to exploit a profitable opportunity. There comes a time in the development of the product when the temptation to continually improve the design has to be resisted if the economics of the whole project are to be assured.

A judgement has to be made when the design is good enough to release, in the knowledge that it could be improved if only... Whether that judgement was a good one will only become apparent further along the line. Good judgement here stems from the collective and collected business experience of a profession whose prime purpose is the provision of material goods and services according to the exacting demands of commercial utility. Accumulated knowledge and knowhow also form the basis for sound judgement in the third design domain in which the commercially viable, stylised formative idea is given full final substance and shape. Good practice is encapsulated in design texts, codes and standards, handbooks and data tables and company procedures. It is built on experiences of engineers who have designed and made things and the largely empirical recommendations that result have passed the test which every designer must apply to every proposition – will it work?

Good judgement operating throughout the three domains, the formative, the commercial and the instrumental, thus exhibits a consistent characteristic. It is a dynamic, for the exercise of good judgement in engineering leads to the creation and construction of new products, machines or systems which in turn redefine, in an incremental way the rules of rightness. At the same time it adds to an enduring foundation of tried and tested practice,

so change can be introduced with some confidence and security.

Is good judgement just common sense? If by common sense is meant a quality likely to be possessed by a clear thinking non specialist, the answer must be a resounding no! Good judgement in engineering design is firmly grounded in a unique engineering heritage.
In design, special knowledge is a necessary prerequisite to responsible choice, so on this ground alone common sense will not suffice to ensure good judgement. Good judgement and education for professional practice and others such as vocational training and HND courses are therefore closely linked and it is pertinent to consider what form that education should take.

4.3.3 Developing judgement

What has become apparent is that the capacity for judgement can only be built up over time. It is a mental faculty which relies heavily on a knowledge of precedent. Vickers (1983) wrote that judgement is made with a sense of obligation to discover the rules of rightness that apply in a particular situation. This means that those who would make an engineering judgement in design for example must seek out the specific 'rules' technical or cultural that apply in an inevitably wide variety of design tasks. This in turn, suggests that a broad professional education is needed to equip designers for that role. Furthermore, as Vickers put it, good judgement depends on a readiness to see things one way rather than another. A readiness to see implies a period of preparation and reflection and a maturity that provides for the evidence about a situation to be assembled and interpreted to inform subsequent decisions.
It certainly depends on a significant level of individual intellectual and professional development and for most of us that takes time. Another important fact is the readiness also implies a willingness to see, an awareness of the necessity for exercising judgement which too may come along with increasing maturity. All in all, good designers are in for a long haul.
If this is the case then it would seem that the development of the attributes of good judgement in design should be started as early as possible in the life of the professional designers. Design education should then aim to develop judgement as an ongoing commitment from the early years in academe through to and including employment in designing. The emphasis of that

education ought to focus on professional practice for it is in practice that the realities exert at full force.

4.4 Teaching designers

The resurgence of design as an important discipline in its own right, however, raises some issues about the university experience as a whole. The work of Perry[43] (1990) has shown that the college years are for many a time of significant intellectual growth. Students typically begin the years with a simplistic view that the world is either right or wrong and black or white. There are few shades of grey and in this world definite answers exist to most questions. The role of authority, be it a parent or professor, is important as a source of those answers. Gradually it then dawns that there can be many answers to the one questions and the feeling grows that any person's opinion is as good as the next. With that sentiment, authority loses some of its security. Next comes the acknowledgement that while all knowledge is relative, some opinions are indeed better than others because they have been more effective culturally appropriate engage with approved value. This leads to an advanced stage in which the individual can assemble evidence about a situation and make up his or her own mind about it. Authority is now but one of the inputs. Perry (1990) described these stages as dualism, multiplicity, relativism and commitment in relativism. Although students may advance through them at different rates and to a different extent, the journey towards being one's own person is according to Perry, a vital part to the university experience of growing up. Design tasks are typically open-ended, sometimes poorly defined, both constrained and energised by commercial considerations and at all times, demanding of judgement. It seems reasonable to assume that the capacity for good judgement in design will parallel intellectual development in some way. This picture of developing intellectual and decision-making powers over time suggests an overall strategy for building competence and confidence in design judgement across knowledge domains. The open ended nature of design can be introduced through exercises which use students' problem solving skills, but are guided by a growing repertoire of good practice. As their world view moves from a simplistic dualism to a more complex

[43] Perry, W.G., (1990) "Cognitive and ethical growth; the making of meaning" in the modern American college , A W Chickering & Associates (eds) Jossey-Bass, San Francisco; pp76-116

relativism, they will more readily appreciate and define the commercial driving forces in design. The capacity for good judgement in design is developed through continuing practice and a clear understanding of that practice.

4.4.1 Educating the designerly thinker

Irrespective of the design domain, traditional educational models in design education are based upon the replication of professional task performance. The measure of learning is generally equated with the evaluation on the product of designing rather than on what might be considered a learning increment. The cognitive properties of design learning have never been the subject of design education. As a consequence, there presently exists a lack of educational theories of learning which function as an underpinning of design education.
In the last decade, however, a considerable body of design research has begun to increase our understanding of the cognitive properties of design, and has provided new directions for the development of design education.

4.4.2 Traditions of design education

Studio-based approaches have been widely adopted as a general educational foundation for design education. From a learning perspective, the studio as a medium for design education has been characterised by certain endemic problems. Cuff[44] (1991) presents a well-accepted description of the centrality of the studio in design education, in her case, in architectural education. She defines the sources for patterns of studio education as derived from the famous French design institute, the Ecole des Beaux Arts. Certain of these patterns include the setting of problems as the initiation of the educational process, the studio as a simulation of the professional environment, the content of studio methodology as a series of well-formulated steps of design process, such as the *esquisse* stage, or the graphic formulation of the conceptual design, the relationship with the studio master as a tutorial relationship based upon design documents, demonstration as a medium of communication, and the jury system as the forum for evaluation of the final product of the design.

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[44] Cuff D., (1991) *Architecture, the story of a practice* Cambridge, MA.:MIT Press

Of these traditional characteristics of the studio, many of which persist until today, it is the concept of experienced-based learning which has been widely adopted as a general educational foundation of design education. The studio is considered as a venue for making designs under the sporadic guidance of the design tutor who intervenes in the student's designing, generally in reaction to the student's explicit design. Any procedural explanations such as the correction of method, may occur in one-to-one session in which the criticism is dialectical, graphical, and based upon exemplification. It is not necessarily articulate of general design methodological principles, and, in most cases, the critical process is inefficient in the transfer of design knowledge.

4.5 Cognitive re-orientation

Over many years Schon's work in educating the reflective practitioner presents two important modifications to the traditional model of design education. First of all, the dialectical nature of design is treated as 'an interaction with the materials of the problem'. The idea of reflection on the problem in the medium of conceptual drawings, or sketching, introduces a cognitive orientation to design reasoning as a foundation of design learning. The second re-orientation is the definition of the distinction between the interactive modes of visual reasoning and design ideation. Finally, the interaction between student and tutor becomes more of a participatory process in which the articulation of principle during the dialectical process of design becomes the responsibility of the tutor as an articulator of the values and issues which motivates changes in the subsequent stages of the design representation as a process of search. Despite these theoretical changes, the educational focus still remains on the representation of the design object., rather than on an explicit articulation of knowledge. However, Schon and others did much to promote the understanding that design reasoning is a subject of seminal importance and that design is characterised by a uniquely significant component of visual reasoning. The cognitive phenomena of visual reasoning in design influence the way in which we might develop an approach to design education which is cognitively formulated, rather than based upon the product making orientation of professional traditions. In addition to the seminal importance of visual reasoning, its interaction with conceptual processes, is a second unique component of design thinking. This linkage between visual reasoning and

conceptual processes is a foundation stone of the contemporary cognitive study of design.

4.6 To design versus to understand design

To design and to understand design are two related but distinct processes. The activity of design necessitates making decisions, comparing alternative routes to take to decide on one, and thinking in abstract terms for conceptualising; thus it is synthetic. On the other hand, the activity to understand design is similar to reading, necessitates deciphering the thought process of the designer, making abstractions and relations, relating the design product to other examples; hence it is analytical. As such the common denominator between the two processes is the capacity of abstraction, ability of thinking in abstract terms. Yet, the nature and the medium of abstraction may not be the same for students with different tendencies. The act of designing is primarily related with the ability of making visual abstractions 'correctly' judging a design product is related to the ability of making articulated verbal evaluations. The reasoning behind this argument is that judgements involve verbal associations such as good, bad, successful.

4.7 Objective of design education

Design education essentially deals with teaching how to design, moreover, rather ideally, with guiding students to discover their own ways of designing. Students enrol in design schools mostly without being evaluated on the basis of their ability to design. Yet they are expected to show a reasonable level of performance in order to graduate. Much of secondary education they receive does not promote visual thinking, whereas design education, by its nature, requires the students to be able to think and conceptualise visually.

While designing, designers utilise various techniques, consciously or intuitively, like sketching both to record and to generate ideas (Goldschmidt 1991). The process of designing involves sequential, and in some cases simultaneous, stages of making decisions and criticism, a process Schon refers to as 'reflection-in-action'. These indicate the incorporation of interactive imagery and visual thinking to arrive at creative solutions which are argued to be' perfectly rational and highly systematic' (Goldschmidt 1994) ways of reasoning. Parallel to the objective of teaching design is a second, almost as important and obvious objective: teaching the process of understanding and criticising a design product. In the case of architectural

design, this may mean visually decoding the relations among spaces, and/or verbally criticising their performance with respect to a set of criteria. Within the context of understanding design, graphic expressions of a design product done by someone other than the designer himself/herself can be taken as cases of visual thinking or visual conceptualisation, as they involve visual interpretation. These visual interpretations may be highly abstract and conceptual in nature, such as deciphering the meanings associated with spaces and expressing the 'figural concept' of design (Goldschmidt 1994). They may be as well be quite descriptive, representing the components of spaces in the form of perspective drawings. Similarly, verbal criticism of design products involve interpretations that reflect linguistic thinking or conceptual reasoning.

4.8 Graphic representations and verbal expressions as analytical tools

Graphic representations have a unique significance in design. Since design primarily deals with the creation of forms, it heavily relies on visual imagery and those tools that helps to express it. Sketches are useful not only as memory aids to record ideas to be recollected but also as inseparable tools of design process for crystallising design ideas and for generating further thoughts. In addition to their function in design process, sketches and other visual tools are helpful in analysing the designs made by others. Diagrams as abstract expressions of the design idea are such examples. The valuable use of sketches in analysing a design product and deciphering its design idea can be viewed as another form of 'reflection-in-action', action being the act of drawing to understand the inherent nature of a project. What the observer does in such a case is selectively drawing the formal and conceptual characteristics of a project, thus graphically representing his/her interpretation of it.

Another category of analytical tools used in criticism and evaluation of design is that of verbal expressions, representing linguistic thinking. Again the critique selects formal and conceptual aspects that characterise a design product, discovers meanings associated with it and interprets them verbally, thus translates the formal relations that he/she reads into linguistic expressions.

4.8.1 Expertise and use of visual analogy in design education

In addition to knowledge, skill is the single most important hallmark of expertise in any domain. Developing potent problem-solving strategies is a cornerstone of skill acquisition. In domains in which ill-defined problems are the rule, like architectural design, skills are acquired in a 'learning by doing', or 'trial and error' manner. Analogical reasoning turns out to be one of the strategies of which skilled designers make heavy use.

4.9 Experts and novices

Differences in skill between novices and experts have been attributed to differences in their representation of knowledge. While novices may represent problems or task situations in terms of irrelevant features that do not lead to a correct solution, experts tend to focus on more profound features. As expertise develops, knowledge becomes more structured and better integrated with past experiences, so that it can be retrieved from memory in larger chunks. This has been examined in different domains; for example in studies of chess where master players use larger and more meaningful structures of knowledge in encoding chessboard configurations than do novices.

Some researchers (Medin & Ross 1990)[45] have reported that experts have a large domain knowledge base and tend to represent problems qualitatively. Even when solving ill-defined problems, in which the goal may not be clearly defined and alternative solutions might be too many, experts are generally aware of what type of relevant knowledge might be useful for solving the given problem.

4.9.1 Analogical reasoning

Reasoning by analogy has been recognised by scientists, philosophers, and psychologists as a mechanism that has the potential to bring forth prior knowledge that can support the acquisition of new information. The use of analogy entails the transfer of relational information from a known situation (referred as source or base), to a situation that needs explanation (the target), where at least one of the related elements is not known. An analogy is

[45] Medin & Ross., (1990) *Cognitive psychology*: New York : Harcourt Brace

defined as a likeness of relations, as in A:B::C:D, or A is related to B like C is related to D. This implies that there is a higher order abstraction that holds equally well for A:B and C:D. When establishing correspondences between source and target, the A, B and C terms are generally given and the D term has to be established. The transfer of knowledge is achieved by analogical mapping. The identification of a similarity between possible relations in a target situation and known relations in the source situation leads to the creation of an analogy.

4.9.2 Analogy and expertise

The use of analogical reasoning was found to be dependent on skill-related individual differences (Novick 1988)[46]. Experts' skill in using analogical reasoning differ from those of novices. When a potential source and a target share surface features, novices tend to generate irrelevant analogies. On the other hand when the source share structural similarities with the target problem, experts are likely to establish a relevant analogy more spontaneously than novices (Novick 1988).

Evaluation of correspondences between source and target changes as a function of the development of expertise. Novices frequently fail to realise how new situations can be understood in terms of prior situations, and how the importance of identifying relevant features can be associated with recommendations for instructions. Contrary to experts, who usually succeed to transfer abstract schemes and are capable of forming context free structural representations of the domain, novices generally fail to distinguish between representations of relevant concepts and source examples, and thus fail to transfer abstract relations.

4.10 Implications for design education

Experience and knowledge in a specific field are general pre-conditions for the development of expertise. Expertise includes the mastery of acquired problem-solving methods as well as fluency in the use of relevant generic cognitive strategies in a particular domain or type of task. Analogical reasoning belongs to the latter in ill-defined problem-solving; visual analogical reasoning is particularly suited to designing.

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[46] Novick L.R., (1988)"*Analogical transfer, problem similarity & Expertise*", Journal of experimental Psychology: Learning Memory & Cognition, 14:3, 510-520

In every domain, the accumulation of knowledge and the practice of methods require training. Cognitive strategies on the other hand, are at the problem solver's disposal as the first steps of professional training. However novices are usually not aware of their utility in the process of problem solving. Architectural design education is founded on the acquisition of design skills through repeated exercising, largely based on trial and error or, in a typical studio situation, on trial and feedback. Novice designers do not need to be taught how to use analogy, they already have this cognitive capacity. They do need, however, to be shown how and why it can be helpful to harness this ability for successful design problem-solving. The use of analogy requires the identification of abstract knowledge structures that correspond to the similarities between known and unknown situations. According to Goldschmidt (1995) the structuring of a design problem through transformations, the ability to make long interrelated chains and moves (larger knowledge chunks retrieved from memory) and the capacity to identify clues are some of the skills of the expert designer. The use of analogy supports these skills. In the architectural studio it is possible to show how the use of analogy enhances these skills. It is believed that students who understand how analogical reasoning serves their design processes can, over time, learn to appropriate and master this strategy with or without explicit instructions to do so.

CONCLUSION

The initial idea behind this thesis was to explore what I thought was a gap, or at least a disparity in the literature. Theories of the design process have been produced in different design disciplines and this has led to vastly different perspectives. Goldschmidt's finding is that the team participants do not resemble different aspects of the individual designer, but rather that the individual designer is a unitary system that resembles the team. It is important to point out that in that particular experiment and with that particular group of designers, they worked productively as a team and reached a relatively successful conclusion to the set task, within the prescribed time. However, it is clear that team work is a social process, and therefore social interactions, roles and relationships cannot be ignored in the analysis of design activity performed by teams. Many aspects of team design activity can be seen to be influenced by social process factors. For example a team can shift among planned and unplanned activities, alternative approach can be ignored or over-ridden, personal commitments to particular concepts can lead to social process actions such as expressing commitment and persuading others. These factors are relevant to the analysis of design activity, and important to the design methodology of teamwork. If designing is also a social process, then it is important to point out how designers interact with others such as their client or their professional colleagues, and to observe the social interactions that influence the activities of teamwork in design. Furthermore, attention has also been directed to designing as a cognitive process, to the cognitive skills and limitations of the individual designer. My aim was to review the process starting with Goldschmidt's work and to substantiate my experimentally based perceptions that she underestimated the value of co-operative work in design. I have elaborated on my reservations regarding her findings.

My framework of analysis drew on existing research. In quantitative study one has to be objective in order to generalise behaviour with the use of statistics. Although statistics were used in the analysis, they were not heavily relied upon in the interpretations. I have outlined my reservations about the efficacy of a questionnaire although more complex and sophisticated questions than the one I devised may be more productive. These interpretations do not represent a definitive view, but simply an objective one, a qualitative judgement and

a judgement open to conjecture. I have suggested the ways in which the term 'design' is hard to pin down and the multiple interpretations arising from its use. Design is a complex activity, and one which needs to be simplified in order to be understood and described. Many published accounts of the design process have emphasised the important role of value judgements in design. In teaching, alternative value systems should be explicitly discussed and compared, and awareness should be developed of the design implications for design. For practice, if designers are to respond to client's needs, it is essential for them to be briefed as precisely as possible, or to find as much as possible, about their clients' values; or if designers' values remain unmodified by their clients' needs, then clients must choose designers whose values correspond to their own.

All design teachers and leaders worry about the difficulty of providing students with 'reference information': how to familiarise novice designers with the enormous richness of experience in the field. Even if one possesses 'libraries of past designs', these are not documented with respect to important questions for novices in a domain, such as solution procedures and alternatives. At present therefore the use of design re-use assistance remains a difficult question and perhaps the main way to advance at this point is to analyse empirical data collected on the actual reuse activities, in experimental contexts but also in real professional work situations. Therefore it is important to teach designers to flexibly use different ways of proceeding in different problem situations, because there is not 'the one right way' which is adequate in all problem situations. It is also important to establish a design environment that is capable of supporting flexibility instead of limiting it. With respect to the influence of problem solving styles on design proceeding, diagnosing and training individual problem solving behaviour may be an essential contribution to optimise design processes and should therefore be included in design education as well as in further vocational training. As the adequacy of a given style of problem solving depends on the characteristics of the situation, a good designer should be able to use flexibly different problem solving strategies and to actually choose the one which best meets the requirements of the situation. Therefore I believe that designers should be trained in the ability to adapt flexibly their problem solving strategies to the demands of the situation.

It is of course very important to know the basic goal of a design process, however the main impression is that most practical design work falls into the category of producing a single solution quickly, which must be satisfactory and able to be manufactured easily. It is important that research in design methodology widens its objectives. To date, the main goal has been to develop products that meet an optimal quality. Another goal to consider is the need to develop methods and techniques that support design in the minimum time with minimum effort. Teamwork design must also be considered under these aims. A still open question is how the personal characteristics of a designer are generated and developed and how their development can be supported. One important principle to emerge for the practice of design is for goals or values to be explicitly recognised and discussed and concisely defined, failing which may result in the designer designing for himself/herself instead of for his/her client. Thus preventing him/her from knowing what his/her objectives should be and also from preventing him/her from following an efficient strategy.

The knowledge we currently possess about the intricacies of cognition and certainly design cognition lead to an increased acknowledgement of the enormous complexities that we face. The most profitable way to investigate therefore is to focus on partial processes and questions, identifying variables and patterns of different cognitive manifestations of design behaviour. Thus in due time we may be able to gain comprehension of the global whole. With a lack of required data, the systematic design approach will have limited success and conventional approach will be more effective under these circumstances. It is perhaps safe to say therefore that a hybrid systematic and conventional approach is the easy way for the development of new products.

Designers perceive that they performed better as a team when they agree on, and subsequently follow a design process. There is a link between how well a team works together and what it produces. Following a design process, be it in an iterative or systematic manner does not necessarily help the team to generate a better design concept or reduce the time

period spent reaching that concept. A team must be led throughout the design activity, however, the team must agree on who should lead it and how it should be led if it is to work effectively as a unit and to avoid confrontation. Although the creative design process can be highly intuitive and individualised that is hard to share, designers are quite capable of

improving how well they work if they strive to make this a project goal. If the team does not agree on the design process to follow, individual team members tend to make opportunistic forays into particular areas of the problems in an ad hoc manner. If other team members do not agree on the direction of that foray then this can lead to a lack of synchronisation in the team effort and a lack of input from one or a number of its members.

I have considered the nebulous issues of creativity, humour and irony and the difficulties involved in defining or systematically engaging them in educational or practical environments. Surprise is what keeps a designer from routine behaviour and difference and eccentricity in the product can relate to saleability. The surprising parts of a problem or solution drive the originality streak in a design project I think that we should draw a distinction between works of practice and works of research. I do not see how works of practice can be regarded as works of research. Doing research is to extract reliable knowledge from either the natural or artificial world and to make that knowledge available to others in reusable form. However works of design practice must not be totally excluded from design research. To date little is relatively known about the mystery of design ability, and that limits our study of 'the culture of design' and perhaps that should remains the goal of design research.

This thesis has sought to discover and debate some systematic ways of understanding how protocols can be established to support and enable teamwork in design, on the assumption that this procedure is capable of producing more effective results. I am aware of the difficulties of encompassing the complex determinants and consequences of all that occurs in the process of moving from an initial brief to a delivered product. Design is not only a problem solving activity, it is also a process by which meanings are created and negotiated. In particular it is difficult to allow for those elements of originality, flair, surprise which are not only valued as the mark of the 'named designer' but are often crucial to the success of the product.

The issue of what constitutes 'research' in the design process is a very current one and for academic exercises designers are required to testify to the 'research elements' in their work but these can range from visiting locales, to testing new materials to discovering previous solutions and accounting for innovation. There is also the issue of where design stops – clearly

the acts of consumption and use incorporate design activities as well as the work of the professional designer. Coming as I do, from a scientific background it is difficult to square my sense of research as deriving reliable knowledge from the natural to the artificial world in ways which can be offered to others in re-usable form with the everyday work of designers. I believe this difficulty is present throughout the methodological problems presented in this thesis.

However, the intention of this piece has been to make a small contribution in analysing the key determinants and procedures involved in the design process and establishing claims for the richness of the collaborative process and to pave the way for further research.

Appendix 1

Design Method Questionnaire

This questionnaire is part of my data capture for MPhil / PhD research project I am undertaking at Middlesex University in the School of Art Design & Performing Arts in order to establish whether or not a methodology can be produced to assist novice designers.

Your participation will be greatly appreciated so please complete and return the questionnaire at the Cat Hill campus. As a follow up to these questions I shall be conducting interviews and if you wish to participate further I can be contacted on the following email address:- Fidou1@mdx.ac.uk

Many thanks for your participation.

1. What is your course title?.....

1. How long have you been on the course?.....
2. What is your area of design expertise?.....
3. Did you have any work experience in the field prior to coming on the course? Yes / No
4. If the answer to question 4 was yes, did you work as part of a team? Yes / No
5. Have you designed (professionally) anything by yourself? Yes / No
6. Do you prefer working in a team or on your own?.....
7. Even as a member of a team, what percentage of the time you were left to design on your own?

   (i) 0-25% (ii) 25-50% (iii) 50-75% (iv) 75-100%
8. Did you find it easier working in a team or working on your own? Team / Own
9. Do you think that teamwork results are worse, same or better than results obtained when working alone? Worse / Same / Better
10. Do you think you used the same or a different technique for your design in teamwork than when you work alone? Same / Different
11. How important do you think intuition is in designing? Very / Little / Not
12. How important do you think a methodology is in designing? Very / Little / Not

If there is any further comments you would like to add please use the back of the form. If required, would you be prepared to be interviewed by me about aspects of your work? If yes please add your name and where you can be contacted.

Dear Respondent

This questionnaire is part of a data capture for a research project being undertaken at Middlesex University (London; U.K.) in the Department of Arts and Design.

The objective of the study is to establish whether or not a methodology can be developed to assist novice designers. Your responses will go a long way in the conduct of this study.

Please spare a few minutes to answer the following questions.

Many thanks!

Fidou Chan

ADPA

Middlesex University

London

U.K.

(1) Whether intuition or a methodology is more important in designing and why?

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(2) Whether there is a difference or not in the way a team of designers or a sole designer bring their work to fruition?

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Name :- ----------

Email address:- ----------

Design Area:- ----------

Appendix 2

Table App.2.1: Tally Chart showing Male & Female Frequencies relating Teamwork result and technique applied

Gender	Male		Female	
Technique Applied	Same	Different	Same	Different
Teamwork result				
Worse	I	III		III
Same	III	𝍸	𝍸	𝍸 𝍸
Better	𝍸 𝍸 𝍸 𝍸 II	𝍸 𝍸 𝍸 𝍸 III	𝍸 𝍸 I	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸

Table App.2.2: Tally Chart showing the frequencies of Methodology Importance versus intuition Importance to Teamwork Result

Importance of Methodology		Very	Little	None
Teamwork result	Importance of Intuition			
Worse	Very	II		I
	Little	III		
	None	I		
Same	Very	𝍸	𝍸	I
	Little	II	II	
	None			
Better	Very	𝍸 𝍸	𝍸	
	Little	𝍸	IIII	
	None	I		I

Table App.2.3: Observed & Expected Frequencies with the computed Chi-square value of Methodology, Intuition & Teamwork result

The observed values:

		Importance of Methodology		
Teamwork	Importance of Intuition	Very	Little/None	Total
Worse or Same	Very	17	7	24
	None or Little	6	2	8
Better	Very	53	7	60
	None or Little	22	5	27
Total		98	21	119

The expected values if the rows and columns are independent:

		Importance of Methodology		
Teamwork	Importance of Intuition	Very	Little/None	Total
Worse or Same	Very	19.765	4.235	24
	None or Little	6.588	1.412	8
Better	Very	49.412	10.588	60
	None or Little	22.235	4.765	27
Total		98	21	119

The chi-square value with 3 degrees of freedom: 3.9798

The p value: 0.2635

Ho: The importance of methodology and teamwork and intuition are all independent

$\mathbf{H_1}$**:** They are not all independent

Result : The significant probability is 0.2635, so accept **Ho** that all these attributes are Independent

Table App.2.4: Observed & Expected Frequencies with the Computed Chi-square value of Teamwork on Design Performance

The observed values:

Teamwork	Improve Perfomance	Makes no Difference	Worsens Performance	Total
Observed Frequency	87	25	7	119
Expected Frequency	40	40	39	119
Total	127	65	46	238

The expected values if the rows and columns are

Teamwork	Improve Perfomance	Makes no Difference	Worsens Performance	Total
Observed Frequency	63.5	32.5	23.0	119
Expected Frequency	63.5	32.5	23.0	119
Total	127.0	65.0	46.0	238

The chi-square value with 2 degrees of freedom: 43.1161

The p value: 0.0000

Ho: Designers have no consensus of opinion about the importance of teamwork

H_1: Designers do have an opinion of the importance of teamwork

Result: A probability of 0.0 so reject Ho and accept H_1 that designers do have an opinion about the importance of teamwork. They believe that teamwork improves performance.

Table App.2.5: Observed & Expected Frequencies with the computed Chi-square value of the importance of Methodology while designing

The observed values:

	Methodology			
	Very Important	Little Important	Not Important	Total
Observed Frequency	98	18	3	119
Expected Frequency	40	40	39	119
Total	138	58	42	238

The expected values if the rows and columns are independent:

	Methodology			
	Very Important	Little Important	Not Important	Total
Observed Frequency	69.0	29.0	21.0	119
Expected Frequency	69.0	29.0	21.0	119
Total	138.0	58.0	42.0	238

The chi-square value with 2 degrees of freedom:	63.5788
The p value:	0.0000

Ho: Designers have no consensus of opinion about the importance of methodology

H_1: Designers do have an opinion of the importance of methodology

Result: A probability of 0.0 so reject Ho and accept H_1 that designers do have an opinion about the importance of methodology. They believe that is important.

Table App.2.6: Observed & Expected Frequencies with the computed Chi-square value of the importance ofIntuition while designing

The observed values:

	Intuition			
	Very Important	Little Important	Not Important	Total
Observed Frequency	84	32	3	119
Expected Frequency	40	40	39	119
Total	124	72	42	238

The expected values if the rows and columns are independent:

	Intuition			
	Very Important	Little Important	Not Important	Total
Observed Frequency	62.0	36.0	21.0	119
Expected Frequency	62.0	36.0	21.0	119
Total	124.0	72.0	42.0	238

The chi-square value with 2 degrees of freedom: 47.3589

The p value: 0.0000

Ho: Designers have no consensus of opinion about the importance of intuition

H_1: Designers do have an opinion of the importance of intuition

Result: A probability of 0.0 so reject Ho and accept H_1 that designers do have an opinion about the importance of intuition. They believe that is important.

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