DEVELOPING INNOVATION THROUGH KNOWLEDGE OF THINKING PREFERENCES

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ABSTRACT

Many business enterprises are facing difficulties and being required to be innovative in their policies and practices as they face competition within a global economy. This research, set in the Al-Jubail Petrochemical Company in Saudi Arabia, took the view that effective innovation was related to the cognitive, creative and interactive skills of the workforce within the managerial and administrative framework of the company. Hence the research had three principal components namely: *(i)* to examine the thinking preference profiles of the workforce; *(ii)* to design a training course in which the thinking preferences became associated with creativity, innovation and collaborative problem solving and, in contrast to other studies, *(iii)* to examine in detail the influence of thinking preferences in the process, performance and perceptions of the collaborative problem solving teams.

A review of research literature gave support to using the Herrmann Brain Dominance Instrument (HBDI) as a measure of thinking preferences (which was administered to 452 employees) and to the application of ThinkPak and Whack Pack cards in the creativity activities. These themes were linked to illustrations and discussions of working practices. Overall the course evaluations were very positive.

A principal component of the research was a detailed study of the performances of 81 teams, in the problem solving tower building activity. The data showed diversity in the HBDI profiles and in the tower designs and implementations. An interesting result was that teams homogeneous or heterogeneous with strong HBDI profiles performed well on the task criteria, whereas those teams with weaker homogenous/heterogeneous HBDI clusters were much less effective. This result, however, has to be related to the leadership capabilities in the teams. Self-report questionnaires on team contributions and interactions suggested that participants tended to follow their dominant thinking preference profiles.

A further important component was the linking of the research materials and findings to the innovative company practices. In this regard, the design of a HBDI databank browsing system and a computer based suggestions framework were outlined and illustrated. Further research suggestions included more detailed analyses of the relation of HBDI profiles and leadership roles to the development of team dynamics and the authentication of the decision making.

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CHAPTER 1

The Background of the Research

1.1 INTRODUCTION

This thesis was written and researched between 2000 and 2005 during a period of rapid technological and political change in the world. Many business enterprises were facing difficulties in adapting to the increased speed of the changes within a global economy. Hence several leading companies were concentrating on *innovation* as a critical factor for success: some well-known examples were Microsoft, Cisco, Oracle, and Google, and they achieved significant improvements. However, success factors can change. According to Hammer (1990) in the Fifties and Sixties the main success drivers were *control* and *security*. But, in the Seventies when computer applications penetrated business enterprises, *control* and *security* problems were met by utilizing computer related tools and applications. Consequently, businesses started launching service as a competitive success factor and, following such improvements in the Eighties, Total Quality Management was seen as providing a competitive edge with ISO as a quality solution for the top organizations. In the Nineties the acceleration of change was mainly due to globalization and the developments in new computer technologies with business enterprises, as noted above, focusing on *innovation* as the main critical success factor.

The research reported in this thesis was placed in the KEMYA Petrochemical Company in Jubail, Saudi Arabia, and directed at ways innovation could be brought within this business enterprise: a particular emphasis in achieving this objective was placed on the effective utilization of the cognitive resources of the workforce. "The corporation as we know it, which is now 120 years old, is not likely to survive the next 25 years; legally and financially, yes, but not structurally and economically." Daly (2000). The new rules of the business game have changed rapidly as illustrated by Esterson (1999) in the comparisons shown below.

Old Success Factors	New Success Factors
• Size	• Speed
• Role Clarity	• Flexibility
• Selected "stars"	• Everyone a leader
• Leaders set agenda	• Leaders create environment of success
• Leaders force change	• Leaders create capacity for change
• Specialization	• Integration
• Knowledge focused on internal processes	• Knowledge focused on customers
• Knowledge is individualistic	• Knowledge is institutional
• Command and Control	• Innovation
• Hierarchical	• Heterarchical, networked
	• Flexible structure easily modified
• Alliances complement gaps	• Alliances create new value and outsource uncompetitive services
• Alliances are built with distant partners	• Alliances are built with competitors, customers and suppliers
• Governance is internally focused	• Governance is internally and externally focused
• Governance is top down	• Governance is distributed
• Long term reward focus	• "Own my own career" mentality focus
• Vertical decision making	• Delegated authority
• Individual and small team rewards	• Collaboration is expected and rewarded
• Coherence is hard wired into process and the organisation	• Coherence embedded in the vision of individuals
• Coherence is internally relevant	• Coherence is tested externally

It is worth commenting briefly on how KEMYA (the company in which the research is placed) stands in relation to these criteria. In the early stages of the research KEMYA was interested in introducing and consolidating innovation within its future vision. Indeed, the company considered it essential to maintain and enhance its competitive edge in the global economy. But in the success factors chart the criteria of innovation, though listed, is not given prominence although some innovative requirements or contributive factors are noted, *e.g.* flexibility in approach and structure, delegated authority, collaboration being expected and rewarded. However, KEMYA is shifting towards the new criteria. For instance, organisational relations

have moved from hierarchical control to structures that take account of employees' preferences and cognitive potential; this shows a shift to more flexible heterarchical networks that can more easily be modified and refocused. In brief the company governance is both internally and externally directed within the company vision and in line with its global interests. Also important for innovation are individual and small team rewards which support creative and synergistic collaborations.

These new success factors are affected by the changes in communication and information technologies, and by changes in education/training and business thinking directed towards human and cognitive factors. These have become even more critical as many businesses cut costs by downsizing, outsourcing, reengineering and restructuring. Growth now depends on the ability of businesses to innovate, and innovation is no longer regarded as the exclusive preserve of research and development departments. Instead, many businesses see that innovation must become part of the core competency of every part of the organization and its network of business partners (McKie, 2004). In a more general prospective, Drucker (1995) states that "Every organization - not just businesses - needs one core competence: innovation. And every organization needs a way to record and appraise its innovative performance." Hence innovation should be planted in the enterprise in ways that are continuous and iterative, and, as defined by Bellon and Whittington (1996), incremental and radical. This involves a requirement to deal with employees as persons with different and preferred styles of working and thinking, and utilizing these abilities in ways that motivate and stimulate others. This in turn suggests changes to training programs so that employees are aware of these influences and their significance in the workplace, and how they might be discharged within their areas of responsibility. But there can be organizational structures within the enterprise that lead to segregation between management and personnel within and between departments, thus hindering such participation and interaction.

This research provided an opportunity to address these issues, influenced by my background in management and education. To reiterate, it is a theme of this research that it is important in business enterprises, set within a global competitive economy, to empower individuals according to their thinking potential and preferences, to ensure their effectiveness within the workplace and to provide opportunities that encourage innovation within their areas of responsibility. But these require new training regimes and education professionals to work hand in hand with business management. Although trainers are showing greater interest in developing the innovative potential of employees in the industrial sector, there are various

approaches to achieving this objective, and difficulties are likely to be encountered. In Saudi Arabia, for example, some creativity and innovation training was started through short courses that contained theoretical issues and associated practical activities. But the training was generic, and did not introduce or develop notions of individual differences, for example, in thinking styles or preferences, or consider how these could be assimilated in the workplace. The consequence was that the courses had only a limited short term impact.

It is a feature of this research that thinking preferences and human factors related to collaborative working and problem solving are important and should be bound into company training schemes where the focus is toward innovation. Hence working with management and policy makers within the business enterprise is critical, as are ways in which, following training, employees have mechanisms for bringing their ideas and suggested practices to wider attention within the company.

Developing innovation is the main objective of this research since innovation is seen as the medium to achieve competitive advantage in a global economy. However, this research takes the view that it is a joint responsibility of the entire workforce, not just Senior Management, *i.e.* that an innovation culture has to be established throughout the company and changes made in policies and practices to meet the innovation requirements. In brief, innovation is seen as an investment in the workforce and an initial phase of the research was to reveal the cognitive potential of individuals, not narrowly but in ways which relate to thinking preferences, collaboration, and creativity. Consequently the Herrmann Brain Dominance Instrument (HBDI) was selected because of its range of cognitive and thinking preferences of individuals (which covers analytical, organizational, emotional/interpersonal, and creative/imaginative aspects). Further, it has strong validation data and a range of applications in Industry. [These factors are discussed and the decision justified in Chapter Two.]

The HBDI preferences are also related to the creative process and collaborative problem-solving. For example, the Wallis model of the creative process (discussed in Chapter Five) noted stages of Preparation, Incubation, Illumination, Verification, and Application. Each one of these stages can be informed and differentially influenced by the HBDI preferences. For example, Preparation might benefit from an analytic approach directed at the creative task, Incubation from the Imaginative preference, Illumination from the Organisational and Creative aspects, and the Verification and Evaluation stages might benefit from the Analytical, Organizational and Interpersonal approaches, particularly as creativity often requires engagement and collaborative interactions within the business enterprise.

This approach to innovation requires participants (*i.e.* the workforce) not only to be aware of the profile of their own thinking preference, but those of others and how this awareness can be of value in collaborative interactions. Accordingly, a second phase of the research was the design and implementation of a training program focused on innovation/creativity and the development of more flexible, fluent and original modes of thinking through a variety of approaches and participative activities, such as Brainstorming. This leads to the organisation of teams undertaking collaborative problem-solving tasks that exercise thinking preferences, creative ideas and participative interactions. The team performances will be influenced in the ways they interact as teams. This raises issues such as Leadership and how the group arrives at and legitimises its decisions.

Overall this research strategy, in its training phases and techniques was designed to stimulate a more creative and participative culture in the workplace, and attempted to link these experiences to Company policies and practices that would enable innovations to take root. Accordingly, an HBDI database was designed to help the Company in its selection for effective cross-functional and other teams, and for directing focused training to appropriate sections of the workforce. Also, a Suggestion System was designed so that ideas could be introduced from all levels in the company and brought directly to Managers and Policy Makers.

1.2 THE AIMS OF THE RESEARCH

Within the innovative rationale outlined previously, the generic aims of this research work were:

- To investigate and analyze the cognitive/thinking preference profiles of employees in various functional and cross functional groups within the business enterprise. [The instrument actually chosen for this analysis was the Herrmann Brain Dominance Instrument (HBDI) and the reasons for this choice and an explanation of its underpinning theories and dimensions is provided in Chapter Two.]

- To design an Innovative thinking training scheme which incorporates an understanding of thinking preferences and creativity, and includes a synthesis of these factors in activities such as collaborative problem solving.

- To examine the relation between patterns of HBDI team profile data and their performances in collaborative problem solving and interactions. Also to liaise with the company's managers and policy makers on practical ways in which the findings of this research can be incorporated within the company's practices.

A business enterprise often depends on interactions within and between teams to achieve their objectives, and achieving a group cohesion can pass through various stages of development. This is likely to be the case if the groups are to engage with other's thinking preferences as ideas are worked through and various decisions are made. Since this research is focused on improving the innovative practices of large business enterprises by exposing and utilizing more effectively the thinking preferences of the workforce, particularly when cross-functional and collaborative groupings are set up within the company, it will be important for the training course not only to explain the HBDI thinking preferences scheme but to ensure participants are aware of the meaning and value of their own preference profiles. Further, it would be advantageous to the business enterprise if such information of employees was available to take into account when making selections and setting up cross-functional groups. For example it might be advantageous to have a balance of thinking styles, though in cases where the group objectives are closely prescribed some bias in the thinking preferences of the group might be required.

It is useful at this stage to point out that there are several instruments which are being used in industry which can provide data on thinking preferences, personality, attitudes, working styles, and creative attributes. Some of the available tools include:

PCSI—Personal Communication Styles Inventor: This identifies individual preferences in giving and receiving feedback, and in communicating. In particular, it seeks to classify an individual's communication style.

DISC: A behavioral tool designed to capture how an individual acts—what are his/her behaviors and emotions? In brief it seeks to classify an individual's behavioral style.

MBTI (Myers-Briggs Type Indicator): A self-reporting personality inventory.

HBDI (Herrmann Brain Dominance Instrument): A thinking styles assessment tool which reflects an individual's approach to thought.

EQ—Emotional Intelligence: This identifies an individual's level of emotional maturity. In particular, it reflects an individual's ability to monitor and regulate his/her own feelings; and to use those feelings to guide thought and action.

All these instruments are in commercial use but, as will be clarified in the reviews in Chapter Two, in this research the decision was made to focus on the thinking preferences of employees as revealed by the Hermann Brain Dominance Instrument (HBDI). HBDI is well validated (Bunderson, 1990) and has a useful pedigree in its applications. The self-report questionnaire is also clear and understandable to both lay and profession respondents. Further, supplementary booklets not only outline the theoretical ideas (*i.e.* the brain quadrant metaphor) but also answer frequently asked questions about HBDI, its reliability and validity and its range of application. Hence materials from these publications are useful to include and illustrate in training courses. To ensure the understanding of the survey questions, the researcher also selected an Arabic version of the survey form so that two forms (English and Arabic HBDI survey forms) could be used in the research because the Kemya (Saudi/American) petrochemical company uses an international workforce

In contrast to previous work, this research takes a broader view in relating HBDI data to selection and the collaborative engagement of teams as they further their task objectives. This requires employees to understand the meaning and implications of HBDI, and how an awareness of their preferences, and those of others can influence and benefit their mutual interactions. This was an important factor in designing the training schemes, as was the linking to creativity and innovative thinking, and the incorporation of problem solving exercises by teams. However, these expectations are dependent on the validity and utility of HBDI, and how such data can be utilized in an effective manner in collaborative working. This was an important part of the training program. Finally, the HBDI and the training experience must be perceived as relevant and useful by the workforce, and by the senior management of the business enterprise, so that the implications for polices, practices, and training can become integrated within the workings of the company.

1.3 AN OUTLINE OF THE THESIS

Against this background the thesis will review the research literature in Chapter Two. This will cover developments in the business enterprise in response to technological advances and

competition within the global economy. Cognitive factors and tools (especially HBDI) will be reviewed in relation to working practices, and training programs in creativity and innovation will be covered, as will research on collaborative problem solving and team building.

Chapter Three will briefly set out the research context noting the background of the petrochemical company, the range of its departments and modes of organization. This is followed, in Chapter Four, by an outline of the Research Design and in Chapter Five by a detailed analysis of the HBDI thinking preferences of four-hundred-and-fifty-two employees from all departments and administrative levels in the company, including cross-functional groups.

Chapter Six discusses the design and implementation of the training program which had three main features: *(i)* the description and understanding of HBDI and their individual thinking preference profiles; *(ii)* the ideas underpinning creative and innovative thinking (linked to HBDI perspectives) and leading to activities designed to improve fluency and flexibility in thinking; and *(iii)* a group problem-solving exercise which could be attempted and solved in various ways, and where performance could be compared to the HBDI data profiles of the team.

Eighty-one teams took part in these training sessions, and Chapter Seven examines in some detail the performances of a selection of high, moderate and low performing groups noting their HBDI team profiles and responses to self-reporting questionnaires of their group interactions and contributions to the problem-solving.

Chapter Eight provides a summary of the research and notes ongoing work and suggestions for further research. These are not only directed at the roles of HBDI in team building and collaborative problem-solving, but also at techniques by which the findings and methods of the research can be incorporated within company procedures, *e.g.* of selection, of training and of noting the creative suggestions of the workforce.

CHAPTER 2

A Review of Previous Research

2.1 DEVELOPMENTS IN LARGE SCALE BUSINESS ENTERPRISES WITHIN A GLOBAL ECONOMY

During the previous two centuries, labour and capital were the two main factors affecting production. However, this situation is now changing as the primary wealth-creating assets are considered to be Information and Knowledge. A brief business history of the world's economy in last century (Khosla, 2000) has shown that in the period between 1900 to 1975, more than 50% of employment was in agriculture, with the wealth and power of people based on land ownership, but in the period between 1975 to 2005, more than 50% of employment became dependent on an "industrial, energy driven economy". The prediction was that wealth and power would be based on factory ownership and developments in global enterprises, while increased competition would require these economies to be knowledge based. Hence skills and human capital were to be the sought-after commodities. These trends are already in evidence as talented human recourses are at a premium.

However, according to Houghton and Sheehan (2000) "the slowdown of growth since the early 1970s in all of the advanced industrial nations, the rise of Japan as a major economic and technological power, the relative decline of the United States, and widespread concerns in Europe about being behind, have led to a rash of writing and policies concerned with supporting the technical innovative process". At the same time, the enhanced technical sophistication of Korea, Taiwan, and other NICs (Newly Industrialized Countries) particularly China and India has broadened the range of nations whose firms are competitive players in fields that used to be the preserve of a few. Clearly there is a new spirit of what might be called "techno-nationalism" in the air, combining a strong belief that the technological (and knowledge) capabilities can be built by national action. (Nelson 1993, p. 3) He notes that "traditional economics is founded on a system which seeks to optimize the efficient allocation of scarce resources, but because of the unique characteristics of information and knowledge the very meaning of scarcity is changing.

Indeed, the 'scarcity defying expansiveness of knowledge' is one of its most important defining features. Once knowledge is discovered and made public, there is essentially zero marginal cost to adding more users."

In brief, technological developments have transformed the majority of wealth-creating work from being physically-based to being "knowledge-based" Technology and knowledge are now the key factors of production. With increased mobility of information and with a global workforce, knowledge and expertise can be transported around the world, and any advantage gained by one company can be eliminated by competitive improvements in another. The only comparative advantage a company will enjoy is its process of innovation *i.e.* combining market and technology know-how with the creative talents of its workers to solve a constant stream of competitive problems, and its ability to derive value from that knowledge. For today's business enterprises knowledge development, utilization and management are essential.

The main characteristics of the Knowledge Economy according to, and adapted from, Houghton and Sheehan (2000) are:

- Information and communication technologies increasingly favour the diffusion of information over re-invention, reducing the investment required for a given quantum of knowledge.

- The innovation system and its 'knowledge distribution power' are critically important.

- The increased rate of codification and collection of information are leading to a shift in focus towards tacit ('handling') skills.

- Learning is increasingly central for both people and organizations.

Initiative, creativity, problem solving and openness to change are increasingly important skills.

Indeed, it can be argued that virtually all the economic growth that has occurred since the eighteenth century is ultimately attributable to innovation (Baumol, 2002) and that today's wealth is created by research, by discovery, and by innovation. The New Economy Index published by the Progressive Policy Institute in Washington, DC, reports that "research and technological innovation account for more than two-thirds of *per capita* economic growth". Hence the successful company of the future must understand how people really think and work

and must adapt its technology to that work rather than the other way around. It must know how to create an environment that allows for continuous innovation by all employees (Brown, 2002).

2.2 THE ROLE OF TECHNOLOGY IN MANUFACTURING AND MARKETING

The role of technology both in manufacturing and marketing has increased considerably but this has to be linked to innovation and adding value to the product within the company. This involves the workforce, its knowledge and working relationships which are fostered by the business enterprise. It is these human characteristics which now figure more prominently in business policies and decision making. Davis (1987) explains that businesses of the future will need to function in a way that eliminates the constraints of time and place by using advanced technology and new organizational structures. He also predicts that many companies will customize and diversify their products rather than producing great volumes of identical goods. Indeed, some of the most dynamic companies and industries have relatively few physical assets, and draw their market value and business base from "intangibles", such as product design, intellectual property, market insight, management know-how, and strong customer relationships. Google, Amazon.com, Oracle, Microsoft, and pharmaceutical firms are examples of organizations that are based on knowledge as their main assets, and the concept of intellectual property, made concrete through patents, contributes huge revenues for leading manufacturing companies. For instance, Sony had more than 30000 patents in the fiscal year ended March 31, 1999, achieving sales and operating revenue of $56.6 billion (Beamish, 2000). The leading manufacturing companies in the world are concentrating on developing new inventions and products that can give an economic advantage in a competitive world. And these innovations in both products and working practices originate in, and rely on the workforce. Hence there are changing demands and expectations placed on the workforce to meet changing objectives which are likely to have effects on the organizational structure and working practices of the company.

These challenges are apparent whether the company is engaged in manufacturing or providing banking and financial services, or running telecommunication services or a transportation business. It is estimated that, nowadays, only about 20 percent of workers spend their day making things. The other 80 percent work in other jobs that require them to move things,

process or generate information, engage in research and design, or provide services to people. Collectively they must understand systems, technology, and matters of supply and markets far more than their assembly line predecessors. Therefore, individuals become more important especially those who can think creatively about solutions and can work collaboratively. This places an emphasis on training and professional development, and to assist the easier transfer of knowledge and ideas many companies are reorganizing themselves, flattening their hierarchies and setting up ad hoc working groups that focus on responding to particular issues (short or medium term) that impinge on policies and administrative practices.

Hence the problem facing companies is how to transform the workforce and the working environment in ways that stimulate employees and overcome resistance to change. This underlines the need for training courses not only directed at technical matters, but which address the thinking capabilities of the workforce and give them confidence in using those abilities more effectively. Such training is moving towards courses that draw on concepts from the social sciences and humanities. [The most recent revision of the OECD/Eurostat Oslo Manual incorporates these changes and will be released in 2005. This will lead to new indicators of innovation which will show how knowledge from different sources combines to add value to the business enterprise and to its workforce.] The consequence for the research reported in this thesis is that training courses associated with innovation should be directed towards thinking skills and preferences and placing them in context, and should therefore include interactive and social dimensions concerned with collaborative working and problem solving.

2.3 INNOVATION AND CREATIVITY

Innovation is a description of change, but a change in context which addresses a problem or an issue of concern to an organisation. The term also indicates a creative element: a solution not only directed at a problem or a perceived opportunity but designed to achieve aims in interesting, effective and novel ways. This brings with it an evaluation, typically given by others, with the implication that the innovation will command at least a degree of support. Thus, innovation requires a creative input placed in context; but contextual influences can also act as constraints on creative thinking, which further challenge the ways innovations are put into practice.

2.3.1 The nature of creativity

Some researchers have considered creativity to be a cognitive skill, and Guilford (1967) labelled it as such within his structure of the intellect model. However others, such as Gardner (1993), take a wider view of the mind which recognizes different cognitive styles and "multiple intelligences" *e.g.* linguistic, logical, spatial, musical and interpersonal which can be stimulated by a wide variety of contexts. Other researchers agree. Johnson Laird (1988 p203) defines creativity as a reference to "mental processes that lead to solutions, ideas, conceptualisation, artistic forms, theories or products that are unique and novel" but Weisberg (1993 p4) notes that for something to be creative it is not enough for it to be novel; it must also have value and be appropriate to the cognitive demands of the situation.

Consequently there are different definitions of creativity and different views of the creative process though there is general agreement that creativity, whether relating to performance, process, or the characteristics of a creative person, brings into focus originality (*i.e.* the ability to move from the common and conventional to establishing associations that hold novelty and interest) fluency ("the best way to have a good idea is to have lots of them" Linus Pauling quoted in Ritchie, 1995 p7) and flexibility of thought (*i.e.* to exploit themes in a variety of novel, distinct and appropriate ways). These are the basic criteria measured in the Torrance Tests of Creative Thinking (Torrance, 1962).

In considering more flexible ways of thinking Liam Hudson (1968) distinguished divergent and convergent thinking. The former emphasizes the many different and varied answers that can derive from a given theme, whereas convergent thinking is more analytic in nature requiring convergence on "correct" answers such as that required in conventional intelligence tests. Hudson believed individuals had different strengths in these thinking skills, suggesting a typology of convergent/divergent thinkers where one style counteracts or overshadows the other. But experimental evidence suggests the distinction is not sharp and is influenced by the context in which the stimuli are set. Zubari (2002) also found these contextual effects in her study with primary schoolchildren which used the Torrance Tests as one of the creative measures. In further developments Herrmann, in his Brain Dominance Model (1989; 1996) distinguished between analytic, organisational, interpersonal/empathic, and imaginative/creative thinking preferences. But while making these distinctions and using them in his typology of thinking profiles, Herrmann emphasized that all these preferences were useful, particularly in contexts which demanded innovative and collaborative problem solving.

2.3.2 Improving creativity

The main problem facing creativity in an organization is the inherited norms and values which can constrain or even block creative thinking, and one of the main purposes of creativity tools is to release the thinking potential of individuals from those restrictions. Traditional industrial oriented training/education does not necessarily promote creativity since the aim often is to produce pragmatic and productive workers that can identify problems, manage technical systems and critique the current state of things. But often little time or credit is given for ideas which disturb such systems or seem focused on more distant horizons. However times are changing and there is increasing interest in bringing techniques such as Brainstorming into training programs. Typically a group is encouraged to generate new ideas in response to a problem or an area of interest. They may use a set of stimuli designed to encourage and spontaneously spark off new ideas while, at this stage, critical judgement is suspended. Osborn (1963) has developed a package of recommendations, and guidelines for brainstorming which, although intended for use by a group, can also be adapted for individuals. These guidelines recommend that judgement is deferred, that quality of ideas comes from quantity, that free-wheeling ideas and associations are to be welcomed, and that evaluation, combinations of ideas and improvements are to be sought in further stages of reflection.

According to Osborn (*op cit*) brainstorming encourages the free running of the imagination as a positive condition for the emergence of potentially original ideas which may prove to be of value. He also proposes some administrative rules for these training sessions, *e.g.* don't criticize, quantity of ideas is to be encouraged, and exploration of ideas that come to mind and their associations are to be discussed later. More specifically, in problem solving situations, he suggests thinking should relate to the nature and scale of the problem and its requirements. Within that framework (which Osborn refers to as the design space) the team can then interactively suggests ideas, which can be free ranging and act as catalysts for other ideas. In this model brainstorming is a collaborative process and it is advisable to form an interdisciplinary team, or a team that is likely to have differing approaches. Initial groups may be large, but Osborn then recommends that smaller groups can focus on, evaluate and elaborate ideas which can be the basis for practical innovation. Osborn is also keen to exploit different modalities, *e.g.* drawings, flowcharts, idea-nets, and he comments that it is sometimes useful to videotape sessions for later review or clarification.

In the literature there is also advice about group size and membership. Osborn (1963) recommends a team of 8-12 participants, the group hierarchy should be flat and an experienced facilitator should establish an environment in which all contributors are valued equally. Diversity is important so it is useful not only to have representatives from different fields of expertise and different levels of experience but diversity also in personality type and background. He comments, "encourage participants to step outside their role as experts, and think outside their disciplines. Humour breaks a lot of ice, and temper specialists with some generalists too". It is also useful for participants to start thinking of ideas before attending the brainstorming sessions.

Evans and Wyler (2004) maintain that three variables determine brainstorming success. These are: *(i)* the nature of the problem; *(ii)* a group's potential for creativity; and *(iii)* a group's understanding of the problem. "A problem's fundamentals are a given and cannot be influenced. The potential of a group can be orchestrated somewhat by choosing a good combination of participants and by having a skilled facilitator, but the most significant factor that can be influenced is the team's understanding of the problem". However Isaken (1998) in a review of brainstorming research, points out that the technique is not always successful and may not produce novel and innovative solutions. He takes a broader view and explores creative problem solving to present a model that can help facilitators and team members choose appropriate techniques for their situation. This model divides creative problem solving into three categories, namely paradigm preserving techniques, paradigm stretching techniques and paradigm breaking techniques.

McFadzean (1998a; 1998b; 2000) explores these ideas and presents some examples of their application. Paradigm preserving techniques search for a solution very close to the source or nucleus of the problem and where the boundaries around the area of search are relatively unchanged (Van Gundy, 1992). In contrast paradigm stretching techniques widen the problem space and encourage more creative ideas such as using metaphors and heuristic techniques. In paradigm breaking, the boundaries of the problem are ignored and search is not confined to the vicinity of any previous solutions or approaches that have been adopted (Checkland and Scholes, 1990; Hicks, 1991; Morgan, 1997). Examples of these techniques have been provided by Van Gundy (1988) and Hicks (1991).

Stroebe and Dehl (1994) also describe a study showing that when groups were formed so that there was heterogeneous or complementary knowledge between members they generate more

ideas than groups that were homogeneous or had members randomly assigned. A further study was conducted by a large design consulting firm in USA. It focused on 45 engineers and was designed to improve creative thinking through a series of brainstorming sessions conducted over a twelve month period. Field notes were taken after each session and several conclusions were noted. For example, in reviewing group outputs, participants were more interested in the idea than in the quality of the idea and its value to the final output. The brainstorming sessions were reported as being enjoyable and stimulating, giving them a chance to look at problems in different ways and without the usual constraints imposed by the workplace. The experience helped to motivate participants and it was recorded that these attributes continued within their day-to-day responsibilities. In brainstorming sessions it seemed that the building of the ideas themselves was more important that producing quantities of ideas; it was the crux of the idea and the ways it could be opened up and elaborated that attracted effort and seemed to support "an attitude of wisdom".

An influential view of aspects of the creative process is provided by de Bono (1992) as a development of "lateral thinking" which has the characteristics of fluency and flexibility in idea generation and which seeks to extend and structure these characteristics in a series of creative activities. de Bono took the metaphor of the "six thinking hats" each being given a different colour to emphasize a different aspect of creative problem solving. First is the White Hat which has to do with data and the initial information about an idea or a problem. The white colour here represents white paper, which is neutral and carries information. Second is the Red Hat which has to do with feelings, intuitions, hunches and emotions about the task, where the red colour represents fire and warmth of response. Then there is the Black Hat which indicates caution, and critical judgement where evaluation of ideas takes place. Fourth is the Yellow Hat (the sun) which stands for optimism and a positive view of the ideas and progress: a Green Hat is for stimulating creative thinking and new ideas, where the green colour represents vegetation and rich growth. Last is the Blue Hat which is for the process control of the enterprise, with the blue colour representing the sky as an overview.

In using the six Thinking Hats to stimulate modes of thinking, de Bono suggests that such activities can be switched from one mode to another by wearing the suitable thinking hat at the right stage in the progression of the creative task. More specifically he notes that the creative pause allows thinkers time to consider their stance during the flow of discussion. Also important is Challenge directed at factors which are influencing thinking, *e.g.* assumptions, and constraints that can lead to the search for alternatives. These alternatives, through the concepts they

involve, can cascade to further alternatives forming what de Bono terms "a concept fan". Hence the importance of de Bono's work, which is wide-ranging, is the ways in which the ingredients of creative thinking are harnessed to the activities of creative problem solving, which, in turn, can lead to the development of the creative person.

2.3.3 Tools for improving creativity

The insights into the creative process stimulated the design of supports, usually in Card Forms, that could provide incentives and guidelines for generating and elaborating creative ideas in ways which disturb conventional approaches. For example Creative Whack Pack (Von Oech, 1992) consists of four sets of 16 cards following the roles of Explorer, Artist, Judge and Warrior, each of which suggests particular types of thinking. Hence the Explorer is expected to discover resources that could be used to create new ideas, and the cards in this suit highlight places and ways to find new information. The Artist has the role of transforming resources into new ideas, and the card provide suggestions on idea-generating techniques. The Judge is for evaluating ideas and deciding how they might be used, or modified, extended or discarded, while the Warrior is focused on implementing ideas in ways relevant to the problem. The aim is to provide motivation and impetus for moving from ideas to action. It is the responsibility of trainers to use the cards in ways which best suit their objectives and contexts. For example it may be arranged as a meeting of trainees at which the cards are randomised and dealt to the participants. As they make contributions the cards are played which indicate the roles they are following and to which other responses are made. The various and wide range of roles, and the ways these are worked out, draw responses that stimulate and bring more fluency and flexibility into the discussions. Also the cards can be used in more conventional brainstorming scenarios.

A further example is ThinkPak (Michalko, 1994) based on a SCAMPER model which sets out particular roles which may be followed in creative problem solving. These are:

S (Substitute) directed at substituting one concept or component with another

C (Create) focused on generating new ideas and fluency in thinking

A (Add) with the aim of elaborating ideas

M (Modify) bringing changes to concepts and ideas and perhaps altering their directional focus

P (Put to other uses) considering ways other uses can be brought into the discussion

E (Eliminate) directed at evaluation of ideas and the consequences of eliminating them

R (Rearrange) suggesting ways in which ideas can be re-arranged and re-related

Based on these roles, ThinkPak provides 56 cards which make their suggestions under the SCAMPER framework. The cards can be used individually and with groups within a variety of scenarios similar to Whack Pack but the cards are more closely focused on their roles. But the cards have "bullet-items" so that diagrams as well as suggestions, questions and examples are incorporated. This makes the SCAMPER approach easier to use.

Herrmann (1989) also reinforces the idea of placing creativity development in problem solving contexts. "Each person's experience is so unique and individual that no one can formulate a definition of creativity that fits everyone. Many people think of creativity purely in terms of inventiveness, and that is surely part of it. But if the process stops there the 'flash' evaporates." Herrmann wants the idea to be manifest, for something to happen as a result. Ideas should be applied in forms that "enable both the experience itself and your own reactions (and the reactions of others) to reinforce your performance. As you and others applaud your creative endeavours, you are likely to become more creative".

Following this theme, a further interesting research development was the proposed identification of particular stages of mental processes involved in creative activities. As early as 1926 Graham Wallas proposed a model of the creative process with four stages: *(i)* Preparation (identification of issues); *(ii)* Incubation (allowing the idea to develop, even laying it aside for a time); *(iii)* Illumination (when the idea takes form and finally emerges); and *(iv)* Verification (the checking out of the idea). Nystrom (1983) also attempted to identify cognitive factors in his model which noted: *(i)* Preparation (which requires receptiveness towards experience, an acceptance of ambiguity, and divergent thinking methods); *(ii)* Maturity in development (requiring independence of thought and a freeing of constraints); *(iii)* Identification of salient factors (which requires an ability to change to an analytical thinking mode); and *(iv)* Evaluation (which requires critical thinking).

Herrmann (1989) underlined the various phases of these models by noting the importance of "thinking in context". He went on to link the HBDI thinking preferences to the stages, suggesting that in Preparation the A and B (analytic and organisational) preferences would be useful. And individuals with these preferences would perform well with investigation issues. He considered that the "C" and "D" (interactive/empathic and imaginative) preferences would suit Incubation with the "D" preferences bringing in new ideas. Then "A" and "B" skills could

be brought into play for Identification, Verification and Evaluation. Herrmann also maintained that commitment to, and ownership of the solution by the team was important. These views suggest that problem solving teams require members that, between them, have strengths in all of the four thinking preferences.

Devising cards under the framework of these creativity models for application within training contexts has proved to be a popular activity and over 150 such thinking tools have been published. They are widely used, though it is hard to find experimental studies which have evaluated their benefits in practice. Rather, users of these tools (or their publishers) usually provide opinions taken from self-report questionnaires together with brief explanatory accounts. In MindSights (Frey, 2005) provides a software resource which seeks to help instructors decide which of the software supporting tools are suitable to their particular purposes. Each of the tools is presented via a template giving an explanation of what the tool is, how it can be used, and a worksheet for trainers to fill in their ideas and methods of use. For some tools MindSights interactively quizzes and guides trainers through scenarios, alternatives and solutions in what is termed a "focused ideation process". The system can also be used as a catalyst with work teams since it can be readily customized to support users' needs. To help this process a Navigation Grid is available which shows types of tasks and thinking strategies involved thus providing links to appropriate tools. MindSights is given a 4-star rating in the reviews, and Whack Pack and ThinkPak card sets both receive five star ratings. [See Innovation Tools: Creativity Software and Tool Reviews at www.innovationtools.com/Tools/SoftwareHeadlines.asp .] These data support the opinions of the researcher in deciding to use these tools within the training programs discussed in Chapter Six.

2.4 COGNITIVE AND PERSONALITY FACTORS IN COLLABORATIVE WORKING

The change in the nature of skills required by industry as it responds to the challenge of competitive innovation requires employer and employee consensus if changes are to be readily and effectively implemented. Companies put effort into changing their cultures, but this comes at a time when the workforce may have some fears that jobs might be lost or deskilled by developing technology. In contrast, Allee (1997) maintains that, in practice, changes in work patterns and policies are largely influenced by exchanges of information and opinions between

colleagues and that this informal sharing is important at all levels within the company. For example, a study by the Xerox Corporation Palo Alto Research Center showed that service technicians learned more about repairing copiers from sharing stories with each other than from reading the manuals, though it was noted that online information systems also can be useful supports for question answering, learning and knowledge building. This raises issues related to training methods and attitude change, but the overall aim is to utilise both informal knowledge held in people's experience with training methods which may well use technology to bring more collaborative and interactive methods into the training schemes. Allee comments that some 'soft' technologies go some way towards supporting these objectives, *e.g.* knowledge sharing forums, and collaborative planning supports that are designed to help the transfer of expertise.

Concurrently with this shift of interest, the industrial sector has been turning its attention to the cognitive and personality characteristics of the workforce, with management considering how these factors of individual difference should be taken into account in team building, particularly in collaborative working and problem solving.

An instrument which has aroused interest is the Herrmann Brain Dominance Inventory (HBDI) which attempts to assess thinking preferences under a four-quadrant brain metaphor. There were three major influences in its development. First, Carl Jung was an early developer of techniques for the classification of behaviour under personality types (Jung, 1923). He proposed that an individual's behaviour is not arbitrary or random, but has a pattern governed by the person's choice of preference for specific ways of functioning. Hence he suggested that such behaviour was classifiable. However personality deals with complex human behaviours and emotions, as well as cognitive processes, and a second influence on HBDI was the work of Roger Sperry. He suggested that the human brain has specialized functions relating to the right and left hemispheres, which can operate independently. Sperry's studies (1967) demonstrated that the left side is normally dominant in analytical and verbal task, while the right hemisphere assumes dominance in spatial tasks, music and other artistic pursuits. Sperry's theories opened the door for many studies and applications linking the thinking preferences of the brain hemispheres to a variety of cognitively related activities.

A third influence was Paul's MacLean's research (1978) on what he termed the triune brain theory, accommodating Biological/Physical capabilities as well as Social/Emotional and Conceptual/Intellectual attributes. Herrmann developed these ideas to build a model or metaphor of the human brain with two paired structures, the two halves of the cerebral system

and the two halves of the limbic system representing four modes of thinking. So, although the birth of Herrmann's work was based largely on physiological researches, he moved the emphasis to four thinking clusters which he termed thinking preferences. He went further and developed links between these thinking preferences (linked to the right/left hemispheres and the neo-cortex/limbic parts of the brain) to real life applications.

HBDI is a 120 item self-report questionnaire designed to elicit a person's thinking preferences under the four quadrant brain metaphor. The responses are classified as analytic (A), structural/organisational (B), emotional/empathic (C), and creative/imaginative (D). Other measures within HBDI include Left/Right dominance, Cerebral/Limbic balance and the ways the thinking preferences might shift under stress. [A more detailed discussion of HBDI is given in Chapter Five.]

A series of large scale validation studies has been carried out by Bunderson (1989) who concluded that HBDI provides a reliable and valid measure of mental preferences, but this validity depends on professional standards in administering the Inventory, and with data being scored by the approved method. A glossary of terms is used to provide meaning for the preferences, but it is also noted that, as with many measures of this kind, the validity also depends on honestly and freely given responses by the individuals who take it. Preference measures like those of the HBDI are coachable, and respondents could learn to produce profiles that are not sincere and authentic (Carey, 1997).

To be more specific, Bunderson reported six studies dealing with internal and external construct validity. These were conducted by himself and James. B. Olsen (1980) at the WICAT Education Institute. These studies involved 8000 participants covering a wide range of subject disciplines. The investigators also took correlates to other tests of cognitive abilities, *e.g.* Gestalt Completion Test, Ravens Progressive Matrices Test, and subtests taken from the Wechsler Adult Intelligence Scales. Further correlates were taken against cognitive style, *e.g.* Paivio Individual Differences Questionnaire, and the Word/Shape Sorting Test, and against personality measures, *e.g.* Four scales from the Myers-Briggs Type Indicator. From these studies Bunderson and his colleagues claimed there was substantial evidence for the internal and external construct validity for four distinct clusters of preference (the analysis methods were based on various types of Factor Analyses), namely the A, B, C, D preferences with second order factors of A*v*C, and B*v*D, and with a single third order factor of Left *v* Right Brain dominance.

It is highly likely that any four category or two-dimensional models of thinking will be over simplistic for many educational and training purposes. Herrmann was aware of this and did not seek to confine individual's thinking solely within the HBDI framework particularly as contextual influences or constraints could also operate against preferred styles of thinking or working. Herrmann also recognised there was a need for further research studies, directed both at validation and at the HBDI's applications in practice.

This researcher considers there are good reasons for recommending the use of HBDI as a means of aiding individual and group reflections on thinking preferences. HBDI is more detailed and situation-focused than many of its competitors, while accommodating many of the constructs which receive incomplete or less reliable coverage in those instruments. [This comparative judgement will be justified later in this chapter.] Herrmann's model is concerned with thinking and doing within practical contexts that include interaction and teamwork. It can provide descriptions at the individual and group level and it is more concerned with process rather than directly with product. It can be used in selection and in team building, but also as an individual reflector of preferences, and hence can be directly useful in training schemes. But it has to be presented as a tool for use in a climate of openness and trust. Bunderson has presented evidence of its validity and that it is psychometrically sound though there are relatively few independent studies of its reliability and validity in practical contexts (Allison and Hayes, 1996). However, although the instrument is not often used in academic research, it is more widely used in training contexts within industry and commerce.

It is difficult to obtain specific evaluative data of the application of HBDI within the business enterprise. Such studies tend to be kept as confidential information within companies and presented, in selective forms, as internal reports. However some general references and comments can be made which give a flavour of the range of applications, and there have been independent reviews of HBDI and its characteristics in comparison with other measures used in industry such as the Myers-Briggs Personality Inventory. [This issue is discussed later.]

A large application of the "Whole Brain" (HBDI) approach was employed by ABC Pharmaceutical Company with a workforce of 43,000 employees (Morgan, 1998-2002). Specifically, the application was directed at sales representatives in Australasia to improve their empathy and innovative thinking. The company first undertook a job analysis of selected employees, and then overlaid their HBDI profiles on these job specifications and their required skills. From this, adaptive training programs were designed to enhance the skill awareness and

innovative competence of the sales workforce. Progress data on performances taken after three, six, nine and twelve month periods showed improvements, and with a time reduction of from two years to less than twelve months to achieve "job mastery" in line with the company criteria. These improvements showed concretely in increased sales revenues over a three year period.

In 1998 the DuPont organisation (Casto, 1998-2002) used HBDI to improve the health and safety standards of staff both on and off the job. Following an HBDI analysis of the relevant workforce, the company decided on criteria for the thinking preferences in each quadrant in relation to safety issues. Then they introduced a training scheme to enable and ensure that operatives were aware of these HBDI characteristics and their safety associations in their job responsibilities and when working with others. The aim was to induce in the workforce a more critical awareness to these aspects. An impact study reported higher safety standards, but it was also noticed that the training experience influenced the ways managers perceived their employees and how they, as managers, conducted their reviews. For example they asked questions designed to elicit values and ideas, and encouraged workers to reflect more and positively evaluate their "significant performances". Such discussions took on a wider orientation and touched on opportunities, constraints and interest factors that would not have been raised previously.

Another application of HBDI was undertaken by the MidWest Procurement Bank (Thomas, 1998-2002). The company provides organs and tissues for transplantation and relies on organ/tissue donors; the company needs to encourage these donor decisions. How this is done by the company employees requires a sensitive and empathic approach, but hospital staff busily engaged with patient care often react to approaches that seek to encourage organ donation with indifference or even view such approaches as an intrusion. Two groups of sixteen employees of the Procurement Bank experienced a Whole Brain (HBDI based) training program that emphasized communication skills, conflict issues and empathic techniques *i.e.* the program focused on "C" and "B" quadrant skills. HBDI profiles of the trainees were used for illustration and awareness training, and as a basis for group activity selections and tasks. The study reported that the teams learned to better position their requests, were more persuasive in their arguments and improved their empathic skills (*i.e.* by listening and taking other views into consideration). Subsequently the groups interacted more successfully with hospital staff and with the families involved. Another unexpected effect was that the members were more effective in dealing with members of the board of directors of the Procurement Bank (who were all experienced clinicians and surgeons). There were fewer disagreements and challenges and

there was some evidence of changed attitudes among the staff. "I'm a better listener" and "I'm better at understanding others" are among the reported comments.

These applications of HBDI have largely been directed at training objectives dealing with particular needs or opportunities perceived by the business enterprise. HBDI has given a useful framework and vocabulary for understanding the relevance of thinking preferences in relation to training curricula and objectives, and has been used to direct self reflection and awareness, as well as guiding the selection of teams in collaborative learning activities. These approaches were also followed by Hallmark Cards (Jefferson and Gustavson, 1998-2002). This company saw opportunities to achieve substantial growth targets, and under a strategic plan which identified knowledge and skill needs, designed a training scheme that focused on team work, specifically with the project and managements teams of the company. The training incorporated HBDI to give an understanding of differing thinking preferences, emphasized the benefits of being aware of such differences in collaboration, and in dealing with innovation. HBDI gave a structure and meaning to the team activities as communities of practice that were "strategy driven" were developed. The system is ongoing and reported to be successful, but no specific evaluative data of these effects have been published.

There are many instruments which attempt to measure and establish typologies of styles of traits of personality, thinking and learning. Coffield, *et al* (2004) have undertaken an extensive and excellent review of thirteen such instruments in a report which asks "should we be using learning styles; what does research have to say in relation to practice?" It should be noted that there is continuing controversy about terminology. Traits assume a degree of permanence and prominence in thought and/or behaviours. Styles seem to make less dominant claims, while preferences suggest patterns will occur but contextual circumstances can inhibit or induce changes—in brief there is some flexibility in the ways preferences are taken up or modified. Hence in considering Trait/Style/Preference measures of thinking, personality and behaviour, data on their reliability and validity are important. This issue is particularly relevant to education and training since pedagogies have to appreciate and come to terms with a complex of influences that concern organisation and management, learning theories, and individual differences, and the dynamics of communication and collaborative interactions. It is not surprising therefore, that very many papers and reports have been written about instruments such as the Myers-Briggs (Personality) Type Indicator (MBTI), the HBDI, and the Kolb Learning Style Model. Thorough research reviews, such as Coffield, *et al* (2004), are extremely useful.

Coffield, *et al* (*op cit*) group the thirteen instruments reviewed under five classes which include those based on conceptions of learning, on cognitive structure, and, of particular relevance to this thesis, on personality types (*e.g.* Myers-Briggs Type Indicator), and on "flexibly stable learning preferences" in which Kolb's Learning Styles and the HBDI are placed.

The review also identifies the various ways such instruments are used, for example, diagnostically, in selection, and (as been noted earlier in this chapter) in training where the emphasis is sometimes strategically focused, or directed at self awareness of preferences with the aim of improving weaknesses or extending the range of thinking.

The MBTI (Myers and McCaulley, 1985) based on Jung's bipolar scales was developed into sixteen personality types which include intro-extraversion, sensing and intuitive characteristics, thinking v feeling and judging v perceiving styles. In brief, the instrument is directed at personality but takes a wide enough view to be related to learning. MBTI is well used in industry and training and Coffield et al note that its reliability measures are high and its face validity "is generally accepted". However its main use has been in selection and counselling to guide students and staff into appropriate areas of employment and study. In practice there is little evidence that utilising such data in the classroom, *e.g.* by matching teacher and learner characteristics has any positive effect on achievement (Coffield, *et al*, 2004).

Kolb's learning styles (Kolb, 1984; Kolb, *et al*, 2000) has attracted much educational interest. It distinguishes four learning styles based on a learning cycle in which "concrete experiences" are a basis for observation and reflections which, in turn, becomes formed into abstract concepts. These stimulate implications leading to hypotheses which can be actively tested providing further experiences. Thus the learning cycle continues. Within these learning activities Kolb differentiates four learning styles, namely: Diverging (*i.e.* looking at things from different perspectives); Assimilating (following an approach focused on ideas, concepts and explanation); Converging (on practical issues); and Accommodating (relying on intuition rather than logical analysis)

Coffield, *et al* (2004) while recognizing the theoretical basis of Kolb's system which is linked to patterns of learning behaviours, note that there is continuing controversy over the reliability and predictive validity of the learning styles. Kolb's intention though was to provide a self-indicator of preferred modes of working: the framework maintains its educational interest because of its suggestions for the design and management of learning experiences, and because of the ideal of

students becoming balanced learners. In spite of this, Coffield, *et al* (*op cit*) conclude that the evidence of its pedagogical impact is slight.

The Herrmann Brain Dominance Instrument (HBDI) has a development history extending over twenty years, and its whole brain approach incorporates growth and development including creativity and empathic factors in collaborating with others. Herrmann hoped the HBDI self assessment information would not only show preference strengths but encourage users to be aware of all types of thinking preference and thus aim to become more flexible learners. However, its use does require a clear understanding of its terms, and since it is a self report questionnaire it can be prone to users projecting ideal rather than accurate profiles. Bunderson's work (reviewed earlier) was large scale in its validity/reliability studies but, as was noted, although relatively well established in the business world there are few evaluative studies of HBDI applications. Coffield, *et al* (*op cit*) point out that its pedagogical implications have not been fully explored or exploited. Their assessment, which was influential in the choice of HBDI for this research, comments: "HBDI is a model which, although largely ignored in academic research, offers considerable promise for use in education and training. It is more inclusive and systematic than many others, taking an open and non-labelling stance towards the development of people and organisations."

2.5 COLLABORATIVE PROBLEM SOLVING

Teamwork is an important ingredient within the business enterprise—"tough problems require teams" (Oakes, 2000). Although it might be expected that collaborative working is common in schools, this cannot be guaranteed in the business enterprise and it is likely that employees will have to be trained in effective group working and thinking. And teamwork is likely to be required for innovation. Indeed individual perceptions and differences in thinking can help to trigger innovative ideas within a group. "Synergy is where the whole is greater than the sum of its parts. It results from valuing differences by bringing different perspectives together in the spirit of mutual respect."(Covey, 1989). Jackson (1992) maintains that an important characteristic of successful teams is the power of creative collaboration, while Schrage (1990) also notes "the process of shared creation is two or more individuals interacting to create a shared understanding that none had previously possessed or could have come to on their own".

However, designing functional teams which take account of their thinking preferences is a complex task and it is not always clear what differences to take into account, how they should be measured and how a group synergy should be brought about. Most approaches to these problems have focused on using inventories directed at cognitive, personality and attitudinal styles, and then considering how teams, appropriate to the types of collaborative tasks, should be assembled, and the previous section reviewed some commonly used instruments.

Typically problems arise when task objectives cannot be met using tried and tested procedures. Often this is because the task is set in a new context, or the conditions of the task itself require a novel approach, hence the link to creativity, lateral thinking (to use de Bono's phrase) and innovation. Various methods of attack have been advocated in the research literature. For Gestalt psychologists such problem solving required rearrangements or reorganisations in thinking leading to insights or re-conceptualizations. But other types of problems such as the Tower of Hanoi require the problem solver to make apparently 'backward' moves away from the goal in order for a progressive cycle of moves then to be set up. Hence, problem solving covers a range of tasks and settings, in which generalities in method cannot be easily perceived but which seem to involve heuristics, such as breaking problems into parts, thinking analogously, and working backwards from the goal. Newell and Simon (1982) attempted to build such heuristics into a computer program (GPS) to solve well-formed problems in crypt-arithmetic, chess and logic. Although this endeavour provided some useful insights its range of applications was limited.

In business settings problems are less well-formed, and typically several solutions can be proposed. Discussion is likely to centre not only on goal clarification and methods, but on particular advantages and disadvantages of the proposed methods in terms of the criteria which the task goals seem to imply. Such problem solving is usually undertaken by teams, so there is interest also in how the interactions and engagements of the participants can be managed efficiently and what techniques to stimulate ideas (*e.g.* brainstorming) might be employed. Typically many commercial training companies consider themselves competent to advise companies in these matters but they also have their own preferences in training methods and tools (*e.g.* ThinkPak and Whack Pack). The collaborative interactions within teams and the 'bonding' that ensues when they are united in a common purpose, and when participants learn to recognize, value, and engage with other viewpoints is clearly important. This raises issues not only of training but of methods for selecting and building effective teams. Again, as was seen from the reviews in the previous section, training companies employ tools (*e.g.* HBDI) to select

teams to a prescription, but evaluative data on process and benefits are sparse and only general outcomes (usually reported as successful) are noted in project reports. No data on the types of interactions between and within teams is given so the process by which solutions unfold and how these solutions relate to the characteristics of the teams remains unclear.

One of the best sources for discussing cognitive preference data in building project teams is provided by Wysocki (2001). He illustrates the discussions, which are based on the use of HBDI, through a series of case studies which are hypothetical but derive from his experience. For example he takes a pool of sixteen participants, with full HBDI data, to make team selections which, in his view, suit various problem tasks. He discusses in a critical way the strengths and weaknesses of these choices and this is the main value of the book. Wysocki illustrates in his case studies the various types of interactions and barriers that may occur under normal working and under stress conditions. Thus he identifies the challenges in team selection and building, the difficulties that can arise, and how they might, at least in part, be overcome.

Using HBDI and the resulting data to deal with specific problems in a business enterprise has been shown to be useful, but the research reported in this thesis holds the view that companies are likely to encounter a whole raft of opportunities and problems when introducing or following a general innovation strategy. Hence it is beneficial if a significant number of employees, not only those in selected groups, become more self aware of their thinking preferences and those of others. Also of interest is how these differences can be utilised within an individual's own responsibilities in the company, and in meetings with others so that such collaborations become more interesting and effective.

2.5.1 Some HBDI applications related to training in problem solving and innovation

It must be repeated again that references taken from business publications and studies reported by training organisations or companies tend to be descriptive accounts which lack details of methods, and data on process which relates outcomes to interactions and HBDI profiles. Further, there is no guarantee of a critical peer review. However, some projects relevant to the interests of this research are now summarised, mainly to indicate the scope of their applications and the various objectives and functions they assumed within the business organisations.

A common objective of companies is to improve productivity, and DeRidder and Wilcox (1998-2002) report such a project with the USDA Forest Service. Following an examination of product efficiency, and drawing on the ideas of Katzenbach and Smith (1993) DeRidder set up teams within the Forest Service using HBDI data to make selections. Some teams were balanced and strong on all four quadrants whereas other teams were strong on three or two quadrants. All the teams were then given problem tasks related to their work. The data showed that the four quadrant balanced teams took longer to complete their assignments, raised more issues in discussion but gained high achievement. The other teams scored less well, and their discussion were more limited and less well focused. In a further series of long term training schemes that engaged a variety of problems and where teams of different sizes were used, DeRidder and Wilcox concluded that quality of performance and efficiency were related to the types of functional tasks given to the teams. For example, when the task objective was clearly focused then efficiency (*i.e.* a measure which took into account speed and adequacy of solution) was best achieved by increasing the size of the team which could work in a coordinated fashion. When the task objectives were more complex then it was more important to have a smaller but well balanced team that could explore a variety of approaches but in a manageable way. Again, the importance of training in collaborative team working, and the building of teams through experience, was emphasized.

Martin's (2000) case study was directed at this latter objective. It was undertaken with undergraduates at University College, Chester and was designed to develop a learning community using cooperative experiential methods in contrast to more traditional learning approaches. Students completed HBDI questionnaires and had their results available for a Workshop in which the Quadrant model and Whole Brain approach were discussed, particularly the use of thinking style differences as a resource in collaborative working. Students were asked to form teams of four or five members with a spread of thinking preferences. These teams had to research a topic (*e.g.* listening skills) by devising a learning strategy, developing their outcomes, reflecting on their methods and writing an evaluative report on the experience. The reports were positive, and collaborative working was judged to be effective because the learning was seen not only as personal growth in developing thinking styles, but also as a collaborative process in which awareness of, and engagement with, other peoples preferences and viewpoints were beneficial. The students also noted that if learning logs were kept during the study they would be useful in reflection and aid the development of both the individual and

the team building process. The general recommendation was that this pedagogy should be extended to other areas of the curriculum.

Using HBDI as a means to encourage creative thinking but also to establish a synergy between different functional groups in a company is reported by Herrmann and Herrmann-Nehdi (1998-2002). The company was Proctor and Gamble which had problems with their brand image, and wanted to improve their advertising investment. It was decided that the advertising agency team and the brand team should think more creatively and in ways which could lead to greater understanding and coordination between them. Training workshops were designed that used HBDI data to make teams more aware of their differing thinking preferences and the characteristics of the Whole Brain approach. Following this, and as part of the workshop, the two section teams were linked in solving a series advertising problems. It is reported that the teams became more engaged, were more interactive and showed more understanding of other viewpoints. The participants and the company considered the project to be a success and altered both their training courses and working practices.

The aim of increasing diversity in thinking was also the focus of a study reported by Herrmann (1998-2002). The context was a multi-national lighting manufacturing company where the concern was that the forty plant managers were very similar, and conservative, in their approaches to management. An extended series of workshops based on HBDI was designed around decision making exercises where emphasis was placed on diversity in thinking and on communication between participants (*i.e.* the thinking preferences associated with the C and D quadrants). The exercises were prefaced by an explanation of the Whole Brain approach and discussion of individual HBDI profiles. From these data both homogenous and heterogeneous teams were formed for the exercises which resulted in "significant differences" in the team behaviours and creative outputs. This led to follow-up meetings in which the results were linked to company management procedures and work optimization techniques. To ensure these methods were assimilated in the company, and senior and middle management were linked effectively, the Vice President took control of the project.

Several case studies addressing company problems which seem to require a more innovative approach use HBDI to identify a mismatch between thinking preferences and the requirements of the task-in-hand, and seek to remedy these deficiencies by devising specific training schemes and workshops. For example, Herrmann-Nehdi (1998-2002) noted a case study which identified problems in relationships with long-term clients of a large commercial printing company. An

HBDI analysis was undertaken of cross functional teams from the sales, operations and customer service departments. It was found that their HBDI profiles had an analytical/organisational (A/B) bias which seemed to match the "mental tilt" of how these teams operated with clients. Training schemes pointed out the meaning of this bias and oriented training towards the "D" (interpersonal/empathic) thinking preferences. The aim was to strengthen the weaker or less preferred styles in relation to job requirements. The reported results were very satisfactory with no long term customer fallout and a strengthening of the customer base.

A similar approach was taken by Iwata (1998-2002) with a company experiencing major growth but encountering problems managing that growth for example with new staff, and with information transfer and communication between sectors of the company. Employees were asked to complete a job analysis grid and to take an HBDI analysis of their thinking preferences. By comparing grids between interacting groups in the company and their HBDI data, and discussing these results it was possible to increase awareness of preferences in relation to job requirements and to make staff transfers to improve communication and performance. This reduced tension between sales representatives and internal support staff and improved employee morale.

In summary, these studies indicate that, in response to competitive pressures, some businesses seek to respond and improve by identifying particular difficulties or constraints within their practices, typically relating to changing job or staff requirements and developing training and workshops (often HBDI based) to overcome them. Such methods carry a relatively high measure of success, but they tend to be ad hoc, produced to meet a short-term need, and focus on particular sections of the workforce. In contrast, the research reported in this thesis takes a more general and wide-ranging approach to innovation. It uses HBDI as a data gathering instrument of the thinking preferences of the workforce and reinforces the value of these data (across the KEMYA petrochemical company) by an understanding of the Whole Brain approach, reinforced by training schemes which incorporate creativity, and exercise and utilise different thinking preferences in collaborative team working and problem solving. Further, assimilation within the company's policies and practices is to be achieved by designing an HBDI database and browsing system, by bringing such courses within the KEMYA training schemes, and developing a suggestion system through which the ideas of the workforce can be brought to the attention of the management Equally important, and in contrast to reported

studies, this research hopes to understand more fully the relationship between HBDI preferences and the processes and outcomes of team working and collaborative problem solving.

This approach to innovation, though wide ranging, is incremental and is to operate within the current organisational structure of the company—though the system is tolerant of different company structures. Hence, we believe it is likely to be successful. In contrast, large companies can respond to innovation and bring about change through fundamental restructuring, for example by downsizing, outsourcing or engaging in takeover bids. These policies can be successful but they result in disruption to the organisation and its workforce, and are generally regarded as high risk strategies.

The next chapter will outline the context of the research *i.e.* the KEMYA petrochemical company in Saudi Arabia, before discussing the main phases and conclusions of the research.

CHAPTER 3

The Setting for the Research

3.1 A BRIEF BACKGROUND OF SAUDI ARABIA AND THE PETROCHEMICAL INDUSTRY

Saudi Arabia is the largest country in the Arabian Peninsula. It has two coast boarders, one on its eastern side at the Arabian Gulf Sea and the other on the western side where there are mountain ranges rising to 9,800 feet to form a palisade defining the Red Sea coast. From the west, the Arabian Peninsula land slopes east to the Arabian Gulf (see Figure 3.1). Shallow seas that covered this region 150 million years ago left behind thick layers of sedimentary rocks perfect for the accumulation of oil and gas. With its crude oil reserves of some 260 billion barrels, Saudi Arabia is also among the world's top five countries in natural gas reserves, now estimated at well over 200 trillion cubic feet.

Figure 3.1 A map of the Arabian Peninsula

The structure of the Saudi petrochemical industry has been evolving throughout its 150 year history, and drivers of the more recent changes have also been present for many years. The foundations of today's petrochemical industry were laid in Germany and the UK as spin-offs of the 19th Century Industrial Revolution. After the Second World War, the industry's focus shifted to North America, and later to Japan, but over the past 30 years or so, the global petrochemical industry has also been undergoing some dramatic structural changes.

The Middle Eastern petrochemical industry developed in the late 1970s to add value to the gas flared at the crude oil well-heads in Saudi Arabia. As oil revenues grew, a coordinated plan emerged to collect and distribute gas that was flared to two yet to be built industrial sites where it could be used in basic industries. The two sites selected were Al Jubail (a city on the Arabian Gulf where the research reported in this thesis was conducted), and Yanbu (a Saudi city on the Red Sea). In 1975 the Royal Commission for Al Jubail and Yanbu was created and given authority to plan, construct, manage, and operate the infrastructure needed to support these basic industries and to satisfy the community needs of the work force employed in these industries. The commission was also established to promote investment in secondary and supporting industries, to develop effective city government, and to train Saudis to take over as many jobs as possible. The commission received an independent budget to facilitate its work.

Since the late 70s, Saudi Arabia and other Middle Eastern oil-producing nations have been attempting to diversify their industrial structures as they seek to reduce their dependencies on oil exports. In this respect, high hopes are held for the petrochemical industry in particular due to the competitiveness of the region's abundant supply of low-cost feed stocks. The industry has been pushing forward with aggressive expansion that has included foreign investment in joint ventures, and its presence in the global petrochemical arena continues to grow year by year. Other countries in the region followed suit, also promoting projects based on ethane extracted from associated gases. The availability and cost of this ethane, therefore, formed the main driver for developing petrochemical projects in the region as shown in Figure 3.2 below.

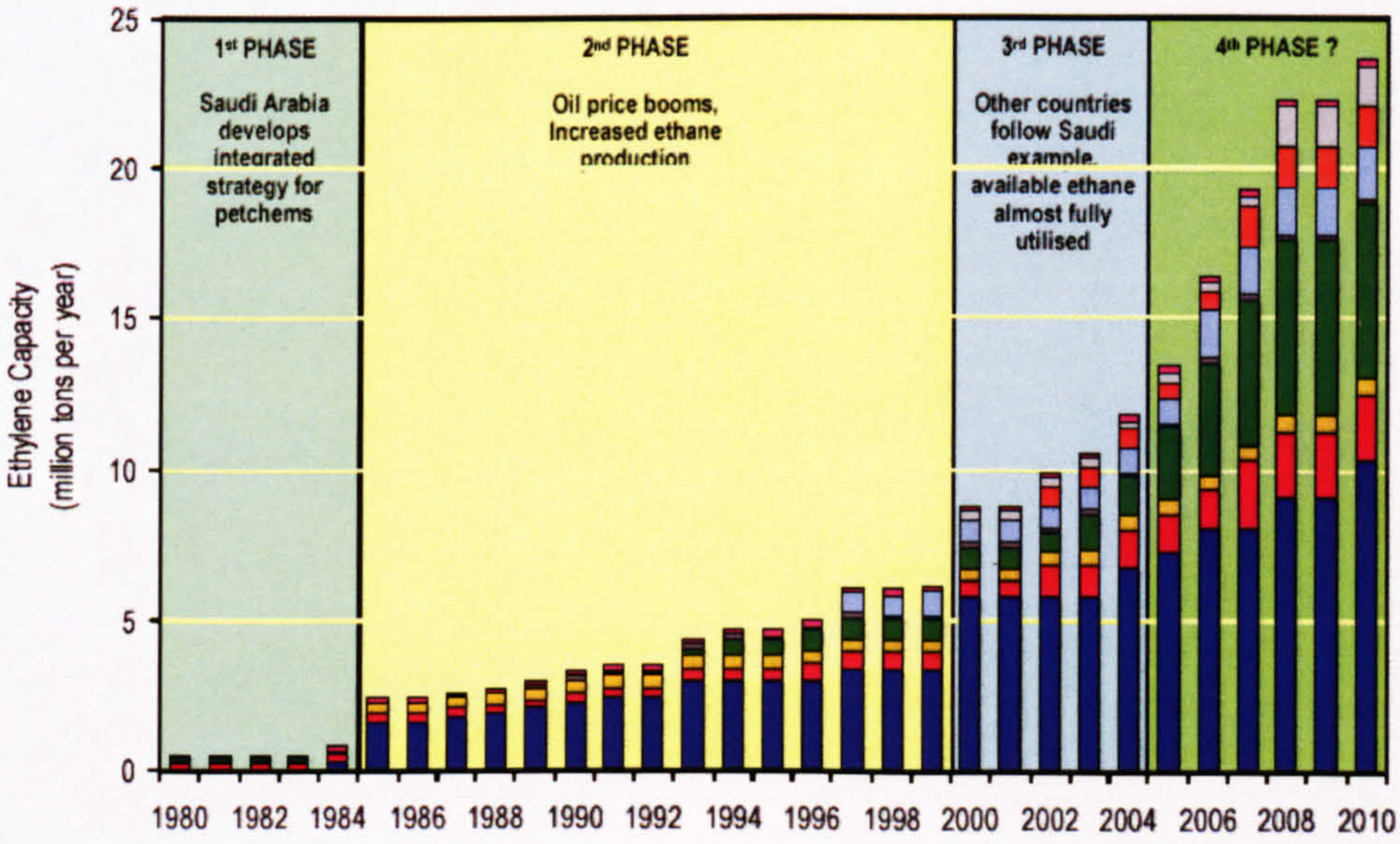


Figure 3.2 Ethylene capacity growth in the Middle East

The region has already embarked on what is termed the 4th Phase, and a number of fundamental changes have occurred in the overall industry structure affecting both the public and private sectors.

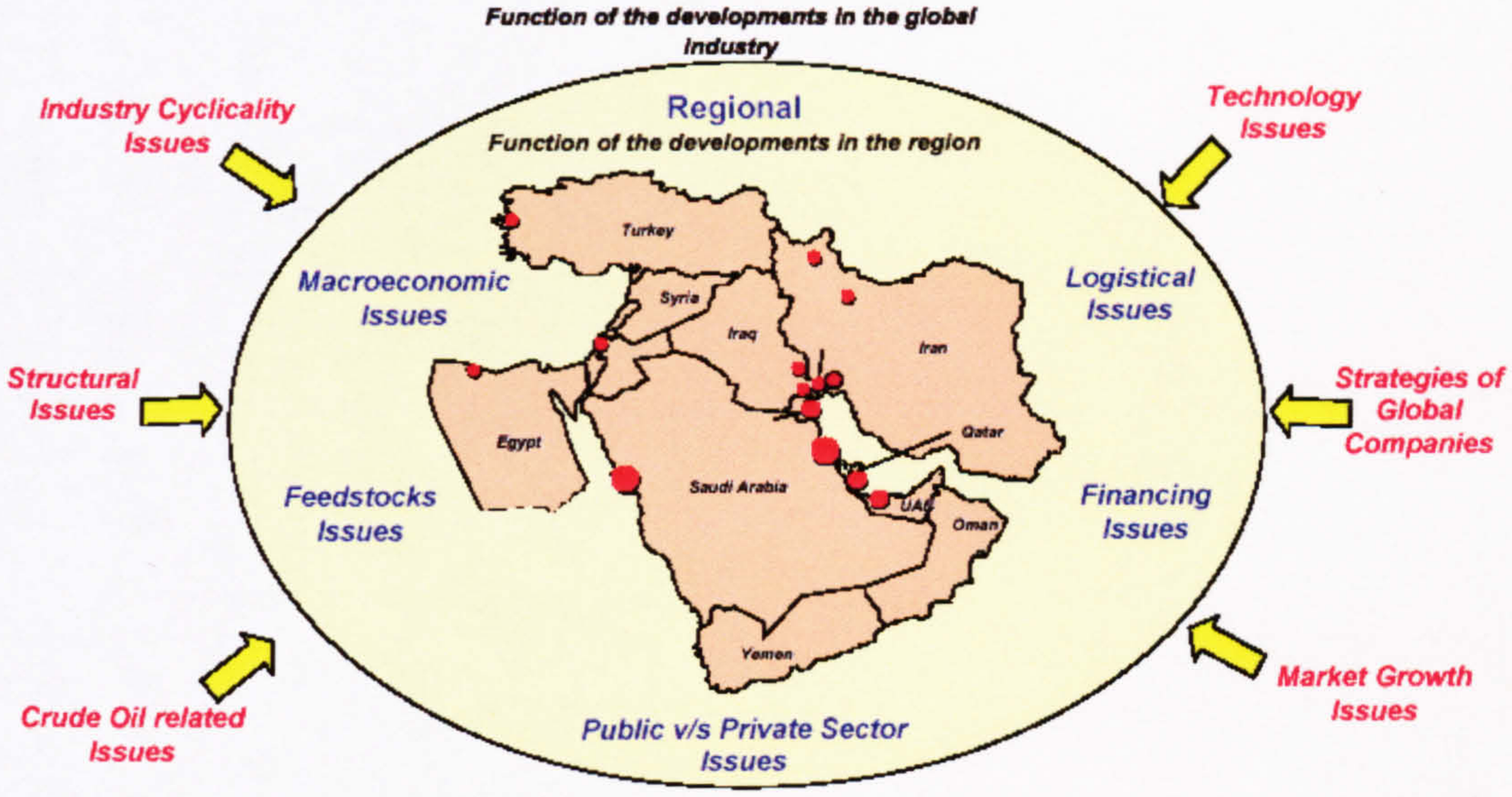


Figure 3.3 A map of the Middle East showing the public versus private sector issues

As shown in Figure 3.3 the public vs. private sector issues are affected by the workforce innovation strategy, since there are significant investment opportunities which, to be fully effective, are dependent on a trained and committed workforce. Further, since investments are often multinational and have to be competitive in the global market place, foresight and innovation are prominent in the thinking and policies of these business enterprises.

3.2 A BRIEF BACKGROUND OF THE SAUDI BASIC INDUSTRIES CORPORATION (SABIC)

SABIC was established in 1976 as the largest listed company in the Middle East with a market capitalization of $120 billion and total assets of $33.3 billion. The company is also the largest independent petrochemical company in the world in terms of market capitalization and net profits. In addition, the firm is the fifth largest diversified petrochemical company in terms of sales, after BASF, Dow Chemical, Bayer, and Du Pont. SABIC consists of eighteen world-scale manufacturing subsidiaries in Saudi Arabia, most of which are operated with regional and/or multi-national partners, such as Exxon Mobil, Shell, Fortum, Ecofuel/ENI, and Mitsubishi

Chemicals, while two are wholly owned by SABIC. Further, SABIC holds a stake in seven sister companies, which amounted to a book value of SAR 2.6 billion at the end of 2004, operating in the fields of petrochemicals, shipping and utilities. SABIC's business activities have been restructured into six Strategic Business Units: Basic Chemicals, Intermediaries, Polyolefins, PVC and Polyester, Fertilizers and Metals. SABIC is currently ranked as the world's second largest producer of Methanol, and Ethylene Glycol; the third largest in polyethylene; the fourth largest in ethylene; and the sixth largest producer of polypropylene. The dominance in the petrochemical sector is principally the result of significant competitive advantage because of access to cheap feedstock from natural gas. This advantage is magnified during high oil prices.

SABIC's current strategy is to expand capacity, and diversify globally into different markets through acquisitions and joint ventures. From the start, the Saudi petrochemical industry has looked for business partners, who would provide licensing technology and product marketing. This has resulted in forming partnerships with international petrochemical companies. So far, about 56.2% of Saudi Basic Industries Corporation's (SABIC) petrochemical production facilities have been founded on the basis of joint ventures. The estimated value of projects under design/planning for the years 2002-2005 is $3.6 billion. This figure represents the total of investments planned by European, Japanese and other international petrochemical companies for joint venture projects with Saudi private sector companies. It is likely that joint ventures in the petrochemical sector will continue to be practical, effective and successful. It is expected that the rate of new joint venture agreements in Saudi Arabia will increase as a result of the implemented new foreign investment law, which does not require a local sponsor for the foreign investor, permits a foreign licensed company to gain full ownership of its project including land, and regulates the maximum tax rate at 30% on profits over $266,666.66. Also, the new law qualifies fully owned foreign companies for loans from the Saudi Industrial Development Fund (SIDF).

According to Al-Mady (2004), the petrochemical industry has and always will be driven by the availability of competitive raw materials first coal, then oil, and now natural gas. In terms of future industry development, the Middle East is at the centre of strong global growth. At the same time, these countries are developing export-oriented projects both government-owned and/or private sector in order to gain larger global market shares in basic petrochemical products.

In the Arabian Gulf region, the cumulative total investment in the petrochemical sector amounted to 37 billion US dollars by the end of 2002. And another 40 billion dollars of new

investments are expected by 2010. Ethylene capacity in the Middle East has grown steadily, from 3.9 million metric tons or 5.4 percent of world capacity in 1993, to 9 percent of world capacity in 2003. At the same time exports of ethylene-based products are forecast to grow from 5.7 million tons in 2001 to 11.5 million tons in 2006. Exports of propylene-based products are forecast to triple in 2006 from 2001 levels of 450 thousand tons. Also, by 2006 extra capacities of benzene and para-xylene based products are forecast. It is expected that Europe and the Americas will remain the world's biggest chemical markets, and their growth rates are expected to keep pace with their annual GDP growth rates.

In summary, Saudi Arabia is a pioneer in the Middle East Petrochemical Sector. The Kingdom has transformed itself in just 20 years, from a net importer of petrochemicals to a major exporter of petrochemicals to more than 100 countries. With the recent acquisition of petrochemical businesses in Europe, SABIC has become the world's third largest producer of polyethylene and the sixth largest producer of polypropylene. Saudi Arabia is also seeking membership to the World Trade Organization (WTO), which will also open doors currently closed to SABIC in the WTO member nations. It is within these developments that the Saudi petrochemical industry has to operate and take full advantage of opportunities that arise.

These observations indicate that Saudi Arabia has strong commitments to become an active player on the world's industrial stage. And it is using its resources and international collaborations to achieve this aim. However, Saudi Arabia also holds a special place within the Islamic world, and its culture and laws take account of this responsibility. But the social and political framework can accommodate, and does support commercial enterprise. Also, Saudi is taking due note of the educational requirements needed to allow people to participate in these developments, and add to their intellectual and material prosperity.

3.3 A BRIEF BACKGROUND OF THE AL-JUBAIL PETRO-CHEMICAL COMPANY (KEMYA)

It is against this background of expansion and competitive development that the research reported in this thesis was placed within the Al-Jubail Petrochemical Company (Kemya), and it was with this company that the researcher discussed and negotiated the form the research could take. This placed emphasis on the utilization of HBDI data, training in creativity, and collaborative problem-solving, and the value of considering thinking preferences in effective

team solution and working. The company is eager to maintain an innovative edge in its policies and working practices, and therefore readily agreed with these research objectives and gave its full support to the work. Periodically, the researcher was invited to give presentations to the company and to attend policy meetings. The researcher is very grateful for this cooperation.

Kemya is a joint venture of Saudi Arabian Basic Industries (SABIC) and Exxon Mobil. The meaning of the term "Kemya" is Chemistry in Arabic language, and Kemya was Saudi Arabia's first polyethylene producer at start-up in 1984. It is also one of the largest polyethylene plants in the world, with an annual capacity of 1.1 million metric tons, and also earned the Construction Industry Safety Excellence Award for its performance during the significant expansion projects from 1998 through 2000. Nonetheless it is operating in a highly competitive industry.

As noted, KEMYA is a multinational organization and a joint venture of Saudi Arabian Basic Industries (SABIC) and Exxon (later becoming ExxonMobil). The aim of this joint venture from the Saudi Government perspective is to utilize its oil assets and to train Saudis to work and operate effectively within a big commercial and competitive enterprise. In its initial stages, KEMYA recruited different nationalities in the operation, engineering and senior management levels, but they also recruited Saudis at all levels. Hence it was necessary to develop a variety of training courses. Staff were technically qualified but it was necessary to enable them to cooperate effectively within a multi-national and multi-cultural workforce under the KEMYA corporate vision. The courses included Quality Programs (Total Quality Management; Your Role in Quality); Safety Programs (safety in relation to chemical issues); and Interpersonal Skills (working with diverse cultures, and effective communication). Also, non-Saudis are requested to attend a course about the Saudi culture even before they come to Saudi Arabia. It should be noted again that although an objective is to enable Saudis to take and fulfill their responsibilities within KEMYA, the long term aim is to have employment policies that have no particular or cultural bias. The company employs the strongest high quality and committed workforce available.

With the research objectives in mind, an initial survey and analysis of the HBDI thinking preferences of Kemya employees were undertaken. The selection of participants was made from all administrative levels and departments of the company with the understanding that these participants would be available to attend the training courses and take part in the other activities required by the research. Four-hundred-and-fifty-two employees completed HBDI questionnaires, and the analysis of the resulting data is discussed in the next chapter.

CHAPTER 4

The Research Design

The overall aim of the research was to improve and direct an innovative culture within the KEMYA business enterprise so that it can operate more effectively in a global competitive economy. The research strategy was to emphasize that such an objective is for the workforce in all departments and at all managerial levels—from Superintendent and upwards: each member of the workforce can become more effective and creative within their particular responsibilities. However, it was necessary for the researcher to explain this approach and gain the support of senior management since the necessary training and other related activities would take people away from the workplace, and would require some technical support. [This support was granted and the researcher reported periodically to company committees.]

Under this strategic view three interlinked components were designed with the HBDI instrument being a coordinating factor in developing the cognitive capabilities and orientation of the workforce. As was noted in Chapter Two, the HBDI spans four types of thinking preferences; namely, the analytic (A), the organisational and structural (B); the empathic and interpersonal (C); and the creative and imaginative (D). A first phase of the research design was to undertake an HBDI analysis of the thinking preferences of a representative selection of the workforce (approximately 500) from all departments, managerial levels and cross-functional teams. The HBDI questionnaire is long (120 items), needs to be understood in its objectives and terminology, and requires participants to recognise its value, to be cooperative, and to be interested in the data it reveals. It had to be understood that no one preference was better than another, but all were useful in undertaking tasks, and to be aware of one's own thinking preferences and those of others was valuable particularly in collaborative working.

The aims of this phase of the research were:

(i) To enable participants to be aware of the meaning of HBDI thinking preference data in relation to themselves and to others, and how this information can be useful in their work, and in working collaboratively.

(ii) To identify, from the analyses, how a training course, linked to creativity and collaborative working, could be fashioned and adapted to the needs of the workforce. [Of particular interest were the C (empathic/interpersonal) and D (creative) preferences data in comparison to the analytic (A) and organisational (B) preferences for a workforce within a highly technical business enterprise.]

(iii) To make an assessment, from this analysis, of the value of establishing an HBDI database to assist the company in assembling effective project teams and cross-functional groups.

A second principal component of the research strategy was the training course available to all employees who had taken part in the HBDI analysis. [In practice, since the course was extensive and employees had to be taken from the workplace, negotiations had to take place with managers, and nineteen courses were given to training groups.]

The courses had three interlinked sections. The first was designed to give greater understanding of the HBDI instrument, the value of knowing the thinking preferences of themselves and of others, and how these differing preferences, all of which are valuable, can interplay in collaborative discussions. Practical collaborative exercises in which participants take up different preferences were used to explain and demonstrate these claims, and each participant, throughout the course was asked to wear a badge showing their individual thinking preferences as shown by the HBDI.

A second section of the course moved the focus to creativity, the various interpretations which have been given to the creative process, and the methods by which creative thinking can be stimulated and improved in its fluency, flexibility and originality. These techniques include brainstorming, lateral thinking and practical activities which will use card based tools (*e.g.* ThinkPak and Whack Pack) as supports. Other related exercises related more directly to the workplace, and again the training course employed group work with the opportunity of exercising the C and D thinking preferences.

The third phase of the training program drew these themes together in a collaborative problem-solving exercise. [In practice, 81 teams each of 4 or 5 persons participated.] The teams covered a variety of thinking preferences, and the problem exercise (designing and constructing a paper tower to support juice cans) was designed to challenge the groups but permit a variety of styles and designs to gain credit. The aims were to examine the characteristics of the resulting tower and consider if there were correspondences in the patterns of thinking preferences of the teams. Also of interest were the interactions within groups, *e.g.* the contributions made by team

members, how others perceived these contributions and if they related to the HBDI thinking preferences. [This analysis was comprehensive and was made a separate chapter of the thesis.]

To conclude, the Research Design is summarised in Figure 4.1.

It should be noted that these activities took place over a four year period from 2000, and were prefaced by a series of meetings and negotiations with the company. The main issues of these discussions were the ideas and practicalities of using HBDI, and the HBDI database design. Similar discussions were needed to outline the training objectives and the management of the training course. All participants in this research, though supported by KEMYA, were voluntary which also brought in matters of confidentiality, *e.g.* the HBDI data and its use by the company. Other issues came to the fore in the design and use of the Suggestion System to take advantage of the innovative ideas put forward by the workforce.

The aim is to improve the innovative culture in the Business Enterprise

Undertaking an analysis of HBDI Thinking Preferences of the Workforce in Departments [Chapter 5]

(i) Raising awareness of the meaning and value of thinking preferences.

(ii) Helping to shape the content and activities of the training course.

(iii) Considering if HBDI could assist the selection practices of, for example, cross-functional teams within the company.

Training scheme relating HBDI, Creativity and Collaborative Problem-Solving [Chapter 6]

(i) Developing understanding of Brain characteristics/HBDI through collaborative diversity exercises.

(ii) Understanding and developing Creative Thinking through brainstorming and lateral thinking activities using ThinkPak and WhackPack tools.

(iii) A collaborative team problem-solving exercise (Tower Building) and relating performance and interaction to HBDI team profiles. [Chapter 7]

(iv) Relating the Training Course to the Corporate Innovative Vision.

Figure 4.1 A schematic of the research design

CHAPTER 5

HBDI Analysis of the Business Enterprise

5.1 INTRODUCTION

Thinking is a necessary and important requirement of humans in both their work and social activities. More specifically, within the workplace this research takes the view that being aware of one's thinking preferences and preferred styles of working can be the basis for improving aspirations, performance and job satisfaction. Such information would also be useful to company trainers in devising and managing their training programs, and to the business enterprise itself, not only through the results of this training but in recruitment and the selection of members of cross-functional groups within the company so they can work more effectively in realizing their objectives and terms of reference. Accordingly, to obtain such data, the HBDI was administered to over four-hundred staff taken from the departments (at all levels of the workforce) within the business enterprise that was cooperating in this research. The analysis and interpretation of these data was to give some insights into the cognitive preferences and make-up of the functional and cross-functional groups that were operating within the company.

5.2 THE RESEARCH CONTEXT

As noted in the previous chapter, the context for this research is the Al Jubail Petrochemical Plant in Saudi Arabia. The company is a joint venture between Saudi Arabian Basic Industries (SABIC), owned by the Saudi Arabian Government, and ExxonMobil. Saudi Arabia has traditionally only involved the private sector through large multi-nationals, such as Chevron, ExxonMobil and BP. For the Al Jubail Petrochemical plant, SABIC holds half the joint venture and Exxon Chemical Arabia (a subsidiary of the ExxonMobil Group) holds the other half.

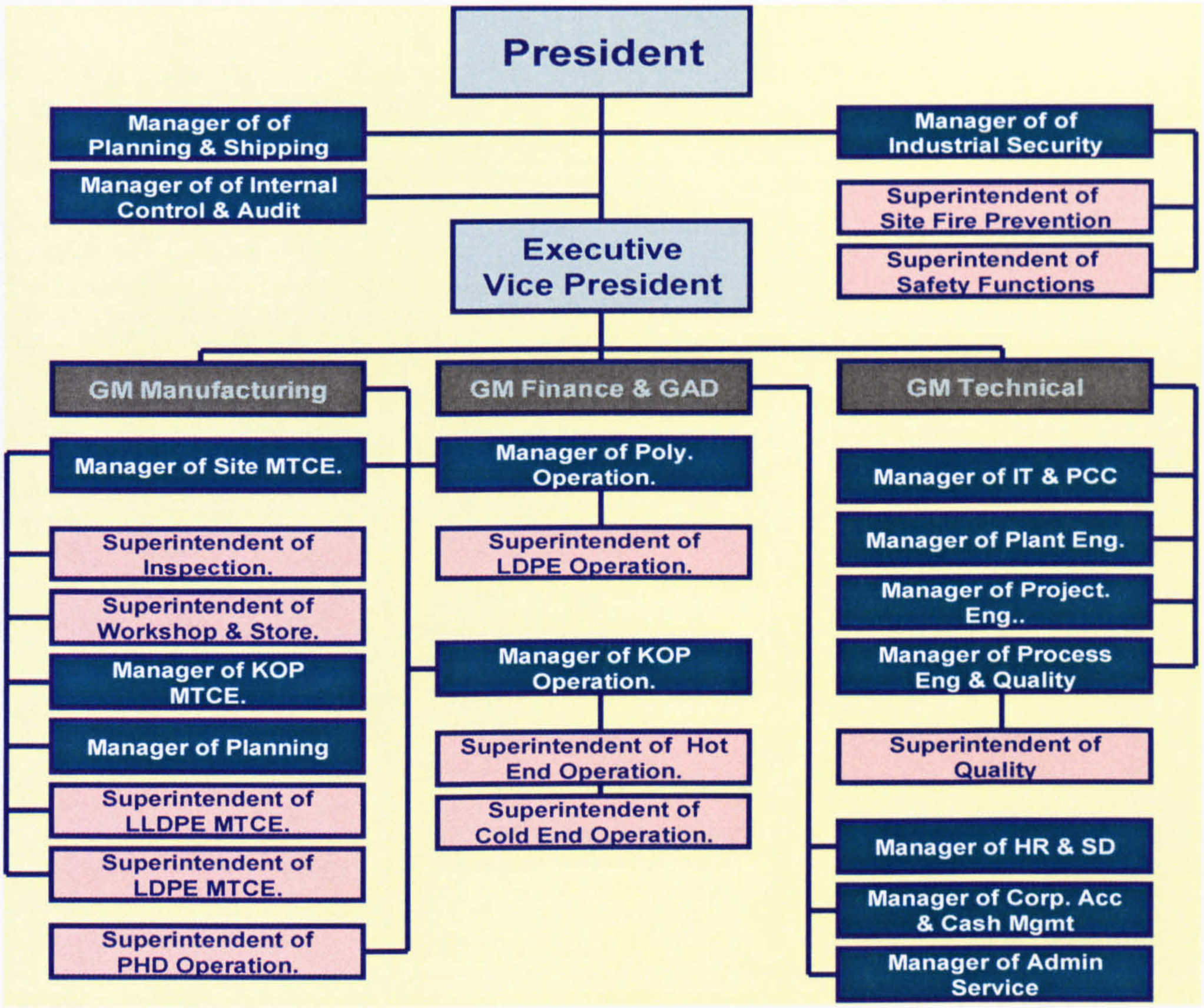


Figure 5.1 The Company Organization: September 2003

The ethylene and polyethylene plant is sited in Al Jubail, Saudi Arabia. The expansion project involves the construction of a 218,000t/yr low density polyethylene plant and an olefin cracker that will produce 700,000t/yr of ethylene and 200,000t/yr of propylene. This expansion includes the de-bottlenecking of the company's linear low-density polyethylene to raise capacity by nearly 40% to 850,000t/yr, which was completed in November 1999. The Olefin III development was started in the last quarter of 2001. In brief, this expansion is a major commitment costing approximately $1-billion. A schematic of the business organization is shown in Figure 5.1.

As can be seen, there are three Divisions; Manufacturing, Technical and Finance, together with high level General Administration. The largest Division is 'Manufacturing' which includes about 70% of the company's workforce. It is mainly responsible for the operations and maintenance of production, and is also in charge of Planning, Inspection, Storing, Packing, and Finishing of the products.

The Technical Division includes about 19% of the company's employees. It consists of the following departments: Information Technology and Process Control, including Plant Engineers, Process and Project Engineers, and Quality Controllers.

The Third Division is Finance and General Administration including about 10% of the company's employees. It consists of the following departments: Human Resources and Staff Development; Corporate Accounts and Cash Management; and Administrative Services.

There are three managers (with the Executive Vice-President) reporting directly to the President of the company covering, Industrial Security; Internal Control and Auditing; and Planning and Shipping.

As can be seen, the business enterprise is large and covers a wide range of policy and practical objectives within its administration. In addition to being a large investment, it operates within a competitive global economy that has to take account of political influences. Hence, large responsibilities rest with the management and with the workforce.

The HBDI analysis was taken from a representative selection of all the functional groups operating within the company, together with cross-functional groups set up by the company, as needed, with specific terms of reference. Note that all the selections of employees for the training schemes within the company were representative of the groups (at all levels) from which they were chosen.

Note that the HBDI analysis is not only to show and record the thinking preferences of employees within the departments, but to comment on these characteristics in relation to the type of responsibilities undertaken by the group. Further, the experience will form an introduction to the meaning of the preferences themselves, and be an introduction to the training program, part of which will explore the thinking preferences, their relationship to creativity, and their relevance to collaborative team working. More specifically the HBDI preferences of the workforce, *i.e.* their relative strengths and weaknesses on the A B C D quadrants will enable the researcher to better shape the training course.

5.3 THE HBDI DATA ANALYSES

The HBDI measures were administered to employees as they registered for training courses within the company (and which formed part of this research project) during 2002-4. The results are discussed in the following sections, starting with the analysis for all employees.

The HBDI is a large (120 item) self-report questionnaire and it is important that people completing the HBDI have some knowledge of the structure of the test, and its history, and the meaning of the terms which are used within it. [These are discussed in Section 6.3.2.] Accordingly, before the test was administered to the groups, meetings were held which introduced the HBDI, noted its value and that it would be utilized in the training programs that followed. Any questions were answered, and the researcher ensured the questionnaires were completed in a positive and friendly atmosphere.

5.3.1 The analysis for all employees in the company

The HBDI survey was administered to 452 employees in the company following the instructions in the published manual. The resulting data profiles under the four quadrants making up the HBDI profile are shown in Figure 5.2 below.

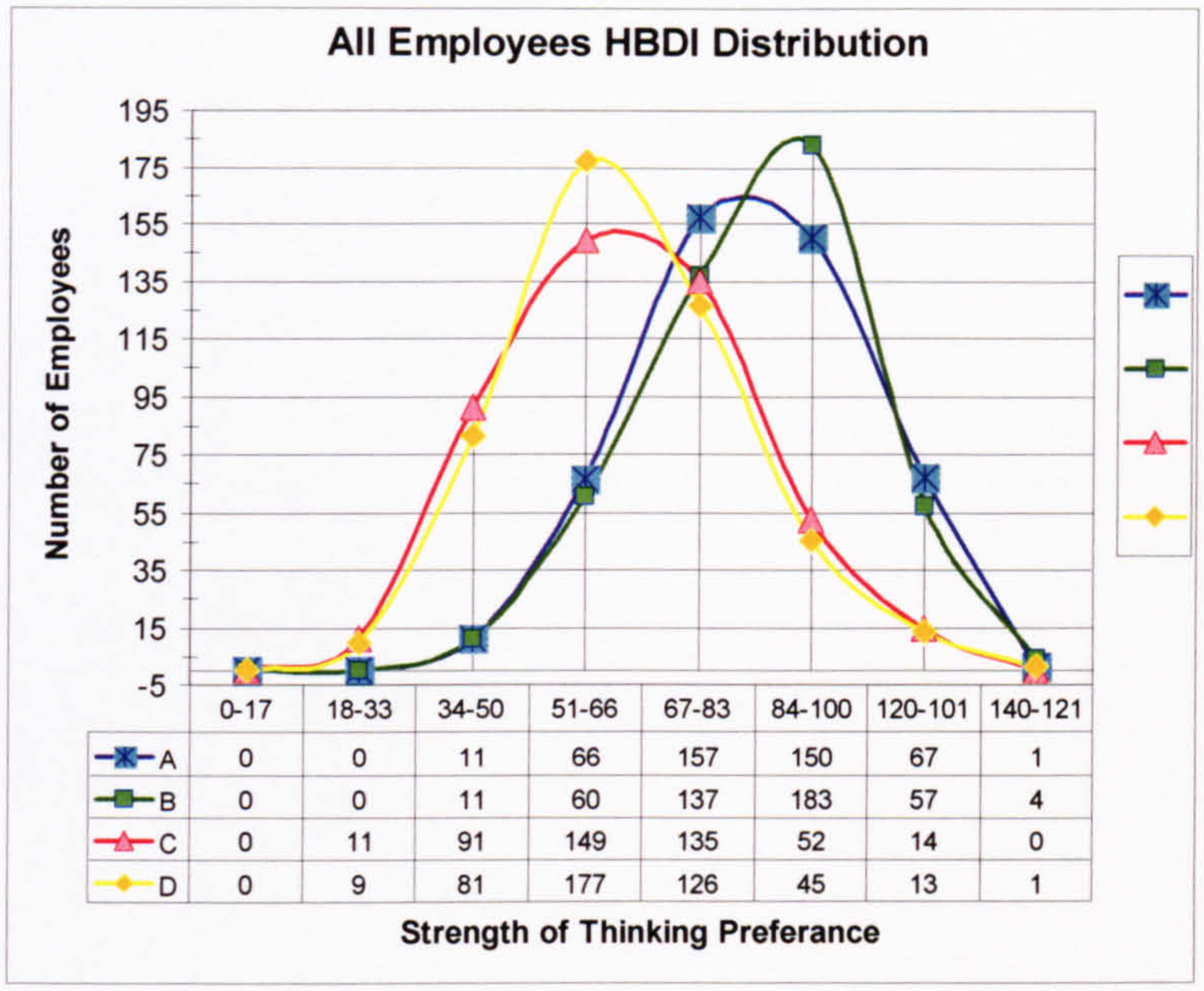


Figure 5.2 The HBDI Data Profiles for 452 Employees

The distributions of the ABCD quadrants scores are relatively free from skew, but the A and B distributions generally show higher scores, and higher mean scores than the C and D distributions. Table 5.1 shows the Mean, Standard Deviation, and Median scores for these distributions.

Although it is useful to summarise the average values and dispersion of frequency distribution in Table 5.1, it should not divert attention from the frequency distribution profiles and tabular data shown in Figure 5.2. For example, although the B (green) profile has a slightly higher mean than the A (blue) distribution, the two graphs have a very similar shape in the spread of scores. A similar remark can be made about the C and D distributions which closely resemble each other. However, although A and B profiles are placed higher on HBDI scores, there is a considerable overlap in values with the C and D distributions. Hence among individuals there can be, and are, diverse A B C D profiles.

	A	B	C	D
Mean	83	84	65	65
Standard Deviation	17	16	17	17
Median	83	84	63	63

Table 5.1 Summary Statistics of the ABCD Distributions for all Employees

Herrmann and Bunderson have conducted many studies (*e.g.* Bunderson, 1989; Bunderson and Olsen, 1980) and have examined 113,000 HBDI profiles. They point out that there are correspondences between preferences and occupations, *e.g.* there is a "tilt" towards the A quadrants and the engineering professions and social workers seem to share a C preference; those in manufacturing tend to a B thinking style; and graphics/interior designers tilt towards the D (creative) quadrant. Indeed Herrmann mentions that, "the closer the alignment between mental preference and job requirements, the more likely is job success and satisfaction". Though the actual distributions of normed profiles for occupations have not been published, and Herrmann's samples have largely involved Western and Hispanic cultures, he considers that scores on a thinking preference above 100 are "Very High", and scores below 50 are "Low". Scores of 50-85 are "Moderate", and 86-99 are considered to be "High". This vocabulary will be followed in the thesis though the grouping of profile scores (*e.g.* in Figure 5.2) will differentiate classes with smaller ranges of scores.

In this Very High category (see Figure 5.2) the A and B quadrants include 68 and 61 employees respectively, whereas the C and D distributions only each contain 14 employees. In contrast, in the lower classes (below a score of 50) the A and B distributions each contain only 11 employees, whereas the C and D scales contain 102 and 90 employees respectively. In order to examine if these differences in the A B C D mean scores were statistically significant, a paired t-test was used. This statistical measure is appropriate since the workforce sample was the same for each of the A B C D sections of the test. [The HBDI 120-item questionnaire can be considered as a multi-measure made up of A, B, C, and D, thinking preference "tests".]

A paired t-test (two tailed) analysis shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$) [see Table 5.2]. In fact the t-stat values well exceed this criterion (t-stat for $p<0.01$ should be larger than 2.98) showing such differences were highly unlikely to have arisen by chance.

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	83	65	83	65	84	65	84	65
Variance	272	293	272	284	255	293	255	284
Observations	452		452		452		452	
df	451		451		451		451	
t Stat	12.45		14.81		17.11		14.44	

Table 5.2 Paired two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

These data confirm that employees are stronger in the left hemisphere thinking preferences, *i.e.* in the analytical, technical, organizational, and procedural preferences, than in the right hemisphere preferences of interpersonal and empathic, imaginative, and intuitive thinking preferences. Perhaps this is to be expected in a scientific and technical business enterprise, although showing a collaborative spirit and imaginative flair are not downplayed in the aims of the company and the requirements of its workforce.

It is of interest to consider the intercorrelations of the HBDI thinking preferences of employees and the Pearson product moment correlations are set out in Table 5.3.

HBDI Main Scores

	A	B	C	D
A		-0.20	-0.65	-0.20
B			-0.04	-0.51
C				-0.13
D				

Table 5.3 Thinking Preference Intercorrelations for all Employees

As expected, and as noted in the literature (Herrmann, 1996), there is a statistically significant ($p<0.01$) negative correlation between A and C, and between B and D (The other intercorrelations A-B, and C-D, do not reach high statistical significance). Hence those with high analytic thinking preferences tend to be lower on empathic thinking, and those high on organizational thinking tend to be low on intuitive thinking and vice versa.

The HBDI analysis also provides data on a 24-point "Adjective Pairs" score, which indicates how the preferred thinking preferences are likely to shift under stress. [The label "Adjective Pairs" arises because it describes the type of items in HBDI which is used to indicate how the respondent might operate under stress conditions in terms of the effects they are likely to have on thinking preferences.] For all employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain [see Table 5.4].

HBDI Scores	Adjective Pairs Scores A	B	C	D
A	0.48			
B		0.54		
C			0.61	
D				0.61

Table 5.4 Intercorrelations between HBDI and Adjective Pair Scores

However, although the same intercorrelation pattern between the Adjective Pairs scores remains, there are now significant negative correlations between B-C, and C-D, *i.e.* between organizational and intuitive thinking preferences, and between intuitive and empathic preferences (See Table 5.5).

	Adj. Pairs Scores A	B	C	D
A		-0.06	-0.49	-0.24
B			-0.39	-0.39
C				-0.38
D				

Table 5.5 Intercorrelations of Adjective Pairs for all Employees

Whilst recognizing the restriction in the range of the 24-point Adjective Pairs classifications, these data indicate also that the correlational contrast between the A-C, and B-D thinking preferences become less pronounced under stress (compare Tables 5.3 and 5.5). But with the exception of the A*v*B correlation, the other negative correlations tend to be larger, perhaps suggesting there is more of a compartmentalisation of thinking preferences under stress.

5.3.2 The analysis for the Manufacturing Division

The HBDI survey was administered to 317 employees (of the total sample) in the Manufacturing Division, and the processed data are shown in Figure 5.3 below.

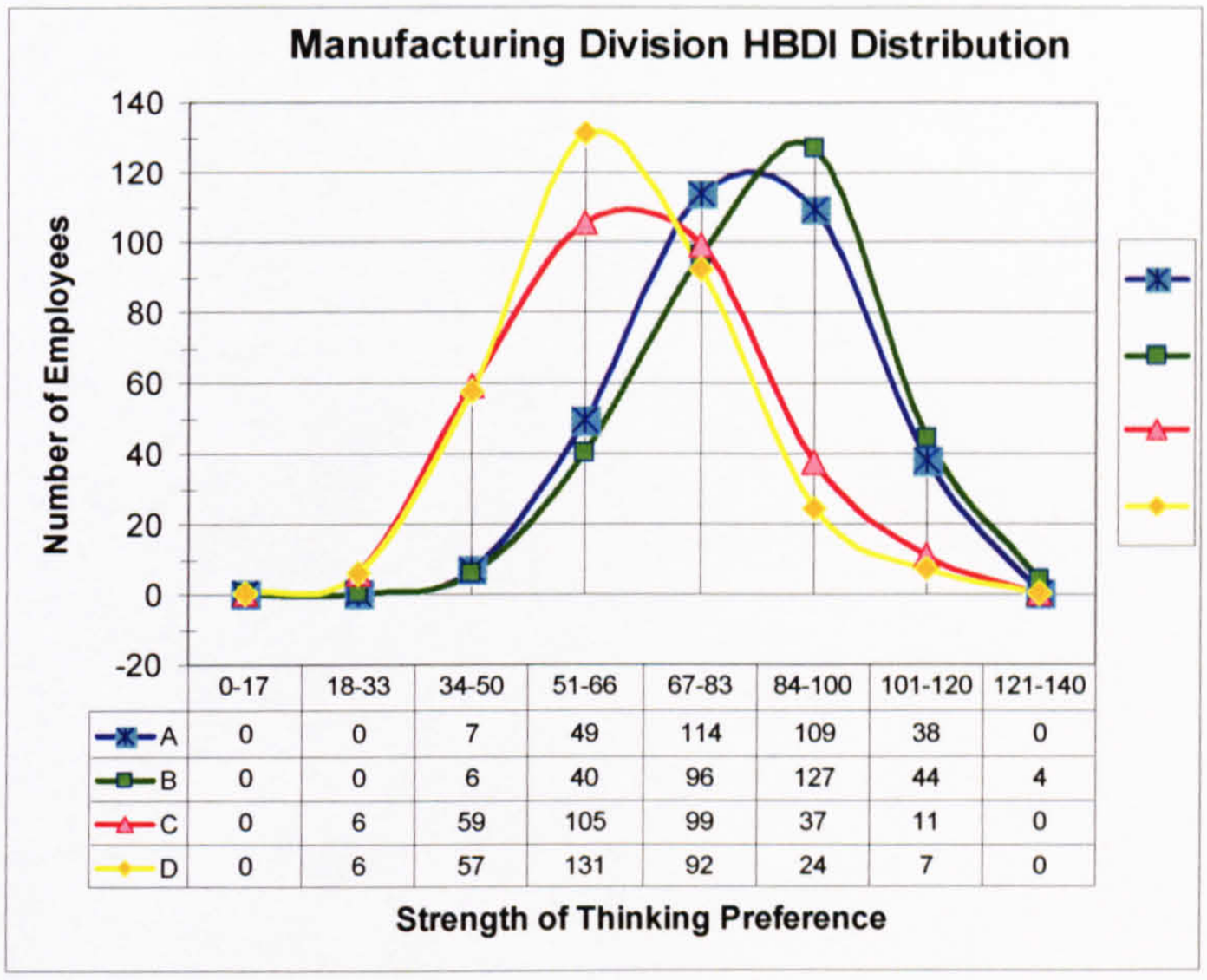


Figure 5.3 The HBDI Data Profiles for the Manufacturing Division

The distributions of the ABCD quadrants scores are relatively free from skew but, as for the larger sample of employees, the A and B distributions generally show higher scores, and higher mean scores than the C and D distributions. Table 5.6 shows the Mean, Standard Deviation, and Median scores for these distributions.

	A	B	C	D
Mean	82	85	66	64
Standard Deviation	16	16	17	15
Median	81	86	65	62

Table 5.6 Summary Statistics of the ABCD Distributions for the Manufacturing Division

In this Very High category the A and B quadrants include 38 and 48 employees respectively, whereas the C and D distributions only contain 11 and 7 employees respectively (see Figure 5.3). In contrast, in the lower classes (below a score of 50), the A and B distributions contain only 7 and 6 employees respectively, whereas the C and D scales contain 65 and 63 employees respectively. A paired t-test shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$) (see Table 5.7).

	A	C	A	D	B	C	B	D
Mean	82	66	82	64	85	66	85	64
Variance	254	287	254	238	259	287	259	238
Observations	317		317		317		317	
df	316		316		316		316	
t Stat	9.32		13.64		14.22		14.12	

Table 5.7 Paired Two Sample t-Test for means scores between A-C, A-D and B-C, and B-D

These data confirm that employees are stronger in the left hemisphere thinking preferences, with the organisational and procedural thinking preferences (B quadrant) being very high. Generally, this matches the required thinking for this division of the company since their business responsibilities require procedural, detailed, and organized thinking.

Table 5.8 shows the intercorrelations (Pearson product moment data) of the HBDI thinking preferences of employees.

HBDI Main Scores

	A	B	C	D
A		-0.25	-0.67	-0.12
B			-0.05	-0.46
C				-0.17
D				

Table 5.8 Thinking Preference Correlations for the Manufacturing Division

As expected and there is again a statistically significant ($p<0.01$) negative correlation between A and C, and between B and D. Hence those with high analytic thinking preferences tend to be low on emotional ingredients in their thinking preferences, and those high on organizational thinking tend to be low on empathic thinking. There is also a weaker but significant negative correlation ($p<0.05$) for this group between the A and B scores suggesting those with high analytic thinking preferences tend to be somewhat lower in their organizational thinking preferences.

The HBDI analysis also provides data on a 24-point "Adjective Pairs" score, which indicates how the preferred thinking preferences are likely to shift under stress. For the manufacturing employees, all the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive and statistically significant ($p<0.01$), indicating that the same thinking preferences are likely to remain (See Table 5.9).

HBDI Scores	Adjective Pairs Scores A	B	C	D
A	0.49			
B		0.51		
C			0.60	
D				0.57

Table 5.9 Intercorrelations between HBDI and Adjective Pairs Scores for the Manufacturing Division

However, although the same intercorrelation pattern between the Adjective Pairs scores remains, in comparison with the HBDI intercorrelations the A*v*C and B*v*D values are reduced (see Table 5.10), *i.e.* their association seems less pronounced under stress. But all the other intercorrelations with the exception of A*v*B are negative and achieve statistical significance ($p<0.05$) indicating perhaps a compartmentalization effect.

	Adj. Pairs Scores A	B	C	D
A		-0.04	-0.51	-0.23
B			-0.39	-0.38
C				-0.39
D				

Table 5.10 Intercorrelations of Adjective Pair Scores for the Manufacturing Division

NOTE: The Manufacturing Division is large and contains several departments. For completeness, the HBDI data from the four principal departments were analysed in a similar fashion, and the detailed results are shown in the Appendix. The interpretations and conclusions drawn from the Quadrant Data profiles and associated correlational tables show the same characteristics, indicating strong homogeneity in the four departments of the Manufacturing Division.

5.3.3 The analysis for the Technical Division

The HBDI survey also administered to 83 employees in the Technical Division. The processed data are shown in Figure 5.4 below.

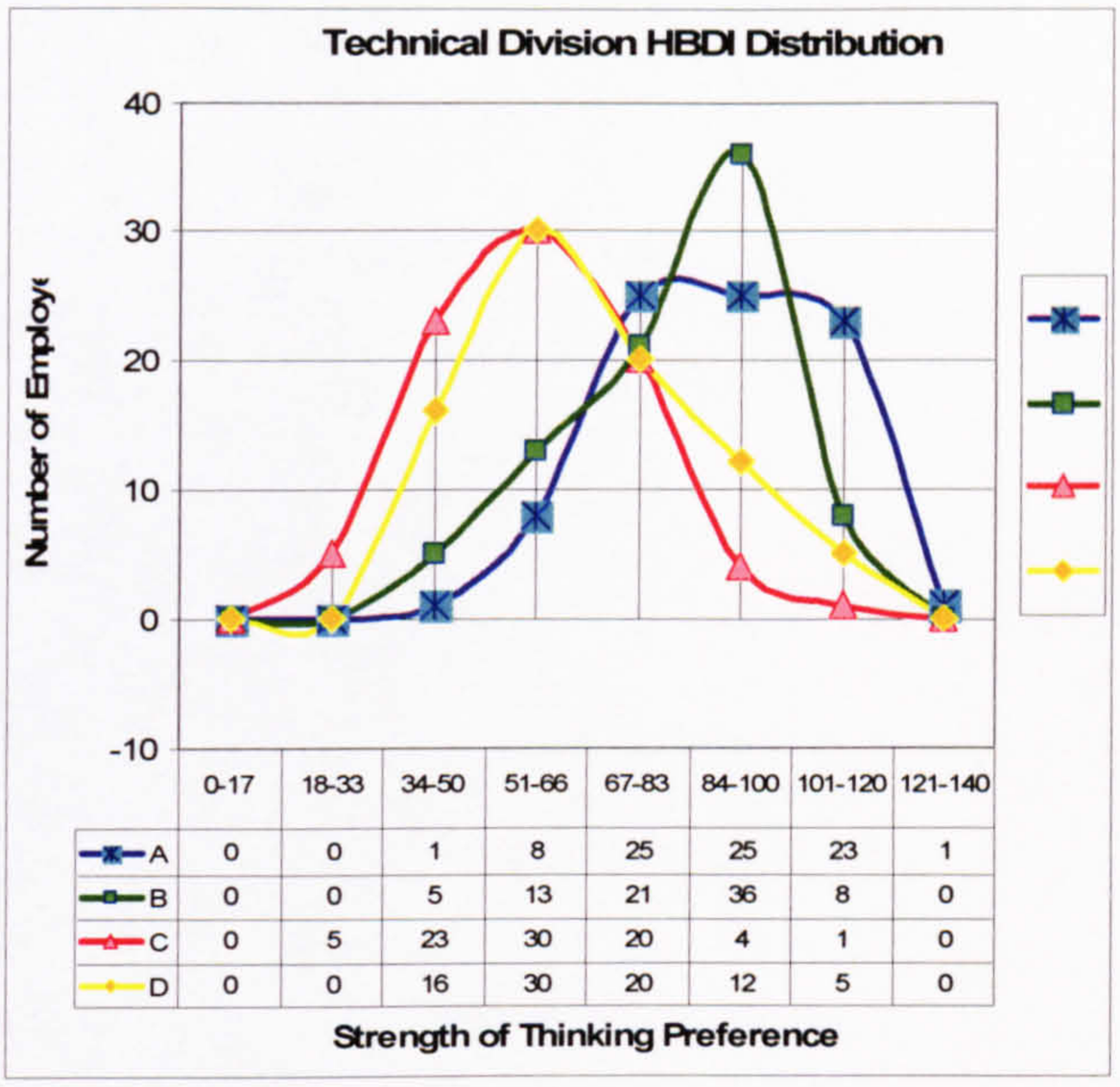


Figure 5.4 The HBDI Data Profiles for the Technical Division

The distributions of the ABCD quadrants scores are relatively free from skew, but again the A and B distributions generally show higher scores, and higher mean scores than the C and D distributions. Table 5.11 shows the Mean, Standard Deviation, and Median scores for these distributions, with the A scores showing a particularly high mean in contrast to the C scores.

	A	B	C	D
Mean	88	81	58	68
Standard Deviation	17	17	16	19
Median	87	84	59	66

Table 5.11 Summary Statistics of the ABCD Distributions for the Technical Division

In the very strong thinking preference class (>100) the A and B quadrants include 24 and 7 employees respectively, whereas the C and D distributions only contain 1 and 5 employees. In contrast, in the lower classes of preference (below a score of 50) the A and B distributions contain only 1 and 5 employees respectively, whereas the C and D scales contain 27 and 14 employees respectively. A paired (two tailed) t-test (see Table 5.12) shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$).

The Technical Division's responsibilities are focused on Project and Process Engineering and Information Technology related to process control. Perhaps it is not unexpected that their

preferences are particularly strong on analytic aspects, and on organizational preferences, and much weaker on the C scales, *i.e.* the empathic thinking preferences.

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	88	58	88	68	81	58	81	68
Variance	304	253	304	358	294	253	294	358
Observations	83		83		83		83	
df	82		82		82		82	
t Stat	9.29		6.25		8.86		3.77	

Table 5.12 Paired Two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

These data confirm that employees are stronger in left hemisphere thinking preferences and particularly the A-Quadrant (24 out of 83 have scores >100) then for the C-Quadrant (27 out of 83 have scores <50) as shown in Figure 5.4.

The Pearson Product Moment intercorrelations of the HBDI thinking preferences of employees are set out in Table 5.13.

HBDI Main Scores

	A	B	C	D
A		-0.13	-0.58	-0.36
B			-0.04	-0.61
C				-0.06
D				

Table 5.13 Thinking Preference Intercorrelations for the Technical Division

As expected there is a statistically significant ($p<0.01$) negative correlation between the A and C, and between the B and D scales, and there is also a significant negative correlation between the A and D scales. The correlation between A and B preferences is not significant. These data again emphasize the strong preferences for analytic and organizational thinking preferences.

The HBDI analysis also provides data on a 24-point "Adjective Pairs" score. For all these employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain under stress (See Table 5.14).

HBDI Scores \ Adjective Pairs Scores	A	B	C	D
A	0.53			
B		0.60		
C			0.68	
D				0.73

Table 5.14 Intercorrelations between HBDI and Adjective Pairs Scores for the Technical Division

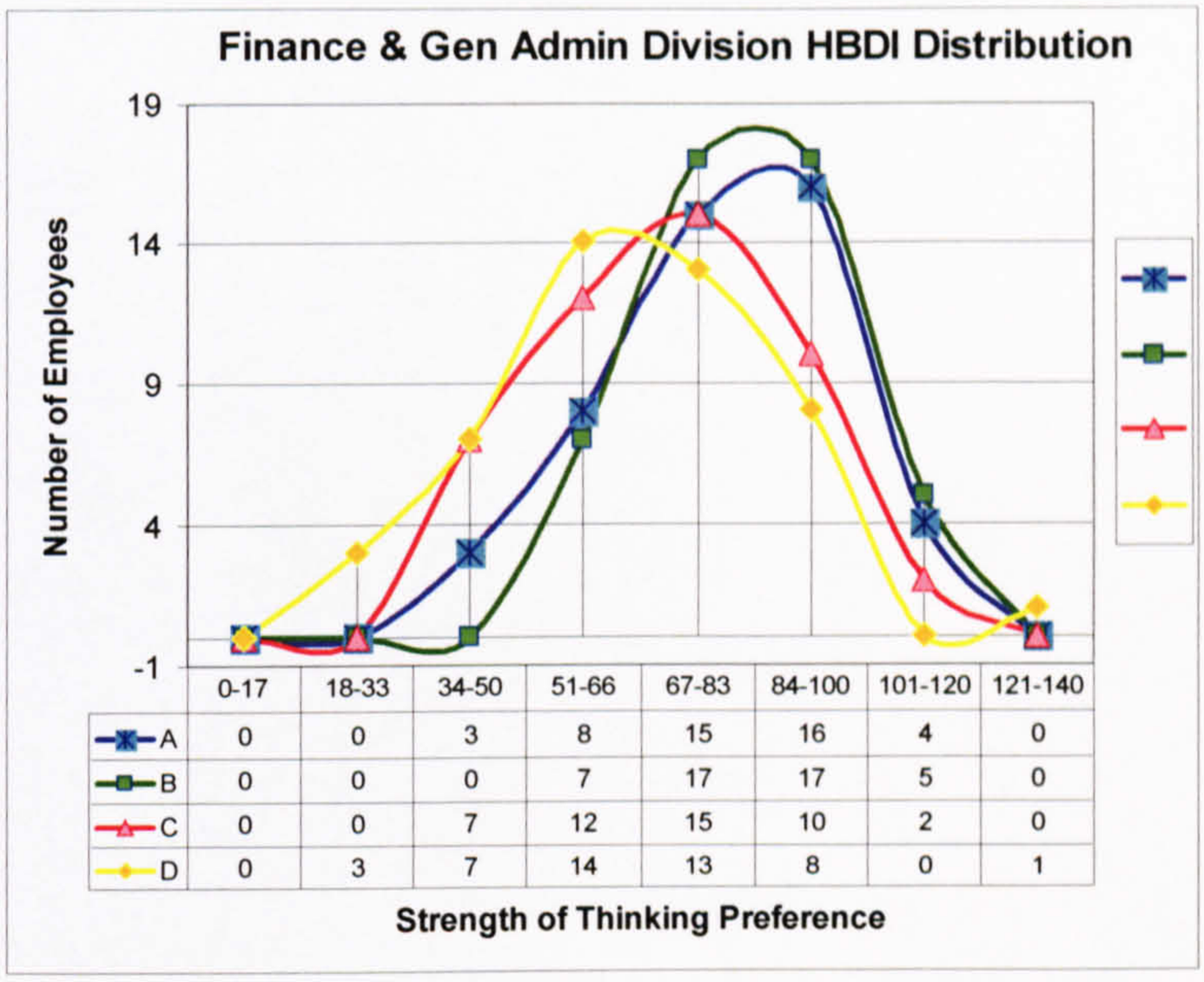
However, although the same intercorrelation pattern between the Adjective Pairs scores A*v*C, and B*v*D remains, as for the HBDI intercorrelations, their values are reduced (see Table 5.15), and, as for the Manufacturing Group the other correlations (with the exception of A*v*B) although weaker, are negative and achieve statistical significance ($p<0.05$). Again this might indicate that their employees keep more closely to their dominant thinking preferences under stress.

Adj. Pairs Scores	A	B	C	D
A		-0.12	-0.44	-0.22
B			-0.40	-0.43
C				-0.36
D				

Table 5.15 Intercorrelations of Adjective Pair Scores for the Technical Division

5.3.4 The analysis for the Finance & General Admin Division

The HBDI survey was administered to 46 employees in the Finance and General Administrative Division following the instructions in the published manual. The processed data are shown in Figure 5.5 below.



	0-17	18-33	34-50	51-66	67-83	84-100	101-120	121-140
A	0	0	3	8	15	16	4	0
B	0	0	0	7	17	17	5	0
C	0	0	7	12	15	10	2	0
D	0	3	7	14	13	8	0	1

Figure 5.5 The HBDI Data Profiles for Finance and General Admin Division

The distributions of the ABCD quadrants scores are relatively free from skew, but again the A and B distributions generally show higher scores, and higher mean scores than the C and D distributions. Table 5.16 shows the Mean, Standard Deviation, and Median scores for these distributions.

	A	B	C	D
Mean	88	81	58	68
Standard Deviation	17	17	16	19
Median	87	84	59	66

Table 5.16 Summary Statistics of the ABCD Distributions for the Finance and General Admin Divisions

The very strong thinking preference classes in A and B quadrants include 4 and 5 employees respectively, whereas the C and D distributions only contain 2 and 1 employee respectively. In contrast, in the lower classes (below a score of 50) the A and B distributions contain only 3 and 0 employees whereas the C and D scales contain 7 and 10 employees respectively. A paired t-test shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$) (See Table 5.17). Hence the data, particularly the low C preference scores (which indicate low empathic and collaborative features) could be at variance with some of the responsibilities and requirements of this group which, as well as dealing with corporate accounts and their management (requiring analytic and organizational thinking), also

concerns Human Resources and Staff Development, and which would seem to involve empathic skills and human interaction.

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	88	58	88	68	81	58	81	68
Variance	304	253	304	358	294	253	294	358
Observations	83		83		83		83	
Pearson Correlation	-0.58		-0.34		-0.05		-0.62	
df	82		82		82		82	
t Stat	9.29		6.25		8.86		3.77	

Table 5.17 Paired Two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

The intercorrelations (Pearson Product Moment data) of the HBDI thinking preferences of employees are set out in Table 5.18.

HBDI Main Scores

	A	B	C	D
A		-0.13	-0.58	-0.36
B			-0.04	-0.61
C				-0.06
D				

Table 5.18 Thinking Preference Intercorrelations for the Finance and General Administrative Division

As expected, there are statistically significant ($p<0.01$) negative correlations between A and C, and between B and D. Also, the A v D correlation, though less strong is also negative ($p<0.05$) suggesting that those high on analytic thinking preferences are weaker in engaging intuitive and creative thinking styles.

The "Adjective Pairs" scores indicate how the preferred thinking preferences are likely to shift under stress. For these employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain (See Table 5.19).

HBDI Scores	Adjective Pairs Scores A	B	C	D
A	0.53			
B		0.60		
C			0.68	
D				0.73

Table 5.19 Intercorrelations between HBDI and Adjective Pairs scores for Finance General Administrative Division

However, although the same intercorrelation pattern between the Adjective Pairs scores remains, as for the HBDI intercorrelations the values A *v* C and B *v* D and A *v* D are reduced (see Table 5.20). However, the other correlations B *v* C, B *v* D, and C *v* D are also negative and achieve significance, again suggesting perhaps some increased specialisation in the preferred thinking style under stress.

Adj. Pairs Scores	A	B	C	D
A		-0.12	-0.44	-0.22
B			-0.40	-0.43
C				-0.36
D				

Table 5.20 Intercorrelations of Adjective Pairs Scores for the Finance and General Administrative Division

5.4 CROSS-FUNCTIONAL TEAMS

Cross-functional teams consist of members originating from different functional departments selected and set up by the company, and held accountable for a common task or set of objectives. The main purpose of forming cross-functional teams is to increase productivity and reduce process inefficiencies in their activities (Faure, 2002). Some cross-functional teams are in existence for a considerable time, *e.g.* dealing with quality control issues, or with health and safety, though the membership is likely to be changed periodically. However, many teams are set up to address particular problems or issues which arise and to which the company has to take action. Hence the selection of the members of cross-functional teams is carefully managed, and a number of considerations are usually taken into account. These include having a range of experience and viewpoints so that teams usually include members from different departments, though several researchers have noted the importance of achieving cohesiveness within the group (Griffin and Hunter, 1993; Hauser and Clausing, 1988; Dean, Dann and Wong, 1992).

Other factors are ensuring the teams have an effective leader and good interpersonal rapport (Hackman, 1987).

The value of taking into account the preferred styles of thinking was also noted in the case studies outlined in Chapter Two, and communicating the outputs of the team for example by report and/or presentation is clearly important if the company is to be convinced to take actions on its recommendations (Ancona and Caldwell, 1992; Hackman 1987). But the principal factors in selection are the skills, knowledge and experience members bring to the problem, and ensuring a balance is achieved in, for example, functional expertise, and task-specific skills such as decision-making (Gladstein, 1992) We would also advise considering the HBDI thinking styles (analytic, organizational, interpersonal, and creative) in the makeup of the teams. It is also necessary for such teams to have access to resources within the company, and to be clear on matters of confidentiality and reporting.

For the HBDI analysis reported in this thesis, two cross-functional teams participated, dealing with Quality Control, and with Health and Safety matters, and their data are discussed below.

5.4.1 The Analysis for Quality Council Committee

The HBDI survey was administered to twenty-two members of the Quality Council Committee who were senior employees in the company, and their processed data is shown in Figure 5.6 below.

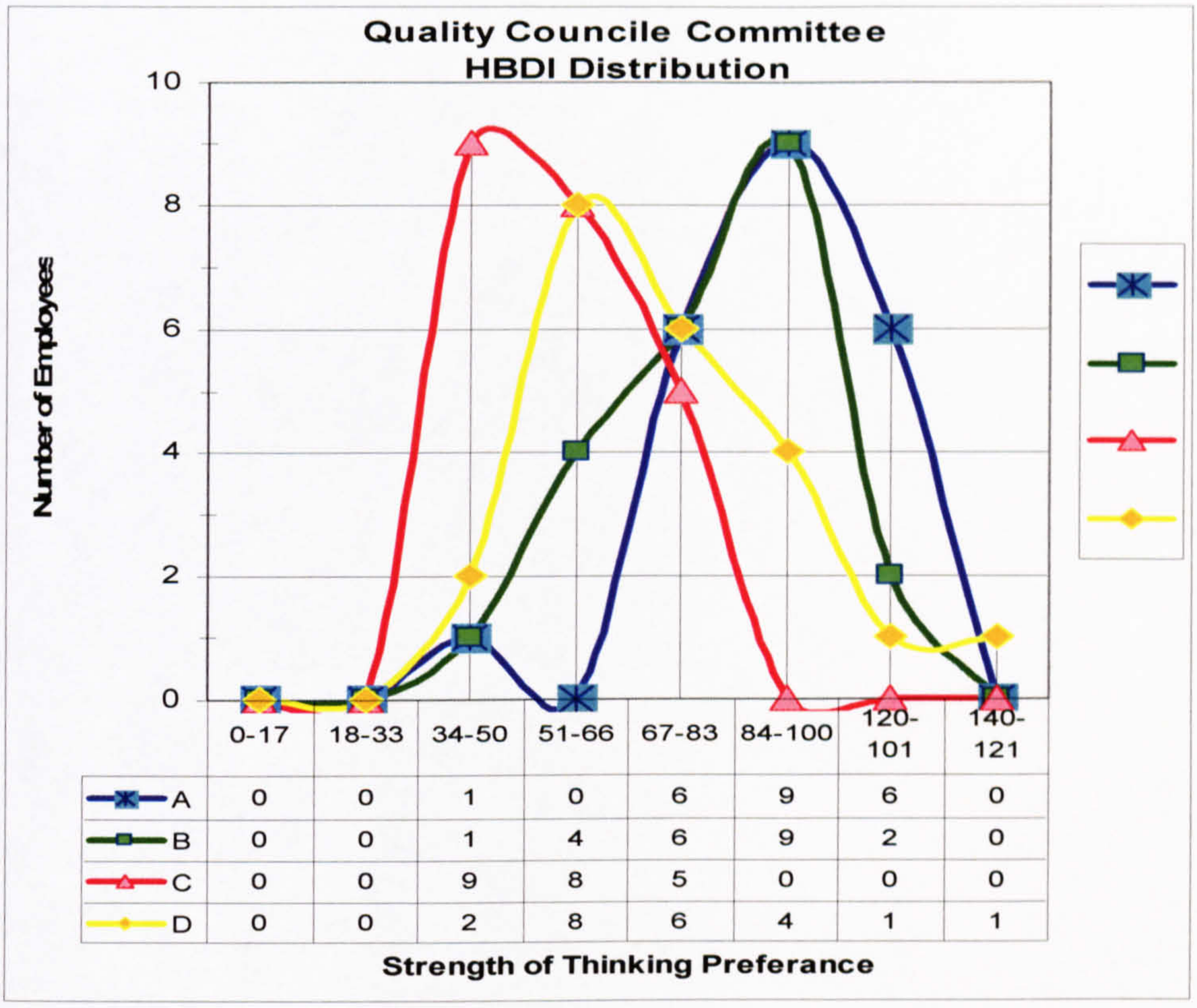


Figure 5.6 The HBDI Data Profiles for Quality Council Committee

The distributions of the ABCD quadrants scores are relatively free from skew, but the A distributions generally show Very High scores, and higher mean scores than the B, C and D distributions, with the mean of the C distribution being particularly low (See Table 5.21).

There are features in these distributions which are somewhat different from the profiles of previous groups. For example, although the A profile (blue) has the highest Mean score, the B distribution (green) has a lower tail but peaks in the same score class (84-100). But both these distributions are more sharply distinguished from the C (red) and D (yellow distribution). This is also shown in the high negative correlations in Table 5.23.

The sample numbers are small, and the results should be treated with due caution, but the low C values in the Interpersonal Thinking preference need to be noted, particularly as this committee has to liaise with departments on Quality Controls and related issues. On this aspect Interpersonal, as well as Technical skills, are important.

	A	B	C	D
Mean	90	78	54	73
Standard Deviation	17	16	14	21
Median	93	81	54	71

Table 5.21 Summary Statistics of the ABCD Distributions for the Quality Council Committee

Scores above 100 are rated Very High, and in this category the A quadrant includes 6 employees, whereas the B, C and D distributions only contain 2, 0 and 2 employees respectively. In contrast, in the lower classes (below a score of 50) the A, B and D distributions contain only 1, 1 and 2 employees whereas the C scales contain 9 of the 22 members and a further 8 in the 51-66 score category. A paired t-test shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$) (See Table 5.22).

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	90	54	90	73	78	54	78	73
Variance	277	190	277	446	271	190	271	446
Observations	22		22		22		22	
df	21		21		21		21	
t Stat	6.65		2.24		4.53		0.74	

Table 5.22 Paired Two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

These data confirm that employees are stronger in the A-Quadrant thinking preferences, *i.e.* the analytical, technical, and logical thinking, than the C-Quadrant preferences of interpersonal and empathic thinking preferences so there is some imbalance in this respect. The B and D Quadrants show fairly strong thinking preferences, so there is a balance in the organizational and the imaginative thinking preferences. Perhaps such a profile is to be expected in a committee responsible for quality issues which require analysis as well as organizational and futuristic thinking. But the group is weaker in the interpersonal preferences, and this could affect both the empathic working of the committee and could result in these aspects being neglected or downplayed in their thinking of future plans.

It is of interest to consider the intercorrelations of the HBDI thinking preferences of employees and the Pearson product moment correlations are set out in Table 5.23.

HBDI Main Scores	A	B	C	D
A		0.24	-0.75	-0.51
B			-0.39	-0.51
C				-0.53
D				

Table 5.23 Thinking Preference Intercorrelations for the Quality Council Committee

As expected, there is a statistically significant ($p<0.01$) high negative correlation between A and C, and a lower but significant negative correlation ($p<0.05$) between A and D, and B and D, and C and D. Hence those with high thinking preferences in these A B C quadrants will tend to be low on the imaginative thinking preferences.

The HBDI analysis also provides data on a twenty four-point "Adjective Pairs" score, and all 22 employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain under stress (See Table 5.24).

HBDI Scores \ Adjective Pairs Scores	A	B	C	D
A	0.55			
B		0.76		
C			0.52	
D				0.68

Table 5.24 Intercorrelations between HBDI and Adjective Pairs scores for Quality Council Committee

The same intercorrelation pattern between the Adjective Pairs scores remains when compared with the HBDI intercorrelation, but the A v C value is much reduced, and the B v C negative value is increased (see Table 5.25). This relative stability under stress is more pronounced than the comparative analyses with previous groups.

Adj. Pairs Scores	A	B	C	D
A		-0.02	-0.06	-0.55
B			-0.65	-0.23
C				-0.41
D				

Table 5.25 Intercorrelations of Adjective Pairs Scores for Quality Council Committee

5.4.2 The Analysis for Safety, Health and Environmental Awareness Committee (SHE)

The HBDI survey was administered to the 9 members of the small Safety Committee and their processed data is shown in Figure 5.7 below.

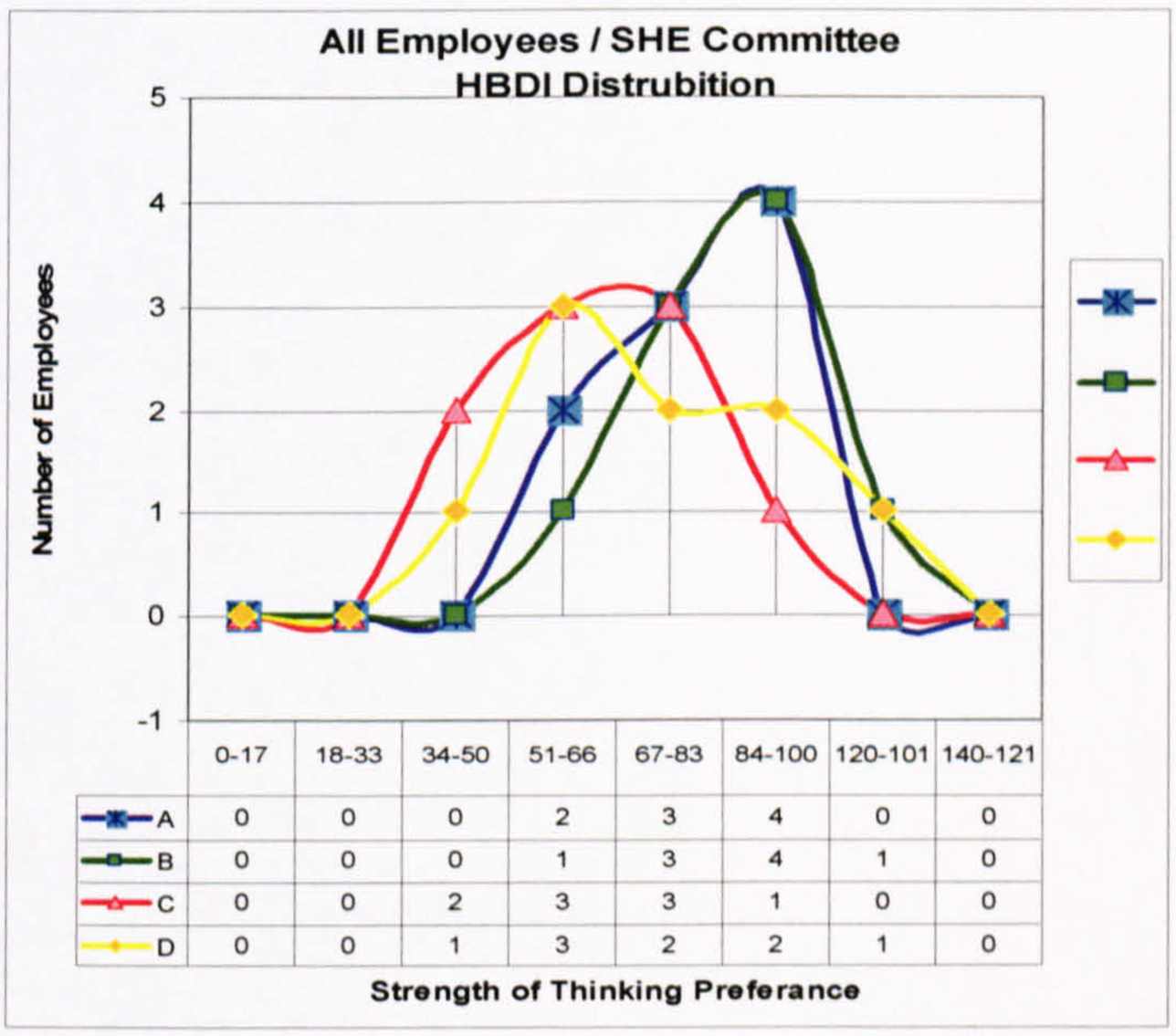


Figure 5.7 The HBDI Data Profiles for SHE Committee

The numbers are small, and the results should be interpreted cautiously, but the ABCD quadrants scores are relatively free from skew. The A and B distributions (particularly the B scores) show higher mean scores than the C and D distributions. Table 5.26 shows the Mean, Standard Deviation, and Median scores for these distributions, with the A *v* C and the B *v* D and the B *v* C differences achieving statistical significance ($p<0.05$). Again the relatively low

representation of Interpersonal (C) preferences should be noted, particularly as the SHE groups will need to closely liaise with departments in determining and implementing their policies.

	A	B	C	D
Mean	76	86	63	72
Standard Deviation	14	13	12	20
Median	78	84	66	69

Table 5.26 Summary Statistics of the ABCD Distributions for SHE Committee

As might be expected, with such a small group there are few representing the Very High Thinking Preferences (1 each in the A and D preferences), or the low categories (2 and 1 employees in the C and D preferences respectively). The A and B preferences have relatively strong representations in the 84-100 category.

These data give some support that employees are stronger in the left hemisphere thinking preferences, *i.e.* the analytical, technical, organizational, and procedural, than the right hemisphere preferences where the Category C mean scores (on interpersonal/empathic preferences) scores are lower, though this trend is much less pronounced in the D (imaginative, creative) quadrant.

None of the inter quadrant differences are statistically significant for this small group, but it is of interest to consider the relative placings of the nine members of the committee (with their own ABCD polygons) shown on an ABCD schematic in Figure 5.8.

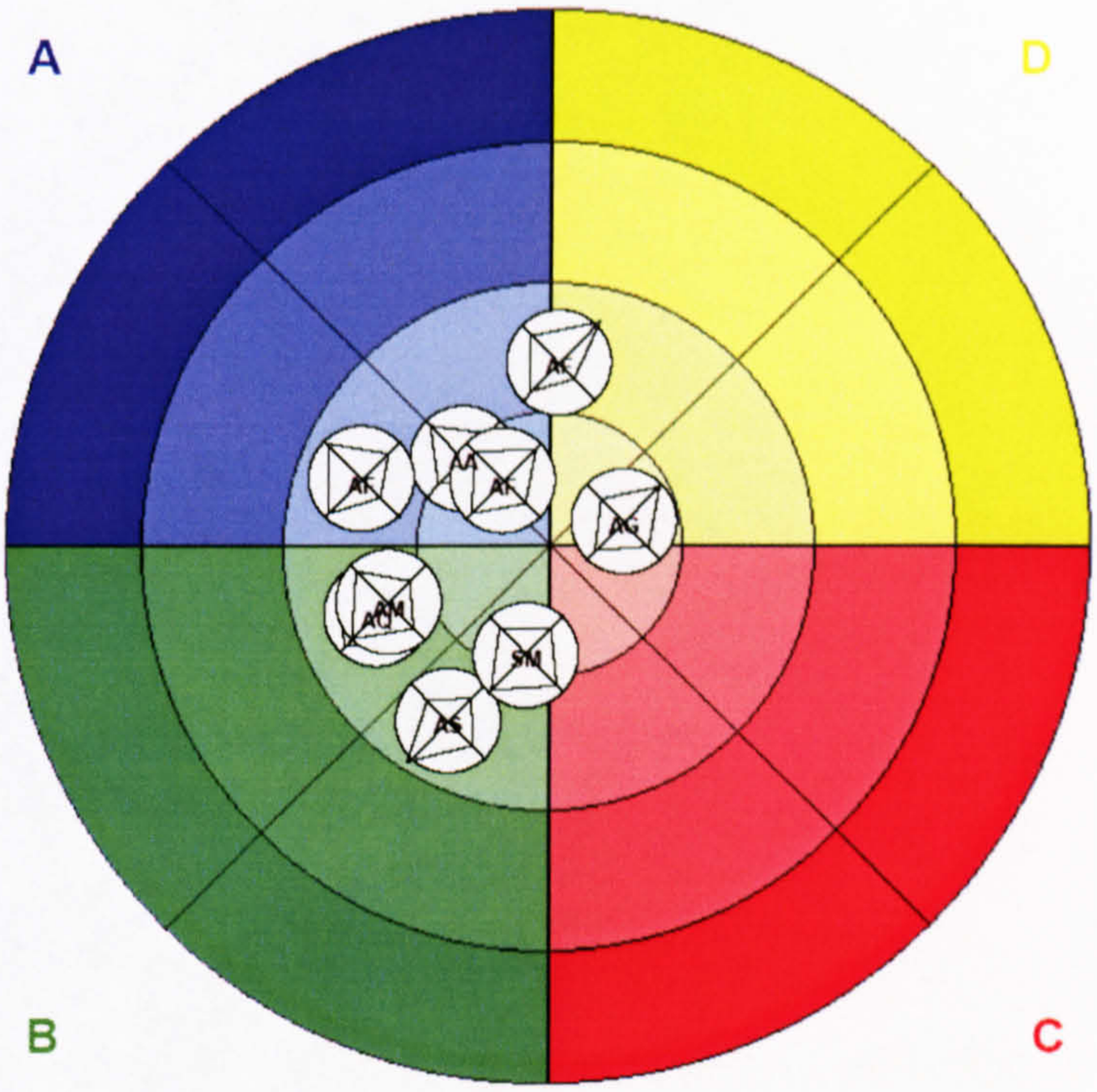


Figure 5.8 Circular Continuums for SHE Committee

This representation of HBDI group performances places each person's profile at the centre of gravity (*i.e.* a balanced average) of their scores. Hence they tend to be placed in their strongest quadrant but with other quadrant scores exerting an attraction towards their quadrant. Each person's profile is represented diagrammatically at that point, where each person's A B C D scores are placed on the diagonal of the quadrant (stronger scores to the circumference), and the resulting HBDI quadrilateral drawn between these points. It can be seen that the group is clustered in the A B quadrants, but the influence (the "pull") of the C and D quadrants is small and the influence of the C quadrant, especially the C quadrant is relatively small. This is a useful type of graphic for visualizing team composition for small groups and will be used in examining the teams chosen for the collaborative problem-solving exercise discussed in Chapter Seven.

It is also of interest to consider the intercorrelations of the HBDI thinking preferences of the employees (though numbers are small), and the Pearson product moment correlations are set out in Table 5.27. However, only the negative D preference correlations are statistically significant ($p<0.05$).

HBDI Main Scores

	A	B	C	D
A		-0.31	-0.36	-0.42
B			0.37	-0.42
C				-0.49
D				

Table 5.27 Thinking Preference Intercorrelations for SHE Committee

For these employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive and strong, indicating that the same thinking preferences are likely to remain under stress, with the exception of the C (empathy/interpersonal preference), though this correlation value is not statistically significant (see Table 5.28).

HBDI Scores	A	B	C	D
A	0.82			
B		0.71		
C			-0.19	
D				0.91

Table 5.28 Intercorrelations between HBDI and Adjective Pairs scores for SHE Committee

However, in contrast to Table 5.27, Table 5.29 shows some differences with the Adjective Pairs intercorrelations notably the strong B-C negative correlation in the Adjective Pairs scores compared with the moderate positive B-C correlation shown in the HBDI Table 5.27. This supports that those strong on the B (Organisational) Thinking preferences will tend to become less empathic (*i.e.* the C Thinking preference) if the collaborative situation or task requirements become stressful. However, the negative D intercorrelations remain.

Adj. Pairs Scores

	A	B	C	D
A		-0.08	0.17	-0.66
B			-0.63	-0.36
C				-0.34
D				

Table 5.29 Intercorrelations of Adjective Pairs Scores for SHE Committee

Health and Safety matters require critical and detailed analytic thinking, as well as combining their directives with an efficient organization. Perhaps the need for creative imagination in these matters is limited, however empathic/interpersonal skills and hence C preferences should be useful as Health and Safety is concerned with the welfare of staff, and its communications need to be disseminated in attractive ways which command attention and cooperation.

5.5 A CONCLUDING COMMENT

This HBDI analysis has been extensive, involving over four-hundred-and-fifty employees from all levels in all departments. However, the analysis showed common trends between all the groups analysed under HBDI measures, namely very strong scores in the A (analytic) and B (organizational) thinking preferences and weaker preferences in the C (emotional/empathic) and D (creative/imaginative) quadrants. This was to be expected in a large highly technical and scientific company, clearly structured in its functions and specialisms. However, these biases are relative and the analysis was summarized in mean scores: individual profiles can be quite different—and this will be evident in the collaborative problem-solving discussed in Chapter Seven. So, how can the company use HBDI data to its advantage?

The company does appoint a number of ad hoc cross-functional groups (the case studies reported in Chapter Two give examples of companies setting up such groups as problems or issues are identified), and the HBDI analysis of the cross-functional groups noted in the last section holds some interest in this respect. Perhaps, more importantly, the company has identified an issue, namely that it wishes the company (via its workforce) to be more innovative and with greater communication and passage of ideas between departments. These requirements seem to relate to the C and D thinking preferences of HBDI, and the analyses have shown these, on average, were the weaker preferences of the workforce. Hence, there is a need for training which embraces these requirements and suggests an understanding of HBDI and one's profile would be useful, with activities which allow participants to take different viewpoints in accordance with thinking preferences. Also, the course needs to provide some understanding and experience in thinking creatively and in working cooperatively in problem-solving tasks that stimulate creative/innovative thinking and communicative and interpersonal skills. The design of such a training course for the employees of the company is the subject of the next chapter.

In brief this extensive analysis has shown the strong trends in the A B thinking preferences with relatively weaker preferences in the C (interpersonal/empathic) and D (creative/imaginative) quadrants. This factor might be relevant in the selection of cross-functional and *ad hoc* groups set up by the company where interpersonal and empathic skills are required or where innovation and creativity is required as well as technical competence in considering future policies. Hence the establishment of an HBDI database (under proper control) could be useful to the company. As noted, the analysis showed relative weakness in the C/D Thinking preferences and the need

for developing Creativity and Interpersonal skills was given particular attention in the design of the training courses.

CHAPTER 6

Design and Implementation of the Training Scheme

6.1 INTRODUCTION

In Chapter Five it was clear that the thinking preferences of the company employees were biased toward the left hemisphere, *i.e.* the "A" preferences which emphasized logical and analytic aspects of thinking and the B preferences which involved organisational styles that emphasized planning and administrative qualities. In contrast, the right hemisphere preferences for the emotional and interpersonal aspects of thinking, and the imaginative, creative and holistic qualities were much less pronounced. These characteristics of the company employees were not unexpected, and indeed are typical for a workforce that has strong mathematical and scientific backgrounds, and where analytic and critical examination of data are required. However, within organisations operating in competitive global economies there is also a need for imaginative and creative ideas and their effective presentation and development between different sections of the workforce that have to communicate and cooperative under strategic and tactical company plans. Hence there is a need for personnel to be aware not only of their own thinking preferences, and how they may be used to advantage, but of the thinking preferences of others, and their differences, and how more sensitive and effective collaborations can become established. It will also be useful if employees could be assisted in exercising their weaker preferences so that they could increase the range of their contributions within the workplace.

Accordingly, the Training Scheme was designed to provide three inter-connected sections. The first was directed at providing participants, who had all completed the HBDI questionnaire, with a greater understanding of HBDI and its theoretical foundations, but also with a greater appreciation of the value of their own thinking preferences and those of others, particularly in collaborative interactions. This understanding was to be reinforced through practical exercises where participants would engage different preferences and perspectives in various diverse tasks.

A second phase of the training course linked the HBDI preferences, particularly the C (inter-personal) and the D (creativity) quadrants, to enhancing the creative thinking of participants. Theories of creativity and the creative process would be given practical form through

brainstorming and lateral thinking tasks supported by the use of the ThinkPak and Whack Pack tools. Examples would be related to the workplace.

The third component utilized and consolidated this experience through a collaborative team problem-solving task, namely to design and build a high tower supporting juice cans, using limited resources (paper) and under some time constraints. The criteria of success were chosen to focus discussion and decision making, but enabled teams to decide on, and implement, designs which could achieve the task objective in different ways. The teams had different HBDI profiles and the research interest was in examining correspondences between these profiles and the characteristics of the tower which was built and the perceived interactions and contributions of team members to the task.

The next section will outline the objectives of the training scheme, and will then be followed by a description of the preparations before the training scheme could be delivered. It will discuss the planning and design of the training program, and its components showing their relation to the course objectives. The conduct of the training sessions is then commented upon, pointing to characteristics of interest, application and the process details. Finally, the evaluation phase relating to the different training parts will indicate how far the training objectives have been achieved. A summary discussion concludes Chapter Six and leads to a more detailed account of a practical application of thinking styles in collaborative problem solving which is featured in Chapter Seven.

It should be noted that since the training required participants to be taken from the workplace and from different departments, the researcher had to negotiate the schedules with the management. They were supportive, and nineteen training courses were delivered to accommodate almost four-hundred employees who were from different departments and employment levels in KEMYA. This company information and the HBDI profiles of employees were useful in shaping the courses (under the objectives and tasks) to meet the requirements of participants.

6.2 THE SPECIFIC OBJECTIVES OF THE TRAINING PROGRAMME

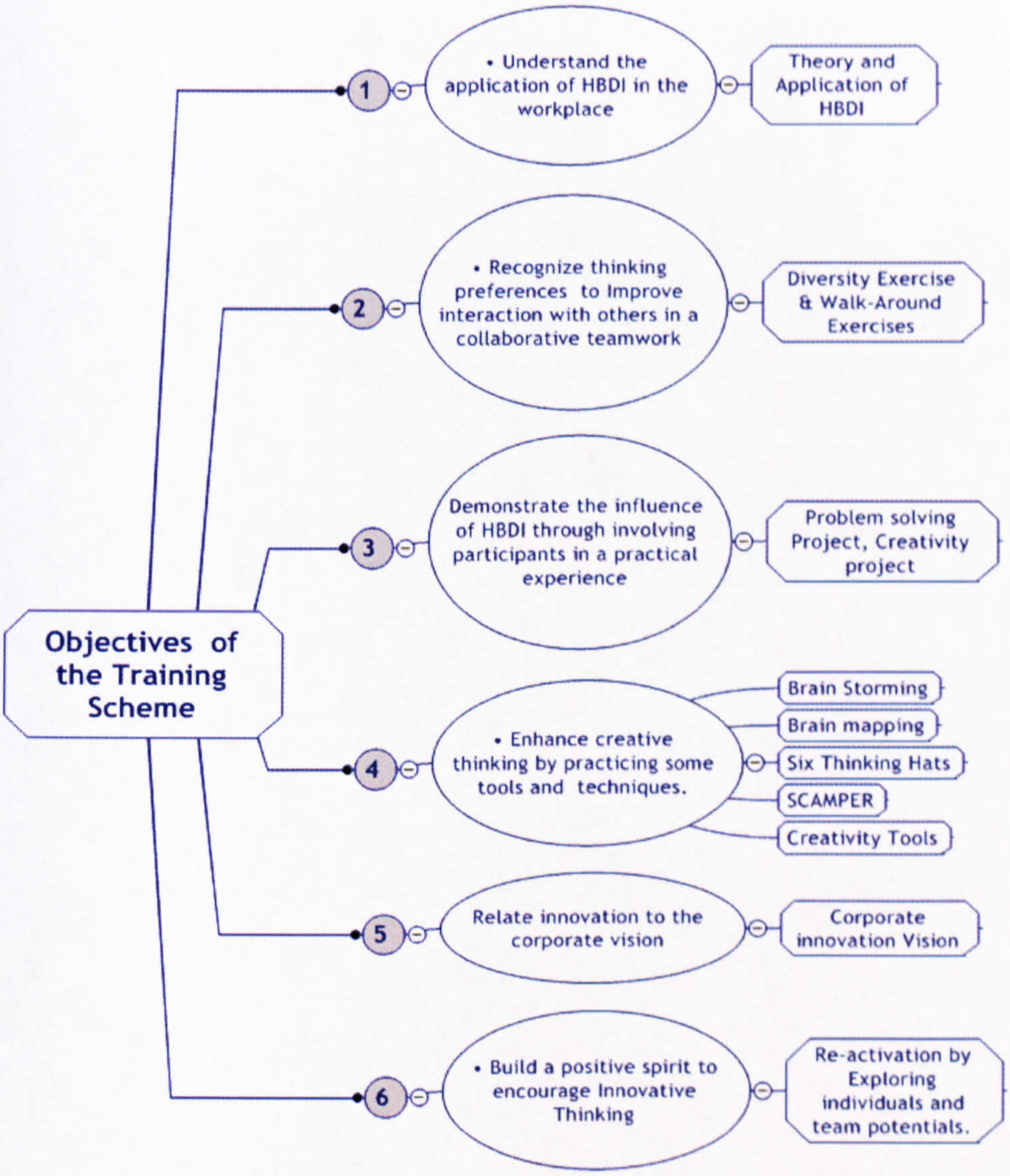


Figure 6.1 Schematic of the training course programme

There are six objectives for the training scheme. The first is to enable participants to understand the HBDI and its interpretations within the quadrant organisation of thinking preferences and, leading from this, to encourage employees attending the course to consider how thinking preference information can assist performance in the workplace. So this objective spans cognitive and practical aspects that relate to skills of problem solving, communication, creativity, and team building within real life contexts.

The second objective is to assist participants to be aware of the meaning and relevance of their own thinking preferences and to recognise the thinking preferences of others in order

to improve interaction within collaborative team working. This will be addressed through various Diversity exercises.

The third objective is to demonstrate the influence of HBDI in collaborative problem solving by involving student groups in a practical exercise in which conflicting ideas and judgements have to be taken into account when making decisions.

The fourth objective is to enhance creative thinking of participants using techniques such as brainstorming and brain-mapping, and to consider various aspects of creativity and the methods available for supporting these activities.

The fifth objective is to relate innovation to the corporate vision of the business enterprise. This will analyse aspects of this vision and define the role of participants (with their knowledge of HBDI thinking preferences) and various methods which can assist in its achievement

The final objective for the training scheme is to build a positive spirit that encourages innovative thinking through individual and team activities that emphasize cognitive flexibility and reflection.

6.3 PREPARATION OF THE TRAINING SCHEME

The training scheme was organised under six themes, each of which related to the specific objectives noted above.

6.3.1 Theme 1: Understanding the Characteristics of the Brain

With participants having completed the HBDI questionnaires in a prior session, the course itself has to introduce the Brain Dominance Theory, indicating its history and Herrmann's views on the hemispherical/quadrant organisation of the brain, and its regulatory effects on cognition and behaviour which lead to the differing thinking preferences of individuals. This will take the form of an illustrated presentation to the group, noting that the composition of the thinking preferences differs for every individual. These differences arise from the functioning of components in the brain and this activity is influenced by the working context and the emotive reaction to that context. From experience people normally tend to develop a preferential bias, but other thinking modes can be used intentionally and can become more prominent. Stress can also affect the thinking preferences. In discussion

it is emphasized that the brain is an interconnected system, is iterative in its processing, and that no one thinking preference is superior to another. All can be valuable in the particular contexts they face.

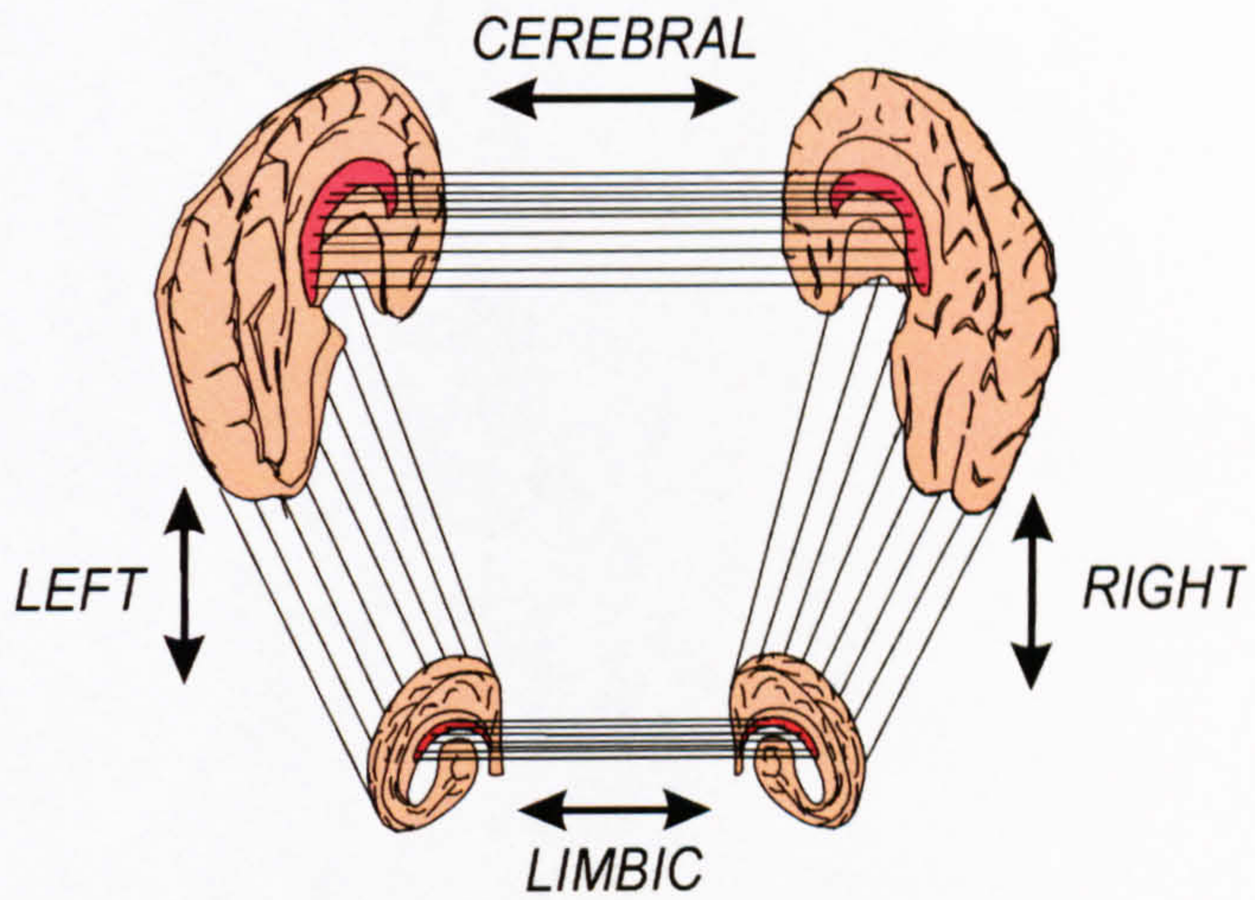


Figure 6.2 Four Interconnected Clusters of specialized mental processing modes

The session is designed to be concise, schematically illustrated and with opportunities for questions and discussion. This will lead into relevant research which point to specialised functions being located in different points of the brain. The work of Sperry (1967) in locating these areas will be noted as a preface to Herrmann's synthesis. This maintained that a brain model can be organised as having two paired structures, the two halves of the cerebral system and the two halves of the limbic system (see Figure 6.2), hence leading to his representation of the four Modes of Thinking.

The major contribution of Herrmann is the relation of his physiologic theories to learning and business applications in issues such as communication, planning and strategy development, decision making, and problem solving. The evolution of his ideas into the four quadrant model will be illustrated and the features of each quadrant discussed in a question and answer session with the students. This section of the presentation is critical and probe questions will seek to ensure that the characteristics of the quadrants and their associated thinking preferences are well understood. For example, Quadrant "A" the upper (cerebral) left can be described as associated with analytical, mathematical, technical and problem-solving. Examples will be given. However, it will be emphasized that this range of tasks is quite wide in their application, and so not only are there different individual emphases within the quadrant; but other contextual influences (*e.g.* working condition, external value judgements) can be important. In brief, the presentation and the question-

answer sessions will endeavour to bring an interpretive balance to the HBDI preferences in practice. Similar approaches will be followed for the other HBDI quadrants.

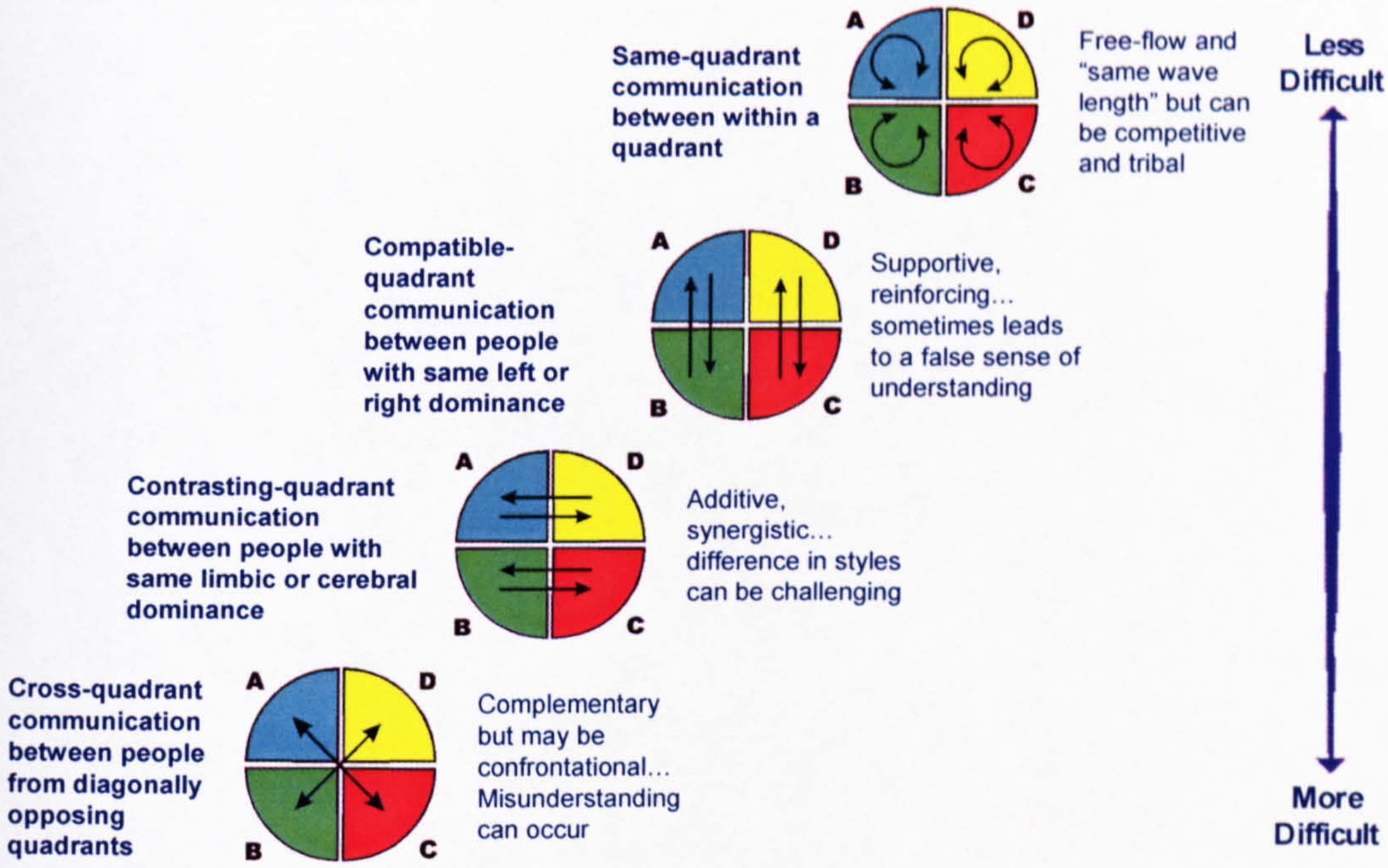


Figure 6.3 Brain Dominance Impact on Communication between People

Herrmann maintains that HBDI plays a significant role in explaining and improving human communications. It helps people to understand the dynamic interaction of teams. There are four situations in the communication process which the HBDI approach distinguishes. The first situation is the same-quadrant communication, when two individuals share the same dominant quadrant. Communication between them can be easy in most cases but it could become competitive. The second situation is the compatible-quadrant communication between people with same left or right dominant quadrants. The communication in this case would be supportive and reinforcing in most cases but Herrmann notes it could lead to a false sense of understanding. The third situation is the contrasting-quadrant communication between people with the same limbic or cerebral dominance. The communication in this case would be additive and synergistic in most cases, but difference in thinking styles could be challenging. The fourth and final situation is the cross-quadrant communication between people from diagonally opposing quadrants. The communication in this case most probably would be confrontational with misunderstandings but it should be complementary. These possibilities are summarised in Figure 6.3, and are relevant to collaborative working and team compositions.

Having achieved an understanding of HBDI and its organisation of thinking preferences under the Brain Quadrants, the theme of the second session will be given a more practical

form as it invites self-reflection on thinking preferences, and their implications in communication which allow interactions with others to be more sensitive and empathic, particularly in achieving collaborative objectives.

6.3.2 Theme 2: Understanding the potential applications of HBDI in the workplace

It was arranged that prior to the training sessions, each participant would complete the HBDI thinking preference schemes, and the analysis data would then become a useful resource to be used during the course. Also, the experience of completing the inventory would convey something of the methods by which the thinking preferences were probed and organised.

Note that it is important for the trainer to meet with participants prior to and during the filling in of the HBDI forms. This is to give some explanation of the inventory and to answer any queries or concerns about the purposes of the activity and how the data will be made available to the individual. It is stressed that HBDI data is confidential. Such a session helps to clear some false assumptions or suspicions, *e.g.* 'Would the data affect my career?' It will be pointed out that HBDI is not a test, but gives interesting profiles of thinking preferences. Hence, clear instructions will be given to the trainees to express how they really prefer to operate, and that those preferences are neither good or bad, right or wrong, but provide insights that should be useful to them The HBDI form will then be circulated and the procedures followed as recommended in the HBDI Manual. It has to be acknowledged that the HBDI is lengthy and contains many terms that need a clear understanding.

Figure 6.4 shows a glossary of these terms. Each participant should always refer to it to make sure that they have a clear understanding of the terms, even though this takes some time. The researcher is on hand to assist in this and also makes sure that all the HBDI items are completed. A section of HBDI includes questions about biographical information, favourite subject at school, preference of work elements and preferred key self-descriptors. Figure 6.5 provides an illustration of the format.

GLOSSARY OF TERMS

analytic - Breaking up things or ideas into parts and examining them to see how they fit together.

artistic - Taking enjoyment from or skillful in painting, drawing, music, or sculpture. Able to coordinate color, design, and texture for pleasing effects.

conceptual - Able to conceive thoughts and ideas; to generalise abstract ideas from specific instances.

controlled - Restrained, holding back, in charge of one's emotions.

conservative - Tending towards maintaining traditional and proven views, conditions, and institutions.

creative - Having unusual ideas and innovative thoughts. Able to put things together in new and imaginative ways.

critical - Exercising or involving careful judgement or evaluation, e.g., judging the feasibility of an idea or product.

detailed - Paying attention to the small items or parts of an idea or project.

dominant - Ruling or controlling; having strong impact on others.

emotional - Having feelings that are easily stirred; displaying those feelings.

empathetic - Able to understand how another person feels, and able to communicate that feeling.

extrovert - More interested in people and things outside of self than internal thoughts and feelings. Quickly and easily exposes thoughts, reactions, feelings, etc. to others.

financial - Competent in monitoring and handling of quantitative issues related to costs, budgets, and investments.

holistic - Able to perceive and understand the "big picture" without dwelling on individual elements of an idea, concepts, or situation. Can see the forest as contrasted with the trees.

imaginative - Able to form mental images of things not immediately available to the senses or never wholly perceived in reality; able to confront and deal with a problem in a new way.

implementation - Able to carry out an activity and ensure fulfillment by concrete measures and results.

innovating - Able to introduce new or novel ideas, methods, or devices.

integration - The ability to combine pieces, parts and elements of ideas, concepts and situations into a unified whole.

intellectual - Having superior reasoning powers; able to acquire and retain knowledge.

interpersonal - Easily able to develop and maintain meaningful and pleasant relationships with many different kinds of people.

introvert - Directed more towards inward reflection and understanding than towards people and things outside of self. Slow to expose reactions, feelings, and thoughts to others.

intuitive - Knowing something without thinking it out - having instant understanding without need for facts or proof.

logical - Able to reason deductively from what has gone before.

mathematical - Perceiving and understanding numbers and being able to manipulate them to a desired end.

metaphorical - Able to understand and make use of visual and verbal figures of speech to suggest a likeness or an analogy in place of literal descriptions, e.g., "heart of gold."

musical - Having an interest in or talent for music and/or dance.

organized - Able to arrange people, concepts, objects, elements, etc. into coherent relationships with each other.

planning - Formulating methods or means to achieve a desired end in advance of taking actions to implement.

problem solving - Able to find solutions to difficult problems by reasoning.

quantitative - Oriented toward numerical relationships; inclined to know or seek exact measures.

rational - Making choices on the basis of reason as opposed to emotion.

reader - One who reads often and enjoys it.

rigorous thinking - Having a thorough, detailed approach to problem-solving.

sequential - Dealing with things and ideas one after another or in order.

simultaneous - Able to process more than one type of mental input at a time, e.g. visual, verbal, and musical; able to attend to more than one activity at a time.

spatial - Able to perceive, understand and manipulate the relative positions of objects in space.

spiritual - Having to do with spirit or soul as apart from the body or material things.

symbolic - Able to use and understand objects, marks, and signs as representative of facts and ideas.

synthesizer - One who unites separate ideas, elements, or concepts into something new.

technical - Able to understand and apply engineering and scientific knowledge.

teaching training - Able to explain ideas and procedures in a way that people can understand and apply them.

verbal - Having good speaking skills; clear and effective with words.

writer - One who communicates clearly with the written word and enjoys it.

Figure 6.4 Glossary of Terms for the HBDI Survey Form

BIOGRAPHICAL INFORMATION

Please complete **every** question according to the directions given. Each response, including your answers to questions 2, 3 and 4, prov important data. When directions are not followed or data is incomplete we are unable to process your survey, and must return it to yo

1. Name _____ 2. Sex: M ❑ F ❑

3. Educational focus or specialist subject(s) _____

4. Occupation or job title _____

Describe your work (please be as specific as possible) _____

_____

HANDEDNESS

5. Which picture most closely resembles the way you hold a pencil?

A ❑  B ❑  C ❑  D ❑ 

6. What is the strength and direction of your handedness?

A ❑ Primary left B ❑ Primary left, some right C ❑ Both hands equal D ❑ Primary right, some left E ❑ Primary right

SCHOOL SUBJECTS

Think back to your performance in the elementary and/or secondary school subjects identified below. Rank order all three subjects o the basis of how well you did: 1 = best; 2 = second best; 3 = third best.

7. _____ Maths 8. _____ Foreign language 9. _____ Native language or mother tongu

Please check that no number is duplicated: The numbers 1, 2, and 3 must be used once and only once. Correct if necessary.

WORK ELEMENTS

Rate each of the work elements below according to your strength in that activity, using the following scale: **5** = work I do best; **4** = wo I do well; **3** = neutral; **2** = work I do less well; **1** = work I do least well. Enter the appropriate number next to each element. **Do not use any number more than four times.**

10. _____ Analytical
11. _____ Administrative
12. _____ Conceptualising
13. _____ Expressing Ideas
14. _____ Integration
15. _____ Writing
16. _____ Technical Aspects
17. _____ Implementation
18. _____ Planning
19. _____ Interpersonal Aspects
20. _____ Problem Solving
21. _____ Innovating
22. _____ Teaching/Training
23. _____ Organisation
24. _____ Creative Aspects
25. _____ Financial Aspects

Please tally: Number of 5's_____. **4's**_____. **3's**_____. **2's**_____. **1's**_____. If there are more than **four** for any category, pleas redistribute.

KEY DESCRIPTORS

Select **eight adjectives** which best describe the way you see yourself. Enter a **2** next to each of your **eight** selections. Then change one **2** to a **3** for the adjective which best describes you.

26. _____ Logical
27. _____ Creative
28. _____ Musical
29. _____ Sequential
30. _____ Synthesizer
31. _____ Verbal
32. _____ Conservative
33. _____ Analytical
34. _____ Detailed
35. _____ Emotional
36. _____ Spatial
37. _____ Critical
38. _____ Artistic
39. _____ Spiritual
40. _____ Rational
41. _____ Controlled
42. _____ Mathematical
43. _____ Symbolic
44. _____ Dominant
45. _____ Holistic
46. _____ Intuitive
47. _____ Quantitative
48. _____ Reader
49. _____ Simultaneous
50. _____ Factual

Please count: seven 2's and one 3? Correct if necessary.

Figure 6.5 HBDI Survey Form page 1

The next sections of HBDI include the selection and rating of hobbies, energy levels, and use constructive adjective pairs to probe self-descriptions and continue with extraversion-introversion assessments. The HBDI concludes five-point ratings that cover feelings, and

preferences in intentions, planning, work methods, organisation styles, and other evaluations of personal attributes such as competitiveness, and characteristics of problem solving methods.

Having understood HBDI thinking preferences and noted their own styles, discussions are conducted on their relevance and contribution to a series of contexts related to the workplace. This provides a preface to the practical exercises in Theme 3.

It should be noted that since the training required participants to be taken from the workplace and from different departments, the researcher had to negotiate the schedules with the management. They were supportive, and nineteen training courses were delivered to accommodate almost four-hundred employees who were from different departments and employment levels in KEMYA. This company information and the HBDI profiles of employees were useful in shaping the courses (under the objectives and tasks) to meet the requirements of participants.

6.3.3 Theme 3: Recognising Thinking Preferences: the Diversity Exercise

After a brief introduction explaining these objectives, the training session is to engage the participants in a Diversity exercise. A first aim is to demonstrate to the participants the level of Diversity among them, and invite them to consider implications of this Diversity. This is followed by a practical exercise using a pack of 64 cards arranged in four sets of 16 cards, with each set being identified by a different colour.

- Each card contains a word with brief explanation related to the thinking preferences of an HBDI quadrant. For example, the 16 blue cards focus on the 'A' Analytic Quadrant and the words and explanations include:

  - RATIONAL: Making choices on the basis of reason as opposed to emotion
  - DIRECT: Frank, to the point
  - LOGICAL: Able to reason deductively from what has gone before

o ANALYTICAL:	Breaking things or ideas into parts and examining them to see how they fit together
o INTELLECTUAL:	Guided by objective, rational processes rather than subjective, emotional processes
o REALISTIC:	Concerned with what is factual or probable rather than speculative or imagined
o PROBLEM SOLVER:	Able to find solutions to difficult problems by identifying and resolving key issues
o TECHNICAL:	Having special, practical knowledge of a mechanical or scientific subject
o FACTUAL:	Concerned with what can be documented or actually happened
o DEFINITIVE:	Clear, exact, free from ambiguity or obscurity
o RIGOROUS:	Having a thorough and detailed approach to problem solving
o MATHEMATICAL:	Perceiving and understanding numbers and being able to manipulate them to a desired end
o CHALLENGING:	Questioning, playing the "devil's advocate"
o CRITICAL:	Exercising or involving careful judgment or evaluation, *e.g*, judging the feasibility of an idea or project
o QUANTITATIVE:	Oriented towards numerical relationships; inclined to seek exact measures
o OBJECTIVE:	Unbiased, based on facts and not affected by personal feelings or prejudice

Table 6.1

- In a similar arrangement each of 16 green cards contains a word with brief explanation related to the thinking preferences of the organizational 'B' quadrant. Examples are:

o PUNCTUAL:	Always on time; time conscious and concerned with meeting deadlines
o DISCIPLINED:	Self controlled, able to follow through with plans
o SAFEKEEPING:	Cautious, careful, protective; concerned with consequences
o ADMINISTRATIVE:	To manage, supervise or direct

o	DETAILED:	Paying attention to the small items or parts of an idea or project
o	INDUSTRIOUS:	Hard working and diligent
o	SEQUENTIAL	Dealing with things and ideas one after another or in order
o	CONTROLLED:	Restrained, holding back, in charge of one's emotions
o	ARTICULATE:	Expressing oneself clearly, readily and effectively
o	PROCEDURAL:	Establishing and following spelled out policies and processes
o	STRUCTURED:	Being concerned with systematic frameworks; operating within set boundaries
o	PERSISTENT:	Tenacious; sticking to a task until it is completed
o	PLANNER:	Determining the necessary steps to achieve a desired outcome
o	ORGANIZED:	To arrange or form into a coherent unit or functioning whole
o	DOMINANT:	Commanding; prevailing over others
o	PRACTICAL:	Disposed to action rather than to speculation or abstraction

Table 6.2

- The 16 red cards are related to the thinking preferences of the emotional 'C' quadrant and include:

o	INTERPERSONAL:	Able to develop and maintain relationships between people
o	RESPONSIVE:	Willing to get involved, extending one to others
o	INTUITIVE(FEELINGS)	Knowing something without consciously rationalising it
o	EXPRESSIVE:	To show, manifest, or reveal one's opinion
o	FRIENDLY:	Kindly, amiable, cordial, genial and helpful
o	SPIRITUAL:	Having to do with sacred matters as apart from material things

- EMPATHIC: Able to understand how another person feels and able to communicate that feeling
- EMOTIONAL: Feeling things deeply
- TRUSTING: Willing to rely upon and believe in the integrity of others; assuming a positive outcome
- ENTHUSIASTIC: Giving yourself completely to whatever engages you
- HARMONIZING: To work toward agreement or feeling of connection with others
- RECEPTIVE: Willing and inclined to receive suggestions and offers from others
- COOPERATIVE: Working or acting together willingly for a common purpose
- HELPFUL: Giving or rendering aid, assistance, or service
- PASSIONATE: Being deeply involved or having intense feelings toward ideas or causes

Table 6.3

- Finally, the 16 yellow cards are related to the thinking preferences of the strategic 'D' quadrant and include:
  - CURIOUS: Inquisitive, eager to learn or know
  - OPEN MINDED: Receptive to new ideas or differing points of view
  - HOLISTIC: See the big picture and understand how parts interconnect to form the larger whole
  - SIMULTANEOUS: Able to process more than one type of mental input or attend to more than one activity at a time
  - INTUITIVE (IDEAS): Knowing something without consciously thinking it out, having instant understanding without need for facts or proof
  - SYNTHESIZER: Able to unite separate ideas, elements, or concepts into a new whole
  - SPONTANEOUS: Responding without effort or premeditation
  - ARTISTIC: Appreciating or creating paintings, music, poetry, dance, sculpture, etc.; sensitive to pleasing elements

		of design
o	CREATIVE:	Able to make unique connections and put things together in a new way
o	RISK TAKER:	Inclined or willing to take chances
o	FLEXIBLE:	Adaptable, able to see things in a number of different ways; willing to change
o	EXPLORATORY:	Investigate new arenas, concepts, ideas, and points of view
o	ADVENTUROUS:	Interested in discovering or investigating the unknown
o	CONCEPTUAL:	Able to grasp key elements of thought and generalize abstract ideas from specific instances
o	IMAGINATIVE:	Able to think beyond the bounds of reality
o	INTEGRATING:	Able to combine pieces, parts and elements of ideas, concepts and situations into a unified whole

Table 6.4

Note that more than one Diversity Pack is used in the exercise depending on the size of the training group. Also, sometimes the training course can be bilingual using Arabic and English, though if the participants are all Arabs then Arabic will be used. Similar considerations apply to all the training materials.

The exercise will start by throwing all the cards onto the floor of the training hall in an unorganised way. Then participants will be asked to move about and look at the cards, and then to select three cards which they like and relate to the most and three cards which they don't like very much. [The word 'like' will not be closely defined but should describe their initial feelings in looking at what is written on the cards.] Then each participant is asked to discard one card that he likes and one card that he dislikes. At this stage it will be useful to remind the participants of the characteristics of the HBDI brain quadrant (neo-cortex/limbic) organisation, after which the ground of the training hall is laid out in 'A', 'B', 'C' and 'D' quadrants. Then participants with two preferred blue cards (the 'A' quadrant representative) will be requested to stand on the outside of the angle of the first corner which represents 'A' preference; and so on for 'B', 'C', and 'D' card holders. Also, if a person has different

colours such as blue and green cards, then they would stand between 'A' and 'B' quadrants to represent the different thinking modes.

Thus the training group is dispersed according to their preferred 'liked' cards, but they also hold the coloured cards (with their descriptive words and phrases) that show their 'dislikes'. The participants are now encouraged to show cards and discuss with their neighbours so that there is a refinement in the understanding of the thinking preferences, and a greater awareness of the Diversity of likes/dislikes within and between the members in the quadrants. Finally, the participants are asked to liaise with a contrasting member, to examine and discuss their likes and dislikes but also, and more importantly, to consider how they might behave and interact in tasks or circumstances that would involve issues requiring communication, leadership, organisation, creativity, and sustaining motivation.

The trainees are educated, articulate and hold varying responsibilities within the company. This is an important part of the training and it is expected that the interactions and discussions of this exercise, in which the researcher will act as facilitator would take three to four hours. But the researcher will use his judgement on the progress and utility of the exercise in making any time management decisions.

This part of the exercise will also give participants further opportunities to become more acquainted with the defining characteristics of the quadrant. Then participants in their groups of four or five are asked to discuss their card selections, ask questions, justify their choices, and thus get to know more about each other and their thinking preferences/views. Participants also are given the opportunity to meet any member of the group and see if they would like to swap any of their cards to get more liked or disliked cards. This might result in giving clearer indications of the strength or focus or range of their individual thinking preferences/views.

This section of the training is completed by a 'Walk Around Exercise.' It is designed to encourage participants to use the different modes of thinking and get new perspectives on problems and solutions. It helps to explore the contrasting ideas and see what new insights arise by 'walking around' a given problem. The exercise starts by selecting two trainees. One stands at the 'A' quadrant side on a special big mat (showing the four HBDI quadrants, see Figure 6.6) placed on the floor, and the other trainee stands at the opposite corner at 'C' quadrant. Then the first Player should ask the other a question compatible with 'A' thinking style and the problem/issue, and the other player should answer the question according to a 'C' thinking preference. Then they walk around. So the first player would go to the 'B' quadrant and the other player should go to the 'D' quadrant. Then the second player should ask a question according to the 'D' quadrant and the first player would answer according to

the 'B' quadrant (see Figure 6.6). This continues until they return to their original positions. This process need not be too regimented, as long as the contrasting circulation occurs—which is of interest to the other team members, who then actively participate into the circulation.

Figure 6.6 Photographs of trainees participating in a walk-around exercise

The initial placing of participants on the quadrant is made independently of the participants' likes and dislikes. Indeed the aim is to improve flexibility in thinking preference application and following the answer to the question, to sequence further discussion. Again, the researcher will act as a facilitator, commenting where appropriate and managing time and turn-taking among the training group. For this exercise the numbers in each group/sub-group will be limited so that the exercise maintains its momentum and is of value even for those in attendance and awaiting their turn.

At the end of this stage of the training it is expected that all trainees will have an adequate understanding of the HBDI thinking preferences, and what they entail, of their own thinking preferences, and will have some experience of being aware and taking account of participants with different thinking styles in a variety of circumstances, *e.g.* leadership, idea creating and problem-solving, planning and organisation in ways which are relevant to the workplace

6.3.4 Theme 4: The Influence of HBDI on Collaborative Problem-solving Teams

This theme involves participants in a practical collaborative exercise which utilises a specially designed problem-solving project. The object of this problem-solving exercise is to allow project teams with differing HBDI profiles to undertake the task but to be aware how participants contribute and interact in the design, planning and performance of the task. It gives practical experience of collaborating with others in a problem-solving task that requires decision making and the consideration of alternatives. The researcher is keen to examine how the different HBDI Teams perform and the solutions which result.

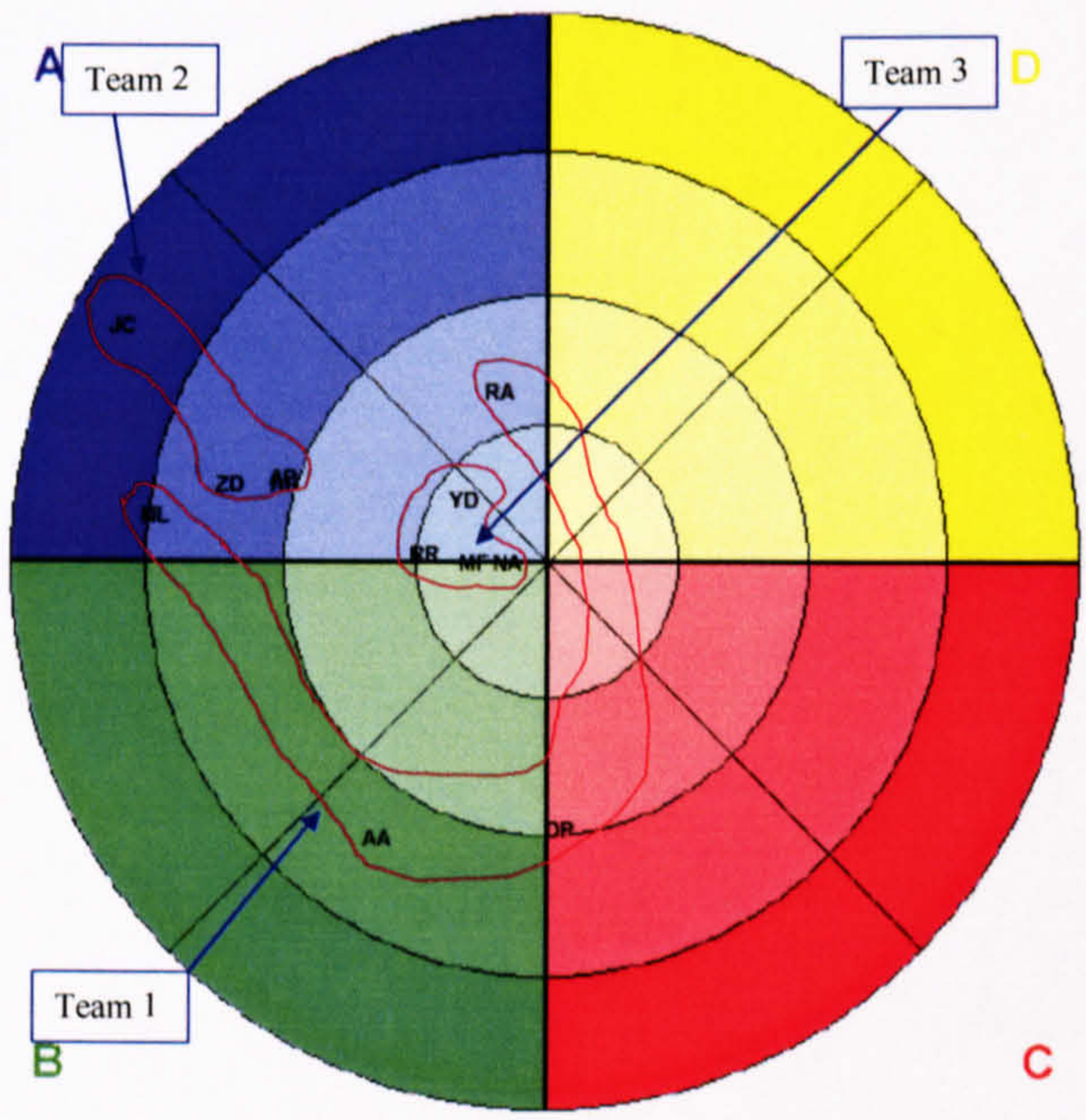
6.3.4.1 Grouping teams for the experiment

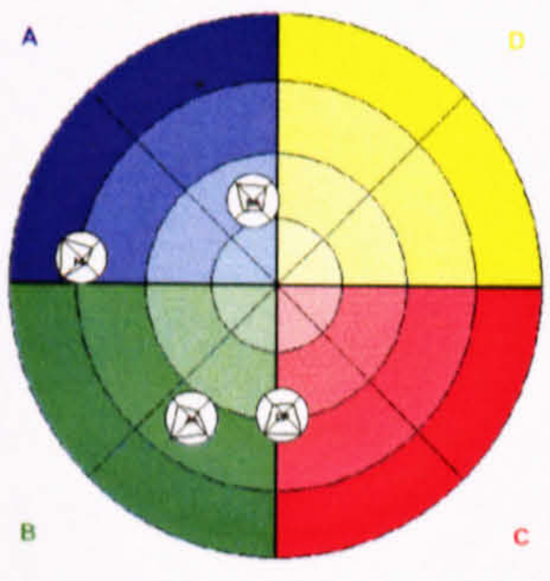
Before conducting the experiment, trainees have to be allocated to different thinking teams. The problem-solving task requires analytical and creative thinking (*i.e.* "A" and "D" thinking preferences), but the exercise requires collaboration between group members and a degree of organisation and holistic thinking to complete the task efficiently within the time frame. (This should exercise "B" and "C" preferences.) Hence empathic and organisational skills will be brought into play.

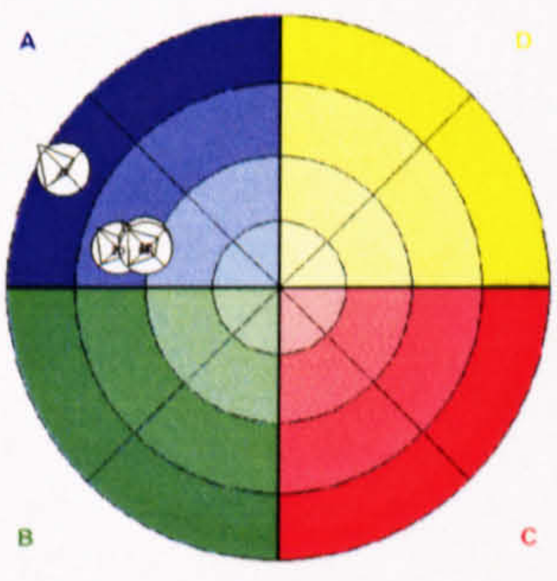
Team No.	Individual's Name	Code	Profile Score				Adj. Pairs				Dominance Percentage			
			A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
1	Abdulhamid M. Al-Suqair	1112	68	111	84	35	7	5	11	1	60%	40%	35%	65%
	Ridwan Bin N. Amin	1221	89	54	51	75	6	2	9	7	53%	47%	61%	39%
	Neville P. Lewis	1132	107	117	29	57	8	8	3	5	72%	28%	53%	47%
	Dilawar A. Parkar	2112	54	101	101	59	3	8	9	4	49%	51%	36%	64%
	Average	1122	80	96	66	57	6	6	8	4	59%	42%	46%	54%
2	Jonathan G. Cole	1132	134	90	18	56	9	9	0	6	75%	25%	64%	36%
	Zuzar S. Dhuliawala	1122	111	87	41	45	7	10	4	3	70%	30%	55%	45%
	Arif Prakosa	1122	122	72	60	41	9	2	9	4	66%	34%	55%	45%
	Aliyar M. Raghuman	1122	102	92	42	60	5	7	6	6	66%	34%	55%	45%
	Average	1122	117	85	40	51	8	7	5	5	69%	31%	57%	43%
3	Nasser A. Al-Qahtani	1121	74	78	66	72	6	7	4	7	52%	48%	50%	50%
	Yunus A. Daud	1222	77	63	51	60	7	9	6	2	56%	44%	55%	45%
	Mohamed K. Fakroodhin	1112	86	78	72	66	6	6	7	5	54%	46%	50%	50%
	Rangaraj M. Reddy	1112	99	81	75	62	6	6	9	3	57%	43%	51%	49%
	Average	1122	84	75	66	65	6	7	7	4	55%	45%	52%	49%

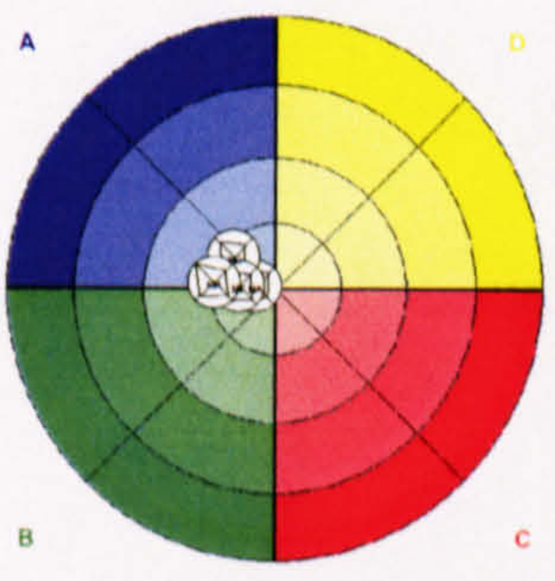
Figure 6.7 Illustrative example showing the HBDI data used in grouping

To assist the team grouping, HBDI survey results were placed on an Excel spreadsheet (see Figure 6.7). It was judged appropriate to have teams of approximately four members each. Teams were then selected, some randomly (*e.g.* Team 1 in Figure 6.7 is heterogeneous, while the second team represents a strong A/B thinking, and the third team is more homogeneous). These data are illustrated in Figure 6.8 which places each participant of a team at the centre of gravity of his profile, and the circle of each profile contains a mini diagram of the "A", "B", "C", "D" preference quadrilateral for that individual. [This method of representing team HBDI profiles is discussed in more detail later.]









Team 1 | Team 2 | Team 3

Figure 6.8 Illustrative examples showing the process of grouping teams using Circular Continuum

The researcher used these methods to arrange more than 81 teams throughout the training programme, but there were constraints. The team allocations had to be made within the

constraints of the training program sessions which had to be arranged with managements as it required employees in the departments leaving the workplace

6.3.4.2 Planning the Problem-Solving Exercise

The researcher designed a collaborative problem-solving project to be similar, in some respects, to real life assignments when there are limitations on personnel, materials, and time, and where a variety of thinking preferences are exercised. The main pedagogical objectives were to allow, and to examine, if the different thinking preferences would generate different strategies in solving the problem and arrive at different solutions.

The exercise was divided into two phases; a design phase (20 minutes) and a building phase (40 minutes). The purpose of this segregation between design and application was to give time (indeed insist on time) being given initially to thinking, planning and preparation. The researcher's role in the design phase is to respond to questions about the problem, to note in general terms how the groups were progressing and to note examples of disputes, agreements and profiles of progress.

The instructions to be given to the teams are shown in Figure 6.9. The problem was carefully designed to generate discussion and decision making between the criteria for which credit is assigned. Much thought was given to these criteria and the points scoring scheme. For example, points are allocated for the height of the tower (particularly above four feet), but points are given for each juice can supported by the tower. This should stimulate discussion about height and stability, particularly as there are graduations in point allocation for stages in the tower height. Added to this are deductions for supporting sheets of paper used; hence a stimulus to be economical in the use of materials. Further, there are deductions for each juice-can not used, but points earned for every minute saved in the production period. These constraints and incentives, it was expected, would give groups many challenges and opportunities for collaborative interchanges in both the design and production. To focus such discussion, the points awarding and deduction scheme was to be made available with the instructions which each team would be asked to consider carefully, and raise any queries, before they started their design and production phases.

Building a Liquid Tower

Objective:
To build a liquid tower using A4 paper and adhesive tape, strong enough to hold up to 6 liquid containers (juice cans) and maximizing the number of points available.The winning team is the team with the most points at the end of the exercise.

Materials:
- 100 Sheets of A4 paper
- 1 Roll of adhesive tape
- Liquid containers (Juice Cans)

Rules:
- Height is from the floor to the top of the Tower (Tower must be built on the floor; maximum height of Tower is 6 feet).
- Only one Tower per team is admissible.
- No materials other than those supplied are allowed.
- The Tower must be self standing (i.e. no support by individuals, walls, chairs, tables, etc).
- All sheets of paper must be accounted for at the end of the exercise.
- The liquid containers (juice cans) must be supported by the Tower and no other means.

Part I - Design Phase: (Duration = 20 minutes)
- This is the period for design only. Any trial structures built during this period must be totally dismantled before the start of Part II
- Lowest can must be a minimum of 6 inches above ground level.

Part II -Tower Building: (Duration = 40 minutes)
- This is the period of putting your design into action.
- When the time is up you must stop building immediately and your points will be calculated.
- However, if you complete before the time is up, you can claim completion and have your own liquid Tower measured. You will be awarded one bonus point for every minute of allocated time remaining.

Additions:
- 1 point for every inch in height vertically from the floor
- 2 points per inch above 4 feet in height
- 10 points per juice can supported by the liquidTower
- 1 point for every minute saved within the 40 minutes
- Add 10 points for every can supported between 1 ft and 2 ft above ground level
- Add 20 points for every can supported between 2 ft and 4 above ground level
- Add 30 points for every can supported between 4 ft and 6 ft above ground level

Deductions:
- 1 point for every sheet of A4 paper used
- 3 points for every juice can not used

Notice:
- Water containers must be laid horizontally, freely without any stickers.

Figure 6.9 Problem-solving sheet for Building Liquid Tower Project

The following materials were supplied to each team:

- 6 small juice cans
- 100 sheets of A4 size
- masking sheet (five metres in length)

- a measuring ruler
- an Excel sheet format to input and calculate the results directly at the end of the exercise

The course and problem-solving exercises were conducted as part of the official training programs of the company. In the event there were eighty-one problem-solving teams (usually with four team members) with several teams operating within one training course. Thus it was not possible to obtain detailed records of the interactions within each group. However, full records would be available of the HBDI team data, and details of the tower products which were designed and built. To obtain data (in addition to the researcher's records of the workings of the group, the following feedback sheet was designed (see Figure 6.10). The first four questions were viewing the opinion of each team member regarding the performance of the task, the difficulties in performing the task, ratings of the success of the team collaboration and any difficulties they faced. The final three questions attempted to gauge the methods and type of collaboration experienced in the teams. The feedback questionnaire was to be given to each team member and Question 5 asks them to identify what they considered to be the main thinking preference of the group. The next follow-up question invites judgements on the contribution of each team member to the problem solving task, with opportunity to explain the reasons for these judgements. The final question, though similar in format, changes the focus towards the interactions and cooperative feelings or atmosphere of team-working. Again participants are expected to give explanations for their judgements and conclusions.

Feedback Questioner

1- **How successful was your group in the problem-solving task?** في لتتعومجم حاجن ىدم ام

☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Poor ؟جيلا ءفيل لولحلا بسنأ قيقحت

2- **What were the difficulties your group experienced in doing the task?**

؟لحل لوصولا ليس في لتتعومجم ت هجاو يتلا تابقعلا ي ه ام

☐ Lack of enough time قفك ىولا مدع ☐ Lack of implementation abilities مدع فوت تاردقلا قيقحتلا
☐ Lack of creative ideas مدع دوجو راكفا قعلبا ☐ Other reason please specify:____________

3- **How successful was your group in working as a team?** ا في لتتعومجم حاجن ىدم هيت فوك ؟قيرف لمعل

☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Poor

4- **What were the difficulties your group experienced in working as a team?**

؟ قيرفك لمعلا ليس في لتتعومجم ت هجاو يتلا تابقعلا ي ه ام

☐ Lack of consensus يأر ىلع عامجلا مدع ☐ Lack of listening to each other يفلا عضعأ ريب ءاغصلا مدع
☐ Lack of effective participation ةلعفلا ةكرشلا مدع ☐ Other reason please specify:____________

5- **What do you consider to be your main dominant thinking preference in solving the task :**

كتلئسا في ,بأ و هالكش قبسلاب يكفت ليضفت زر

☐ Analytical Thinking يليلحت ريكفت ☐ Organisational Thinking يميظنت ريكفت
☐ Emotional Thinking يفطاع ريكفت ☐ Visionary Thinking ةيؤرلا ىلع دمتعي ريكفت

6- **How would you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?**

؟تامهاسملا ةعيبط يه امو ؟جيلا ءفيل لولحلا بسنأ ميقت في كئلمز ةمهاسمو لكتمهاسم ميقت فيك

Your Self: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
1: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
2: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
3: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
4: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------

7- **How much you assess the interaction and the contribution of your group members to the working practices and contributions and co-operative social feeling in the group?**

و هام لتتعومجم ءضعأ ةمهاسمو لعافت ىدمل كميقت

Your Self: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
1: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
2: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
3: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------
4: ☐ Excellent ☐ Good ☐ Satisfactory ☐ Moderate ☐ Small
Please Explain:------------------------------

Thank you for your co-operation. This data is <u>confidential</u> and will not be used in any training assessment.

Figure 6.10 Problem-solving Experiment Feedback Form

6.3.5 Theme 5: Encouraging participants to enhance their creative thinking

In the course, trainees will be introduced to six creativity techniques, namely Brainstorming, Mindmapping, the Six Thinking Hats proposed by de Bono, the ThinkPak Tool, the Creative Whack Pack, and the Creativity Instrument. These tools and techniques are designed to help trainees think creatively about troubleshooting and developing new solutions to problem situations, and there will be opportunities for trainees to use these tools in team exercises. Each team will have four or five participants, and will be given the opportunity to select any two of the six tools. The role of the researcher will be to explain the features of these selected creativity tools, and how they might be used in a collaborative environment.

By way of introduction it will be noted that people operate creatively in different ways and styles that can also be influenced by their thinking preferences. For example, those with strong analytic preferences may probe the problem analytically as a source for greater problem definition, and hence a stimulus to creative problem-solving. Others with an organisational preference may be stimulated by the suggestions of others and see relationships between varying ideas. Those strong on the "D" quadrant preferences may directly engage in thinking akin to brainstorming and mindmapping. But the point will be made that all these are legitimate and are useful and add value of collaborative problem-solving.

Brainstorming: the first technique to be considered uses group interaction to generate many ideas in a short time period. Such ideas are attained in a non-judgmental, unrestricted manner from all members of a group to produce an extensive list as possible of ideas, thoughts or alternative solutions. Each person in the team is asked to think creatively about a given problem and write down as many ideas as possible. These ideas will only be reviewed later in the evaluation phase. Hence the aim is to encourage flexibility and originality of thought, leaving the critiquing and their evaluation to a later phase. After some guidelines on how to conduct such sessions, the trainees will be divided into groups and, after choosing a problem topic (usually from those suggested by the researcher), will be asked to generate ideas within a short (5-10 minute) time period.

As a warm-up exercise the groups will begin by generating ideas for the ways a simple object, *e.g.* a Clothes Hanger, can be used. The researcher will take the role of a facilitator stimulating, as necessary, each group. When they finish this the trainer might ask if groups made any assumptions—*e.g.* it was made of metal. He would then take a rough count from each group of the number of uses suggested in total and estimate how many different uses

were suggested. The trainees will probably be surprised at what they thought, and although many ideas would be impractical or even uninteresting it should encourage them to free up their thinking. A further and more complex example will then follow, leading to a brief discussion on the advantages and limitations of brainstorming.

Following these introductory tasks, Mindmapping will be discussed and is a technique for developing associations of ideas. A small problem-solving exercise will be given to participants not concerned with their work, *e.g.* how to get rid of mice from the house. They will be advised to start with central ideas and use these as catalysts to develop and generate associations, thus producing relevant knowledge which gives "the bigger picture". Through these associations and, on reflection, the structure of complex thoughts and methods should become more evident. This exercise is likely to take 20-30 minutes.

The researcher will then use a further example, *e.g.* planning a camping journey, which concentrates on the ways that mindmaps can be used to show clear associations with directional arrows indicating process links, and with coloured nodes to distinguish between types of concepts, ideas and implications. Next the researcher will organise a discussion on the main advantages and limitations of the technique and the applications in which it might prove most useful.

Then, the trainer will demonstrate a mindmap using MindManager software showing its features and ease of use. [However participants will not be able to use the software themselves during the session since the classes will be too large.] He will also demonstrate how to convert mindmaps to Word and PowerPoint files.

These activities will then lead to a more general discussion of creativity with **Six Thinking Hats** being the third technique for developing creative thinking. This is a methodology devised by Edward de Bono (1992) and represents six different thinking hats or "styles" of thinking about a subject or problem, with each thinking hat being given a different colour. The scheme will be outlined, discussed and illustrated. For example, a White Hat emphasizes information based thinking relevant to the problem, whereas a Yellow Hat invites exploratory thinking that probes values and benefits. A Green Hat is concerned with generating new ideas, opportunities and perceptions, while a Black Hat brings in judgment—why something may not work, and teases out difficulties and tests feasibility. A Red Hat is concerned with feelings, emotions, and intuitions, with a Blue Hat managing the thinking process through planning and controlling the thinking activities. [Links to the HBDI preferences will be made where appropriate.]

In this session the thinking hats activity will be placed in the following scenario filled out with some details to make the exercise more relevant to the make-up of the training group. A development committee is investigating the possibility of a certain project. Unfortunately, a dominant member of the committee (a Mr Black) noted certain difficulties and dangers that could affect the feasibility of the project. Due to shortness of time and lack of preparation from the other committee members, the project is rejected. The researcher will ask the trainees to comment on the case and its conduct, pointing out agreements and disagreements in their judgements. Then, the researcher will ask the group to nominate someone (on the committee) to play the Blue Hat (managing) role identifying and summarising the criticisms, ideas and agreements under the various thinking hats. This will reveal any deficiencies (*e.g.* in emotive or interpersonal issues) that have not been addressed. This activity will require the participation of team members to take on a 'hat' as if they were in the committee themselves.

Throughout, the researcher will ensure the trainees have a proper understanding of the roles of the thinking hats, that issues are clearly stated with trainees discussing them only from the perspective of the various hats, and ensuring that all the six hat roles are represented in some form—both prior to and in the final discussion.

Following these activities, the participants will be introduced to various tools designed to improve originality and flexibility in thinking in structured ways. Following a literature review and examination of some materials, it was decided to use the SCAMPER ThinkPak (Michalko, 1994) the Creative Whack Pack (Von Oech, 1992) and, because of its Arabic origins, the Creativity Instrument.

SCAMPER ThinkPak Tool is a deck of 56 cards used to generate innovative ideas that can be used individually or for groups, and uses questions as a key to generate ideas. SCAMPER stands for the first letter of each of the following question words:

S = Substitute?

C = Create?

A = Add?

M = Modify

P = Put to other uses?

E = Eliminate?

R = Rearrange or Reverse?

Within the course, each team will begin by generating ideas to improve a simple object, *e.g.* clip, pen, table, chair, cup and glasses. Each team will begin by given a Card Deck and for a

period of 30 minutes, each participant will be asked to take two random cards from the deck. The cards will be used for stimulation and a team leader will give opportunity for each member to lead the discussion with agreed suggestions being recorded. Then, for a period of 10 minutes, each participant will be asked to take a random card from nine cards and to use that criterion in evaluating the ideas. Hence the suggestions of the group are filtered, after which each team will present their suggested improvements and conclusion. Finally, the session will end by discussing the advantages and disadvantages of the conclusions, with comments on the value of SCAMPER as an aid to the creative thinking process.

Creative Whack Pack (von Oech, 1992) is a creativity tool composed of an illustrated deck of 64 creative thinking strategies. For instance, the first card to the left in Figure 6.11 includes a title phrase "Drop an Assumption" and attached to it in the drawing image of a head representing a free wheeling of ideas, and a paragraph about free-wheeling ending with a question. By associating the problem (things we want to develop) with the title and the image in the card, and by reading the paragraph and the question with team members, this combination might trigger a brand new idea. Hence the concept behind Creative Whack Pack is the associative strategy which provides an 'angle' and catalyst for the generation of ideas. The cards will be used in a short exercise by the teams being given a problem. The experience and value of Whack Pack will be discussed by the group in the context of creative problem-solving.

Figure 6.11 Creative Whack Pack Creativity tool with three samples

More directly in the course the Creativity Instrument will be used. It is an Arabic tool authored by Dr Tariq Al Suwaidan to help people to generate creative ideas and apply them in business applications. Hence, this part of the course brings creativity directly into the workplace. The Creativity Instrument divides the creative activity into a set of stages which includes:

- Preparation Stage: Reach mental readiness.

- Exploring Stage: Deep cognitive investigation
- Transforming Stage: Tie imagination to reality
- Incubation Stage: Give chance to the unconscious
- Illumination Stage: Trigger brand new ideas
- Evaluation Stage: Strength and weakness analysis
- Implementation Stage: Establish roadmap plan

Associated with each stage is a set of generic terms (about 20) written on separate cards attached to an illustrative example. This technique will be discussed with problems and examples taken from business in ways similar to those noted above.

The aim of introducing these creativity inducing techniques and tools is to show the various facets of creative thinking and how they can be employed in a variety of situations either individually or collaboratively within a group that is likely to have members with different thinking preferences.

In the final stage of creativity training, each team will select a design problem from a given list and choose two creativity tools to use in their creative idea generation and innovative solutions to the problem. The role of the researcher will be to encourage and help them in using the tools correctly. Each team will be asked to summarize the outcomes in two flip chart sheets. The first will contain the features and feasibility of the product in relation to the problem, and the second sheet will show a drawing of the product that can be used in explanations to the trainee class. Evaluative comments from other teams on these presentations will be encouraged.

6.3.6 Theme 6: Relating innovation to the corporate vision

In all sessions, participants are able to comment in group discussions. Also, the researcher will ask anyone showing unease with content or with organizational decisions to express his feelings or concerns. Then the trainer would ask and discuss with the participant and with the class how these feelings or anxieties might affect performance, and what might improve the situation. Everyone has the option to express their reactions and suggestions which might be innovative. Hence, the course itself, and its conduct, can become opportunities for development and innovation.

The point being made here is that, in courses of this nature, the trainer has to encourage confidence and positive attitudes, and employ the concerns and ideas of participants as useful instances for discussion. Similar attitudes can be transferred to the workplace, and examples of innovation arising from the workplace (some in the Petrochemical Industry) will be used in illustration. Hopefully, from discussion, participants will realise that creativity can be an attitude of any employee at any level in the company since all employees can recognise problems and be innovative in making suggestions for improvement.

EXERCISE

From a managerial point of view, how we do we rate the following items according to their importance in creating an innovative environment?

(1(one) being most important and 10 being least important)

1. Broad contact with stimulating colleagues ( )
2. Tolerance of non-conformity ( )
3. Freedom to work on areas of greatest interest ( )
4. Creativity training programmes ( )
5. Criticism by supervisors or associates ( )
6. Encouragement to take risks ( )
7. Opportunity to work alone rather than in a team ( )
8. Regular performance appraisals ( )
9. Monetary rewards ( )
10. Recognition and appreciation ( )

Figure 6.12 Exercise rating importance of factors in creating an innovative environment

However, the large organizational structures of big business enterprises can constrain them to be conservative. Hence companies need to set up structures to receive innovative suggestions for improvements and, on their part, employees need to be alert to opportunities for innovative thinking. In order to provide a context for discussing these and similar issues the following exercise (Figure 6.12) will be given. From the ratings and their justification, useful class discussion should emerge.

The Kemya Company has agreed to institute innovation as part of their policy and organization strategy, and made it one of the critical success factors. Also, they have supported training efforts to educate the workforce in achieving these aspirations. Hence, an important step was the establishment of an Innovation Steering Committee (to which the researcher acts as a Consultant), and to develop a charter which made clear the Innovative and Creative objectives (see Figure 6.13).

INNOVATION STEERING COMMITTEE (ISC) CHARTER

OBJECTIVE:

- Institute Structured Innovation and Creativity Culture as part of Kemya's Working Environment by year 2003

EXPECTED OUTCOMES:

- Deployment of Innovation
  - Cross-functional teams will be formed using the principles of innovative.
  - Functional teams will be trained to use innovation & creativity in routine activities and, where possible, staffed based on innovation techniques.
- Create self-assessment tools for continuous evaluation (will have Kemya Facilitators/Trainers).
- Innovative Ideas about what our contacts (SABIC, ExxonMobile, Suppliers, and.... etc) do for Kemya.
- Hiring practices will include the criteria of HBDI.

BOUNDARIES:

- Area of Focus : - Process & Management - Primary
  - Product/Marketing - Secondary
- References: System will be based on Organization Innovation Quotient (OIQ).
- Will introduce the process of innovation in year 2001 and begin structured innovation era by 2003.

MEMBERSHIP:

- Stewardship by Quality Council.
- Leader : M.A.Al-Samman
- Facilitator : M.S. Baj'ba
- Members : A.M.Al-Maker A.S. Al-Sharif W.L. Clayton
  Omar Al-Humaidi (Consultant)

MEETING FREQUENCY:

- Monthly

Figure 6.13 Innovation Steering Committee Charter

Finally, in the training course, participants will be introduced to the company policy on innovation and creativity in the workplace. The trainer will introduce and discuss a suggestion pathway so that innovative ideas could be brought to the attention of managers and policy makers. [This innovative support will be discussed in ongoing work in Chapter Eight of this thesis.]

6.4 ORGANISING THE TRAINING COURSE

Having developed the Course Themes, the activities and associated materials, it was necessary to organise them into the Training Course. The course will start by introducing the objectives of the course and presenting a timetable of the program, noting that each element in the training program is designed to follow a certain theme. In actuality there were approximately twenty training sessions, each including between 8 and 33 participants. Note that the researcher had to arrange courses in discussion with Company Managers as it took employees away from the workplace; hence the difference in numbers and backgrounds of trainees attending the courses. However, this gave an opportunity for the researcher to arrange contexts and examples in ways which suited the particular trainees. Overall almost 400 trainees participated in the sessions, and a typical resume of the organisational features and conduct of the course is given below.

6.4.1 Day 1

All trainees attending courses had undertaken the HBDI questionnaires and had received their profiles. There had been presentations on Herrmann's Quadrant model and the interpretation of their ingredients to the thinking preferences. Hence, after a review and discussion of the model, and to further underline and develop understanding, the main activity on the first day is the Diversity exercise which takes about four hours. The aim of this activity is for participants to recognize thinking preferences of themselves and others. As part of the theme, every participant is given a badge-card showing his profile together with a personal HBDI profile folder. Some participants were hesitant about using their badge-cards, but this was soon overcome when they understood that if someone didn't show his profile others may speculate wrongly. Also, the more senior employees set a good example on this issue.

The Diversity exercise, was explained earlier (Section 6.3.3). After choosing Diversity cards as described, participants are distributed in the training hall according to their profile-cards, with the hall floor representing a metaphorical model of the brain's four quadrants. Individuals with contrasting thinking preferences (as shown by their card colour) were selected, *e.g.* strong A with a strong C, or a strong B with a strong D, then a discussion is encouraged with participants noting from their cards how they would or should deal with each other's thinking preferences in collaborative contexts. In general, most people participated well, taking instances and generating counter examples. They liked this session very much because of the differences and similarities shown up by the Diversity cards.

Indeed the Diversity exercise was a good methodology to explain the whole brain thinking approach by a non-lecturing method. The trainer would walk to the side of the group discussing, asking questions, listening to comments and making suggestions. Many participants gave excellent feedback about the method, *e.g.* "the Diversity exercise session lasted about four hours but we didn't watch the time as we were very interactive". One technique appreciated by the participants was an anchoring methodology, *i.e.* to relate some attribute to a position (location) so, when appropriate, a pointer to the location focused the comments.

At the end of the day, a group exercise was introduced. This was to classify a list of action statements according to the listener preferences which linked HBDI preferences to the workplace. In brief, the exercise required group discussion in classifying action statements in relation to the thinking preferences it would stimulate or require. These action statements included creating:

- A written schedule & action plan to further departmental objectives.
- An overview of progress within a department.
- An explanation of how changes will or can be made to come about in a department.
- A statement of long-term objectives for a company.
- A resumé of how "others will react" to proposed changes in a company.

The exercise was useful since it enabled group members to negotiate together, not only discussing the preferences involved in each action statement, but also how to effectively communicate with work colleagues. It was designed as a summary at the end of the day to reinforce the link of HBDI to applications in the workplace.

Some frequent questions typically arose, *e.g.* What is the best profile? And the answer is: For what purpose? Your own profile is the best for you, but everyone has different preferences, and everyone can make valuable contributions, especially if you are not only aware of your own profile but that of others. Often in the breaks, a trainee would bring his personal profile folder and discuss it with the researcher. The discussion might include work issues and sometimes even family matters. From the company's perspective, such discussion is welcome as happiness at home is reflected positively in the workplace. [It should be noted that the validity of HBDI doesn't apply for the age of less than 16 years and it is preferred that the assessed individual has employment for the reason that there is a part in the survey about the work elements].

6.4.2 Day 2

After the Diversity experience, and to maintain motivation and to convince participants of the relevance of the course, the principal theme of Day 2 was further directed at the trainees' understanding of the range of applications of HBDI and its potential benefits in the workplace. The main sessions were directed at the need for effective communications, creative thinking, team building, and for leadership and strategic thinking within the working practices of the company. The roles HBDI could play or be utilised under these aspirations was continually brought into the discussions.

Communication: this considered how to interact with people according to their differing HBDI profiles, underlining the fact that all preferences were likely to be of value and could act as a focus for thinking. For this some case studies and situations were considered and discussed by groups and their conclusions compared. However, it was underlined that in real life there are other important factors as well, such as know how and experience. Further, an important requirement was for management and the company to establish communicative paths between the levels of management, and of differing departments, and that cross-functional teams were a good way of establishing this.

Creativity: the main element was the discussion of creativity and an outline of its theories and stages model. Some participants were not sure how precisely creativity models should be defined, and that in practice it would sometimes be difficult to assemble a team with ideal thinking preferences. Their comments formed the basis of interesting group discussions. It was pointed out that even if a team lacked strong preferences in a quadrant, an awareness of the characteristics of the quadrant could be a stimulus for thinking and could be instrumental in improving their performances. Individuals are adaptable to the context and not bound within their preferences. In brief, the researcher's role was to clear out the creativity blockers in responding to discussions and encouraging all participants to develop their thinking preferences and be more aware of the thinking preferences of others.

Team Building: the participants knew their HBDI profiles and had some awareness of the preferences of others in their team. So, different characteristics of teams and how they might operate are discussed, and examples taken where particular cross-functional groups have to be set up.

Leadership: it was pointed out that "a leader is someone who has followers", *i.e.* leadership is influence, and is particularly important in team working. The HBDI model, it was proposed, helps a leader to know the profiles of potential followers and can take advantage of their thinking preferences in group facilitation and in strengthening communication

between them. Participants were placed in groups of 4-5 members and were given exercises to specify their views of appropriate leaders' profiles for the given contexts by selecting leadership adjectives from a list. This led to useful discussion and the feedback from participants was very positive, particularly from senior managers who were interested in making links between the checklist and their thinking preference profiles.

From these small case study discussions, each team reported its conclusions to the whole class. Examples of the contexts or scenarios given to teams included:

- A manager of a quality assurance team with "A" profile bias and has employees of "B", "C" and strengths in their "D" profiles. How can this team be managed or facilitated to achieve quality assurance objectives? What roles were employees likely to play?

- A supervisor of a product design team with "B" profile has employees with "A" and "C" preference profiles. How is this team best managed or facilitated to achieve the objectives of the product design?

- A manager of a research and development department with a "C" bias in his profile has employees with "B", "C" and "D" profiles. How can this team best achieve their objectives?

The overall reaction to these exercises was positive since the aim was to link the requirements of the task (communication, creativity, team building) via HBDI preferences to practical management issues. It gave opportunities to link theory to practical contexts, in ways which generated discussion and encouraged (in the summaries) interactions between different participative groups.

6.4.3 Day 3

The next stage, and the theme of this training day, was to enhance and develop creative thinking. As a warm-up exercise the trainees are asked to solve the 'Nine-dots Brainteaser'. This puzzle is well known and generic and any participants who had done the problem were asked to be active observers. The researcher stimulates the activity by asking cued questions, *e.g.* Are there any blockers? After discussion, the suggestions are made, *e.g.* "Don't limit your thinking inside the box. Be open, think outside the box", reminding trainees to be aware and more open about the assumptions they make in their thinking about problems.

After this warm-up exercise, the activities switched to the techniques and tools to assist creative problem solving which were outlined in Section 6.3.5 (Theme 5) of this thesis.

The BrainStorming technique (which was known to some trainees) and the related discussions and activities were particularly well received. Participants interacted enthusiastically and gave many positive and supporting comments. They saw the advantages demonstrated with many ideas generated—several of them excellent. Also, the experience reinforced their feeling of ownership over the ideas.

MindMapping was approached from three directions. First, participants noted the difference between the traditional outlining and mindmapping creative technique. Second, the researcher provided an illustrative presentation of the brain mapping technique and, third, a demonstration of the Mind Manager software was given. These approaches were interleaved with practical activities and discussions as outlined in the Section 6.3.5. The technique of mindmapping was well received, but there were differences of opinion about the usefulness of the software, some preferring the manual drawing approach, while others were appreciative of the software facilities and the ways the computer based output could be easily interchanged with others.

The Six Thinking Hats technique also attracted interest and the general feedback was good. [The practical task is described in Section 6.3.5 where participants took roles determined by their Thinking Hat.] However, some were confused on the relationships between the HBDI thinking quadrants (*i.e.* the preferences) and the differing styles of the Six Thinking Hats, especially as both of them are using colours to denote differences. Also, some oversimplified the thinking hats approach wanting to designate particular people to particular hats, thus missing the point that all "hats" are useful in engaging with a problem.

When using ThinkPak Tool (SCAMPER) this creativity exercise was composed of two steps. The first was generating ideas by using SCAMPER questions and the other step was to evaluate the ideas using the evaluation cards. In general, the feedback was positive, but there was comment about the lack of an Arabic translation. Another comment was about the background knowledge and experience necessary to take full advantage of the technique. Others though took a freer interpretation of terms and considered this was a release to their thinking, rather than a constraint

Again the Creative Whack Pack activity (see Section 6.3.5) was well received. It was considered useful in generating new ideas but others noted that it doesn't help to implement them and give them practical form—hence it acts more as a brainstorming aid. There was interesting discussion on this point.

The final activity used Creativity Instrument which has an Arabic origin, and the tool helps to trigger new ideas by using an associative concept by giving only one word in each card but indicating a creative linkage. One of the positive comments about the tool is that it is systematic and follows stages from preparation to implementation. Most of the participants liked it because of the use of the Arabic language. Others suggested there should be a more specific development of the tool that would serve the manufacturing business enterprise more directly.

6.4.4 Day 4

The researcher managed the Creativity Tasks in ways that encouraged participation and discussion, and these judgements meant that the Day 3 Program was not tightly timetabled, and could, if necessary, could carry over to Day 4. Indeed Day 4 continued the Creative Thinking theme with the main aim being to build greater confidence and a positive spirit to develop innovative thinking. Typically, creativity blockers were discussed and some participants considered creativity aspirations were idealistic because in reality they have to combat large organisational structures, inertia, and resistance to change. These difficulties were seriously considered as were the ways positive thinking could overcome such impediments. [This theme of Innovation within a Corporate Vision would be returned to in the final session of the course.] In the breaks and afterwards some participants brought personal examples and problems so that practicalities (and encouragement) were brought into the open and were discussed at the individual as well as at the class level. Indeed, after the training many participants sent e-mails seeking advice to resolve some of the creativity blockers so in this respect the interaction continued beyond the confines of the course. Hence, with groups showing keen participation and interactions, having a looser timetable with clear breaks was advantageous to the course aims.

The other important activity on the fourth day was the creativity project which lasted about four hours and is outlined in Section 6.3.5. The main aim was to stimulate and enhance creative thinking. Although a list of design problems was available (supplied by the researcher), teams could adapt these or set up their own problems. Some teams selected relatively simple objects to design and develop; but others were more ambitious and insisted on selecting real life work related services or procedures. Even though the activity was lengthy (since two creativity tools were chosen to assist this exercise) there was a lack of time to cover all related issues but teams at least had opportunities to grapple with a problem to which their tools were applied. The importance of the team leader was apparent in energizing and motivating the team members. At the end of the session, each team was

asked to draw a sketch of their project and solutions, and then teams were asked to evaluate each other by ranking them according to quality of design and the creativity inherent in the idea. [The aim of this evaluation was to stimulate and focus discussion rather than arrive at an order of merit.] Several senior executives attended these short presentations of projects thus showing appreciation of the activities and efforts of the teams. A principal comment about the creativity support tools was the difference in what they required and the time taken to use them. For instance, the creativity instrument needed longer time than the other tools. In general, the interest and interactions of participants were high, and the competition among them added to the motivation and made them feel that time was passing very quickly.

6.4.5 Day 5

At this stage the course draws together the principal themes related to thinking preferences, innovation and creativity, and collaborative problem solving. There are two large activities to exercise these themes. The Walk-Around Exercise (outlined in Section 6.3.3) was to help participants to recognise their thinking preferences in practical ways. The students are arranged in pairs and they rotate around the Walk-Around Mat (showing HBDI quadrants), each of them opposite to the other asking questions related to the quadrant they are standing in. The learning point is that when players stand in their preferred quadrants they were fluent in the questions and answers, but less fluent in the other quadrants. To help or stimulate them in these quadrants, the audience (*i.e.* those students not currently using the Mat) shout out suggested answers. Hence the exercise is participative, and generates a good stimulating atmosphere with the supervisor/researcher monitoring and making appropriate summary comments. Overall the response to this activity was very positive, with employees from different levels in the company discussing the critical issues.

The Walk Around Exercise was followed by Building a Liquid Tower Project: this is a collaborative problem-solving exercise in which small groups of participants (usually four in number, and with different HBDI profiles) are engaged in building a tower (using paper) to support juice cans. The materials and criteria for which points are awarded have been described in the previous section of this chapter (Section 6.3.4.2), and a detailed account and discussion of the results of this activity are the subject of Chapter Seven. Hence, only a brief summary of the activity will be given here.

Teams were formed with different thinking preferences and, before the start of the project, instructions were given. During the activity the trainer/researcher made observations, clarified any difficulties and ensured the design and building phases were kept to time. The

participants knew their HBDI profiles and had engaged in the walk around exercise, and so were aware of the implications of the different HBDI profiles. The reaction of the participants was very enthusiastic and had a competitive edge between the teams that was motivating. Figure 6.14 Teams engaged in Building a Tower Project gives an illustration of the scene.

The results of the exercise were made known to the participants, and this again generated discussion between the teams. The questionnaire forms were also completed, and the conduct and discussion of the results and these data are set down in the next chapter.

Figure 6.14 Teams engaged in Building a Tower Project

The final session, Corporate Vision, was to relate the Innovation Program to the Corporate Vision of the company. The commitment of senior managers to innovation in the workplace, the training program, and the development of the Kemya Suggestion System were described and discussed, emphasizing the roles of employees in ensuring that the innovation schemes were successful and applied in the workplace. The need for a browsing scheme to assist (controlled) access to HBDI data was outlined, together with the features of a suggestion framework (the Kemya Suggestion System) so that innovative ideas and comments from the workplace could be brought before company managers and policy makers. The response of the participants was very good because, as some of them noted, it

gave more value and responsibility to employees and helped to build a greater corporate spirit.

6.4.6 Evaluation

Training is a costly investment to companies, particularly as it takes groups of participants away from their paid work for several days. Hence companies are keen to see a return on the training investment, and part of this evaluation is for a company questionnaire to be completed by participants at the end of the course. The training described in this thesis was no exception and these data with a brief discussion follow to complete this chapter.

The course had to accommodate the company's arrangements for releasing employees from the workplace. Hence the participants on each course could vary in numbers and in type of employee. However, the observations of the researcher and the comments of the trainees showed the course attracted interest and was well received. The training arrangements sometimes resulted in time limitations for some of the activities, and for adequate feedback and reflective discussions to take place. In summary, the course had three main themes: *(i)* giving knowledge of HBDI, its underpinning theories and the importance of being aware of the thinking preferences of self and of others, particularly in collaborative working; *(ii)* fostering creativity and relating innovation to the workplace; and *(iii)* providing an opportunity for small teams to engage in collaborative problem-solving where thinking preferences and creative ideas could influence the problem-solving process and its results.

The company questionnaire (given to all their courses) contained items which required participants to give value ratings on the course overall, the instructor, the training methodology, and the associated materials and facilities. The results from 270 employees who were able to complete the questionnaire, with the researcher's summary comments, are given below in Table 6.5 and Table 6.6.

COURSE EVALUATION SUMMARY						
Legend		**Poor**	**Aver-age**	**Good**	**Very Good**	**Excel-lent**
COURSE	Was the course interesting and informative?	0	0	15	68	178
	To what extent did the course meet your specific job requirements?	0	0	25	91	145
Summary Comments These data show that almost all participants believed that the course was interesting and informative. 68% rating the course as excellent; 26% as very good; and none giving an average or poor rating. A similar data pattern applied to the ratings on relevance, *i.e.* meeting the needs of job requirements. 56% of participants evaluated the course as excellent in this respect; 35% of the ratings were very good, 9% gave good ratings and again none was average or poor.						
INSTRUCTOR	How well did the instructor present his subject?	0	0	30	71	160
	How well did the instructor use the training aids?	0	0	20	85	155
	Was the instructor helpful to your needs and difficulties?	0	15	40	60	156
Summary Comments These data show that participants believed the instructor was at least good in presenting the material. Indeed, 61% rated the instructor as excellent; 27% as very good; and 12% of them evaluated him as good. There were no average or poor grades. A similar pattern applied to the instructor's use of training aids. 60% evaluated the instructor as excellent in this respect; 33% of them as very good; and 7% of them as good. Again there were no negative ratings. For the helpfulness of the instructor, 58% of participants believed that the instructor was excellent in this respect; 22% of them evaluated the instructor as very good; and 15% as good. However, 5% of participants rated the instructor as average, probably because of the difficulties of giving sufficient individual attention to the number of participants in the training courses.						

Table 6.5 Rating questions of the course and instructor

COURSE EVALUATION SUMMARY						
Legend		**Poor**	**Aver-age**	**Good**	**Very Good**	**Excel-lent**
INSTRUCTIONS	How effective was the training methodology?	0	10	31	50	175
Summary Comments The subjective ratings of the effectiveness of the training methodology were high and 97% gave a good or better rating: though 3% of the participants gave an average rating.						
MATERIALS & FACILITIES	Where the training aids supportive and relevant?	0	15	25	70	150
	Were the written materials easy to read or understand?	0	10	35	46	170
	Were the facilities suitable for the course?	0	10	25	60	165
Summary Comments For the support given by the training aids 58% of participants evaluated the support and relevance as excellent, 27% gave very good ratings and only 5% considered them to be average. Again, high ratings were given for the written materials; 65% gave an excellent rating for ease of reading and understanding; 18% noted they were very good; 13% gave a good rating, and only 4% evaluated the materials as average. Very similar ratings applied to the facilities being suitable for the course.						

Table 6.6 Rating questions of the training

The researcher has provided comments on the conduct of the courses, and detailed discussion of the collaborative problem-solving exercise is given in the next chapter.

However, the above data show that the course (presenter and materials) received very positive ratings on the criteria set out by the company.

At the end of the company evaluation form was the question, "What is your action plan in response to the training program?". Some of the answers were: "to strengthen communication"; "to appreciate other people's ways of thinking"; "to listen more to other peoples' ideas". Other participants commented about a change in their role being more ready to adopt changes. Others noted the value of the HBDI brain concept by improving ways of mixing with and working with other team members, and the value of knowing their own thinking preference profile. There were other comments relating to collaborative working and establishing group bonds. Almost all the participants expressed their positive appreciation of the course, many hoping that the course would be given to every employee of the company.

For some of the courses, time allowed participants to complete a more specific questionnaire designed by the researcher. The trainees were asked to give frank responses which reflected their considered opinions. They were reminded that responses were anonymous, and the data was regarded as confidential and would not be made available to the company. The data in Table 6.7 show the ratings of 127 employees on questions directed at innovation and the HBDI.

Employees' Questions 127 participants	Greatly %	Somewhat %	Slightly %	None %
1. Did the Kemya Training Program help you understand yourself better?	73	20	7	1
2. Did the Kemya Training Program help you understand your colleagues better?	79	15	5	1
3. Did the Kemya Training Progam help in enhancing the communication between you and your colleagues?	55	27	16	2
4. Do you believe the Kemya Training Program helps Kemya become more productive?	69	18	13	0
5. Did the Creativity Training and Innovative Thinking help change the way you creatively think?	51	41	8	1
6. Did you find difficulty in understanding the HBDI Survey?	1	6	13	80
7. Do you believe that people fill in the HBDI survey accurately?	42	31	23	3
8. Do you believe the HBDI Survey is accurate?	70	12	17	2

Table 6.7 Responses to Employees' Questions

These data note that a large majority considered the course helped them to understand their capabilities and those of their colleagues better, but the effects on inter-communication had less (though still a majority) support. Participants tended to agree the course should benefit the company, but were less sure on judging if the course changed the way they think creatively. A large majority found little difficulty in understanding HBDI, though there were differences of opinion as to whether they believed people answered the HBDI in a realistic or idealistic way. This is a criticism of the HBDI reliability/validity noted in Chapter Two, but it is of interest to note that a larger majority believed that the HBDI survey itself was accurate. Perhaps this reflects their judgement that their HBDI profile was an accurate measure of their own thinking preferences.

A questionnaire was directed at participants who had a managerial role in the company. Nineteen questionnaires were completed, and the results are shown in Table 6.8. These data show strong support of the view that the Training Program would help them better understand the employees they manage and their communication with them. There was also support for the view that the Training Program would have a positive effect in the work environment. However, there was less strong support for its value in making team selections (items 4, 5, and 8) and its effect on their team selection methods. Perhaps this is understandable—the HBDI can be taken into account (hence the support shown in the ratings) but other factors are also likely to influence selections (hence the moderate support level shown in the Table). However, there was considered support (Items 6 and 7) that the Training Program could, or had, added value to the employees, *e.g.* in their problem-solving abilities. At this point in time, the managers would have little opportunity for making direct judgements in the workplace (hence, perhaps, the only moderate support given to Item 9) so their ratings reflect their assessment of the value of the course they experienced.

Managers' Questions 19 participants	Greatly %	Somewhat %	Slightly %	None %
1. Do you believe the Kemya Training Program will help you to better understand your subordinates?	63	21	11	5
2. Do you believe Kemya Training Program will help you in communicating with your group/colleagues?	68	16	11	5
3. Do you believe that Kemya Training Program will have a positive affect in the Work environment?	58	26	11	5
4. Do you believe Kemya Training Program adds value to team selection?	42	42	11	5
5. Do you believe Kemya Training Program will affect the way you assign tasks matching the thinking preference of your employees?	37	42	16	5
6. Do you feel Kemya Training Program adds value to your subordinates?	48	42	5	5
7. Do you believe the training will add value to the problem solving ability of your subordinates?	58	32	5	5
8. Would you consider thinking preferences (HBDI) an important factor in selecting recruits?	42	42	11	5
9. Have you noticed that your subordinates' participation and suggestions have increased since they attended Kemya Training Program?	32	32	26	10

Table 6.8 Managers' Responses

6.5 A SUMMARY OF ACHIEVEMENTS

The training courses had three main components. First, reinforcing the understanding of HBDI, and the characteristics of the thinking preferences with practical exercises showing the value and contributions of preferences, and of taking them into account in collaborative tasks. Second, outlining and discussing theories of creativity and the creative process, with interactive tasks, based on brainstorming and lateral thinking and supported by the ThinkPak and Whack Pack tools, giving a practical form to these techniques in ways that related to the workplace. The third component was the team problem-solving exercise to design a high tower, supporting juice cans but with some resource and time constraints. The interest is in the ways team HBDI patterns seem to influence team interactions and the designs and implementations of the tower building. [This interest is fully examined in Chapter Seven.]

The training courses (nineteen in all) accommodated participants from different departments and different levels in the company. The questionnaire data confirmed the success and interest in the courses, the perceived value of their content, the delivery by the researcher, and the blend of theory and related practical activities with opportunities for interaction and discussion.

It was clear from these data and the notes of the researcher that the interactive components were well received. Worth particular comment is:

(i) In the first phase, the wearing of badges by the participants which showed their HBDI profiles and became the focus of much informal as well as informal discussion. Also, the Diversity and Walkabout activities which encouraged participants not only to be more aware of their own thinking preferences, but the value of taking account of those of others.

(ii) In the second phase, the brainstorming and team activities using the ThinkPak and Whack Pack tools were useful in focusing participant understanding of the interlinked components of creative thinking in context. Also allowing teams to suggest their own problems and present their views and solutions to other teams stimulated critical and useful commentaries.

(iii) The third problem-solving, tower building phase was of considerable interest and will be reviewed in Chapter Seven, but the closing discussions of the course on the ways the innovative culture could be supported in the company through the use of a suggestion system were very well received.

CHAPTER 7

Problem Solving Exercise

7.1 INTRODUCTION

Chapter Six discussed the training scheme and its activities, but the problem-solving exercise which was a principal component of the training was merely outlined. This chapter describes and discusses the problem solving study in more detail. The main objective was to make a link between thinking preferences and performance within a collaborative problem-solving context. Thinking preferences had been measured for all employees using HBDI and the significance of these profiles was illustrated in the Training Course, and in the Diversity and Walkabout Exercises. An important feature of the collaborative problem-solving exercise was employing such knowledge in a task where judgements had to be made, decisions agreed upon and where performance and progress, *i.e.* the conduct of the activity, was a shared responsibility. A further aspect was to understand team dynamics under pressure. Team members may interact in ways which are influenced by their thinking preferences, but these should interplay with constructive roles as they understand the problem progression and the collective team dynamics. Finally, the problem-solving exercise involves discussion and evaluation, and is a reflection on what has been achieved.

In brief, the aims of the problem-solving exercise were:

(i) To examine the performances of the collaborative teams in the tower building exercise under the criteria discussed in Chapter Six. The main drivers of a high performance were a high tower capable of supporting a large number (maximum 6) of juice cans at a high level. Other bonus points were awarded for the economical use of resources (*i.e.* saved paper) and for completing the task within the time limit (*i.e.* saved minutes).

(ii) To relate these performance indicators to the HBDI profiles of the team members. For example, were there general associations between quadrant strengths, or particular distributions between the quadrant profiles which appeared to be beneficial in supporting a strong team performance in the tower building exercise?

(iii) To examine the perceptions of team members about the process of tower building, *e.g.* how the team operated and cooperated, if leadership seemed an important issue, and how team members described and rated the type and value of their contributions and those of others in relation to the tower building. A further aspect of the evaluation was to consider any associations between these characteristics of the trainees and their own particular HBDI profiles.

Overall, and in contrast to other research, this study would—it was hoped—provide informative data and reflections of the problem-solving process as well as on the quality of the final tower build itself. Also, it was of particular interest to note the insights provided by HBDI data in providing explanatory links between process and product.

The features of the problem-solving task have been explained in Chapter Six, namely that the tower could be built in several different ways, that careful consideration had to be given to the criteria, *e.g.* not only were points awarded for a high tower but also for the number of cans supported: the higher the tower the more strength and stability would be needed to support the cans. Also, bonus points could be earned for using less paper to achieve these aims, and the time (40 minutes) was chosen to put some pressure on the teams in the tower building, and bonus points could be earned by completing the task within the allotted time. In brief, there were many discussion points about procedures which would arise both in the design phase and during the tower building itself.

It should be emphasized that the problem task was chosen to exercise all the HBDI preferences. For example, it is useful to analyse the criteria in relation to tower design and building (A preference). The thinking and interactions of groups need to be organized and structured towards the task goals (B preference). Clearly there is a place for creative and imaginative thinking (D preference), and—since the exercise is a collaboration—interpersonal and empathic skills (C preference) are important.

To obtain data on the working procedures and interactions of teams was clearly going to be difficult, since it was expected that a typical training session would contain 6-8 teams. The researcher would move between teams and make notes on points of interest, but this was limited and the logistics of the task and its administration precluded video recording. Further, it was the perceptions of the trainees about team working, and the nature and value of their contributions and

those of other team members that were of interest. Accordingly, a questionnaire was designed that was directed towards these objectives, and this will be discussed in Section 6.7 of this thesis.

7.2 COMMENTS ON THE EXPERIMENTAL TASK

The main task was to build a liquid tower using A4 paper and adhesive tape, strong enough to hold up to 6 liquid containers (juice cans). The winning team is the one which can achieve the maximum points at the end of the exercise. The Given Materials for each team are limited to; 100 sheets of A4 paper, a roll of adhesive tape, and 6 Liquid containers (juice cans). The participants were placed in teams (the procedure is discussed later) and the exercise had two phases, a design phase which was a preparation for the actual tower building phase. After a brief preliminary talk the instruction sheet (see Figure 7.1) was given to participants. They were asked to read it carefully; any questions were answered, and the exercise began.

Building a Liquid Tower

Objective:
To build a liquid tower using A4 paper and adhesive tape, strong enough to hold up to 6 liquid containers (juice cans) and maximizing the number of points available.The winning team is the team with the most points at the end of the exercise.

Materials:
- 100 Sheets of A4 paper
- 1 Roll of adhesive tape
- Liquid containers (Juice Cans)

Rules:
- Height is from the floor to the top of the Tower (Tower must be built on the floor; maximum height of Tower is 6 feet).
- Only one Tower per team is admissible.
- No materials other than those supplied are allowed.
- The Tower must be self standing (i.e. no support by individuals, walls, chairs, tables, etc).
- All sheets of paper must be accounted for at the end of the exercise.
- The liquid containers (juice cans) must be supported by the Tower and no other means.

Part I - Design Phase: (Duration = 20 minutes)
- This is the period for design only. Any trial structures built during this period must be totally dismantled before the start of Part II
- Lowest can must be a minimum of 6 inches above ground level.

Part II -Tower Building: (Duration = 40 minutes)
- This is the period of putting your design into action.
- When the time is up you must stop building immediately and your points will be calculated.
- However, if you complete before the time is up, you can claim completion and have your own liquid Tower measured. You will be awarded one bonus point for every minute of allocated time remaining.

Additions:
- 1 point for every inch in height vertically from the floor
- 2 points per inch above 4 feet in height
- 10 points per juice can supported by the liquidTower
- 1 point for every minute saved within the 40 minutes
- Add 10 points for every can supported between 1 ft and 2 ft above ground level
- Add 20 points for every can supported between 2 ft and 4 above ground level
- Add 30 points for every can supported between 4 ft and 6 ft above ground level

Deductions:
- 1 point for every sheet of A4 paper used
- 3 points for every juice can not used

Notice:
- Water containers must be laid horizontally, freely without any stickers.

Figure 7.1 Problem solving sheet for Building the Liquid Tower Project

Part I - Design Phase:

In the design phase, which lasted approximately 20 minutes, participants were encouraged to understand the problem and think about a proposal for the tower construction. A flip chart and markers were given to each team to draw their proposal and make notes. In addition, each team was encouraged to hide its proposal and the tower in the building phase from other (well separated) teams. The role of the facilitator was to observe, make notes, and answer any points of information.

Part II -Tower Building:

A time period of 40 minutes was allowed for the tower building. This was not long and chosen to put some time pressures on the team. The points system and was also chosen to highlight different aspects of the problem-solving task. Maximum height would be useful, but stability is needed to support the cans—and how many cans could be supported? There are deductions for sheets of paper used (in rolled form) for the supports, suggesting economic use of this resource, and for juice cans not used—pressure therefore to support many cans. And a point is given for each minute saved within the forty minute time period. Hence there are many factors to be discussed in the planning phase—and in the building phase when the designs have to be given a practical form

As shown in Figure 7.2, if the tower length is 5 feet (60 inches) and carries the six cans above 4 feet (48 inches), then 324 points could be achieved, *i.e.* 90% of the maximum points (without saved time points, unused paper points and unused cans deductions). Finally, regarding the unused cans, for each one 3 points will be deducted, but for every can carried by the tower 10 points are awarded—with an additional 10 if it is between 1 and 2 feet, or an additional 20 if it is between 2 and 4 feet, or an additional 30 if it is between 4 and 6 feet. These criteria, though in some sense arbitrary, were carefully judged in terms of the diverse features involved in the task, and the task difficulty.

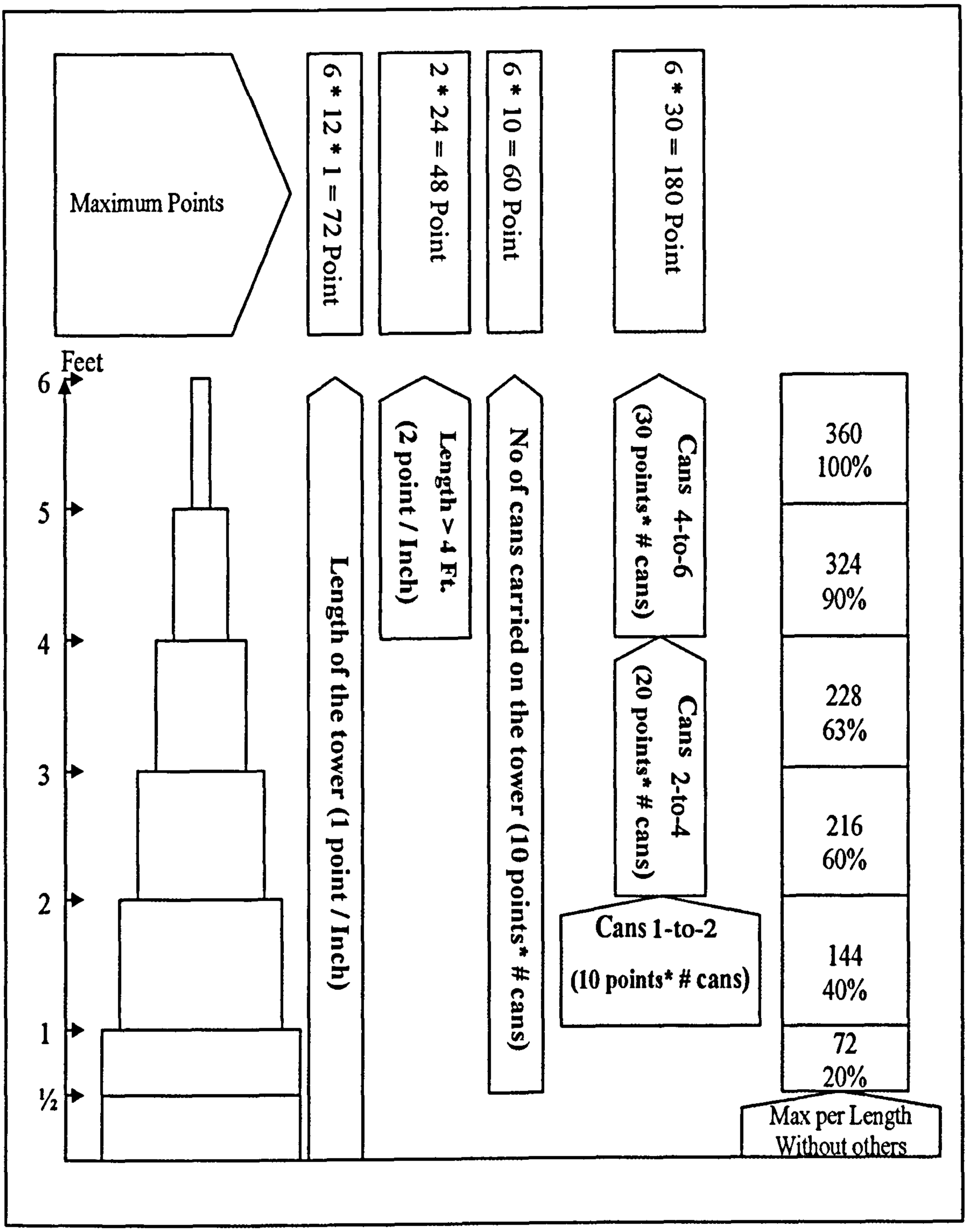


Figure 7.2 Illustration of analysis chart for the Tower Project

7.3 THE ORGANIZATION AND CONDUCT OF THE SESSIONS

The organisation of the training sessions and the administration of the problem-solving exercise were influenced by the trainees' KEMYA responsibilities and assignments. However, the company was supportive and, through negotiations, 358 trainees were able to take part in the training and in the collaborative team exercise. All members on the training course had taken the HBDI questionnaire, and all trainees for the problem-solving had experienced the session on HBDI awareness and creativity that were described in Chapter Six. In discussions with the company it was made clear, and agreed, that the training and hence the problem-solving should involve staff from all departments and at all managerial levels from superintendents and above. Consequently, all the training sessions, typically comprising 20-30 participants, included a variety of nationalities, cultures, management levels, and departments. The design of the training course, and its range of activities, enabled the training to be designed and delivered in ways that suited each audience while maintaining the same objectives, the sequencing of sessions and the instructional content. It was through the workplace related activities, and the type of interactions which resulted, that allowed the course sessions to be tailored to the trainee audiences.

This diversity was beneficial to the problem-solving team selection since trainees could be placed in teams, typically of four or five members, in which participants were not with their near working colleagues, though in the training sessions it is likely they would have had some interactions and established some relationships. The researcher, within these restrictions, selected some teams which had an HBDI (homogeneous) bias in their thinking preferences, some which were heterogeneous with strengths in 3 or 4 quadrants, and others which were randomized selections. In brief, there was variety among the teams in their composition of KEMYA departments and managerial levels and in the patterns of their HBDI profiles.

[NOTE: In this chapter individuals' names have been used, and this introduces a more personal touch to the narrative and discussion. However, to preserve confidentiality, the thesis has been placed on restricted circulation, and resulting publications will take care to make performance data and associated comments anonymous so that individuals cannot be identified.]

Thus in the training sessions 358 trainees took part in the collaborative problem-solving exercise. Within each training session 4 or 5 participants were allocated to a group forming 81 problem-

solving groups in total. Table 7.1 gives examples of the group allocations. Before conducting the experiment, trainees were put into teams which had a variety of thinking profiles.

Team No	Individual's Name	Code	Profile Score				Adj. Pairs				Dominance Percentage			
			A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
	Abdulhamid M. Al-Suqair	1112	68	111	84	35	7	5	11	1	60%	40%	35%	65%
	Ridwan Bin N. Amin	1221	89	54	51	75	6	2	9	7	53%	47%	61%	39%
	Neville P. Lewis	1132	107	117	29	57	8	8	3	5	72%	28%	53%	47%
	Dilawar A. Parkar	2112	54	101	101	59	3	8	9	4	49%	51%	36%	64%
1	Average	1122	80	96	66	57	6	6	8	4	59%	42%	46%	54%
	Jonathan G. Cole	1132	134	90	18	56	9	9	0	6	75%	25%	64%	36%
	Zuzar S. Dhuliawala	1122	111	87	41	45	7	10	4	3	70%	30%	55%	45%
	Arif Prakosa	1122	122	72	60	41	9	2	9	4	66%	34%	55%	45%
	Aliyar M. Raghuman	1122	102	92	42	60	5	7	6	6	66%	34%	55%	45%
2	Average	1122	117	85	40	51	8	7	5	5	69%	31%	57%	43%
	Nasser A. Al-Qahtani	1121	74	78	66	72	6	7	4	7	52%	48%	50%	50%
	Yunus A. Daud	1222	77	63	51	60	7	9	6	2	56%	44%	55%	45%
	Mohamed K. Fakroodhin	1112	86	78	72	66	6	6	7	5	54%	46%	50%	50%
	Rangaraj M. Reddy	1112	99	81	75	62	6	6	9	3	57%	43%	51%	49%
3	Average	1122	84	75	66	65	6	7	7	4	55%	45%	52%	49%

Table 7.1 Illustrative example showing the grouping of teams

The data in Table 7.1 is used to illustrate the grouping process experiment. It shows twelve employees in three teams. The first team represents a heterogeneous team (see the profile for Team 1 in Figure 7.3) with strengths in the A, B and C HBDI quadrants. The second team shows a strong "A" thinking and its members are homogeneous in this respect. The third team tends to have combinations of more "A" and other quadrants, but none is of high preference, *i.e.* it is homogeneous in the similarity of the profiles of its members, but these preferences are of relatively low strength.

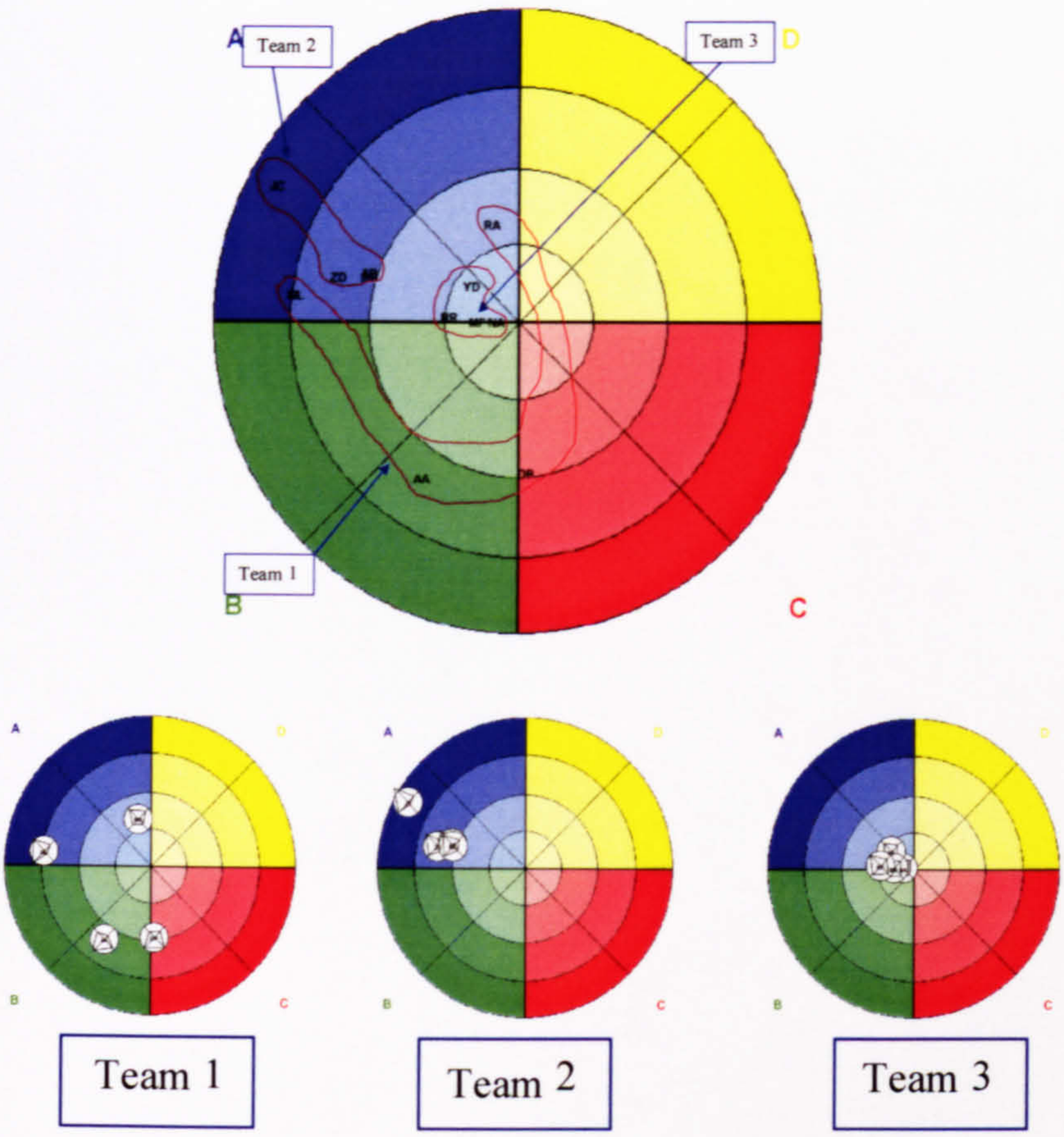


Figure 7.3 Grouping process using Circular Continuum

Where possible, teams were selected in these ways to show some differences in their profiles—which may have effects on team performances and the interactions between its members. Also each team selected its own leader.

The design phase and the construction phase: a brief comment

In the design phase participants were encouraged to discuss the problem and think about a proposal for the tower construction. A flipchart and markers were given to each team and twenty minutes were allocated to this phase of the activity. It was noticed that some of the groups tended to read the instructions, and then quickly talked about building the tower. Other teams discussed the criteria and their importance at greater length before moving towards an outline plan. In

general the groups responded well, were participative in their discussions and the challenge of the task, and the perceived competition with other groups seemed to sharpen their enthusiasm.

Details of the tower building phase and the performances of the teams are discussed in the later sections of this chapter. Overall the teams worked enthusiastically, but there was diversity, not only in the types of tower that were made, but in the ways teams worked. Some teams allocated parts of the work to individuals, but others worked more collectively, and those differences merit a closer examination. The role of the experimenter was to observe, occasionally adjudicate on the stability of a tower, and to remind groups of the passage of time.

[Before the performance data are discussed, it is worth noting that with respect to the maximum height of the tower some teams had the idea to lengthen the tower by a long thin column similar to the antennae on the top of the tower. This does not invalidate the rules and it also saves the paper resource. Materials were limited and some teams found they were short of adhesive tape, or paper, or time, and this caused a number of difficulties.]

7.4 THE PERFORMANCE DATA OF THE TEAMS

The problem-solving involved 81 teams and extended over 19 training programs. The numbers attending the training programs varied and for each program the number of problem-solving teams varied from three to eight. A summary of the performance data and the thinking preferences for each team are shown in Table 7.2 (Parts 1 and 2).

Team number	No of members	Saved minutes	Tower Length	inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	unused Cans	Score	A	B	C	D	A Adj	B Adj	C Adj	D Adj	Lt	Rt	Cr	Lm
1	6	0	24	0	6	5	1	0	70	0	224	88	80	55	75	7	6	6	6	0.56	0.44	0.55	0.45
2	5	0	33	0	6	0	6	0	11	0	224	67	96	59	63	7	7	5	5	0.57	0.43	0.45	0.55
3	5	0	50	2	6	2	4	0	1	0	215	100	76	58	56	7	6	7	4	0.61	0.39	0.54	0.46
4	4	3	22	0	6	6	0	0	72	0	217	66	84	74	77	5	8	7	4	0.5	0.5	0.48	0.52
5	4	3	28	0	5	0	0	0	40	1	118	92	86	47	67	7	6	5	6	0.61	0.39	0.55	0.45
6	5	6	25	0	6	0	6	0	50	0	261	72	75	68	74	6	4	9	5	0.51	0.49	0.51	0.49
7	5	4	28	0	6	4	2	0	47	0	219	97	76	57	59	8	5	7	4	0.6	0.4	0.54	0.46
8	5	7	69	21	3	0	3	0	22	3	221	95	73	57	72	7	5	6	5	0.57	0.43	0.56	0.44
9	5	15	72	24	6	0	0	6	78	0	453	108	69	47	69	9	5	5	5	0.6	0.4	0.61	0.39
10	4	0	72	24	4	0	0	4	40	2	314	104	91	43	58	9	8	4	3	0.66	0.34	0.55	0.45
11	4	16	28	0	6	3	3	0	71	0	265	85	79	58	74	8	6	4	6	0.55	0.45	0.54	0.46
12	5	0	50	2	2	0	2	0	32	4	134	72	93	81	50	6	6	8	3	0.56	0.44	0.41	0.59
13	5	0	70	22	6	0	6	0	37	0	331	74	84	63	74	7	4	7	5	0.54	0.46	0.5	0.5
14	4	10	32	0	6	2	2	0	45	0	207	84	68	69	63	7	6	7	4	0.54	0.46	0.51	0.49
15	4	8	11	0	6	0	0	0	82	0	161	88	85	51	62	8	8	4	5	0.61	0.39	0.52	0.48
16	4	14	14	0	6	6	0	0	86	0	234	87	69	68	74	8	5	7	5	0.52	0.48	0.54	0.46
17	4	2	59	11	6	3	2	1	7	0	250	97	70	49	77	9	6	2	8	0.57	0.43	0.59	0.41
18	4	1	31	0	0	0	0	0	68	6	82	81	92	63	55	8	6	7	3	0.59	0.41	0.47	0.53
19	4	3	35	0	6	4	2	0	42	0	220	72	83	75	72	7	5	8	5	0.51	0.49	0.48	0.52
20	4	5	56	8	6	1	2	3	6	0	283	73	92	71	65	6	5	7	6	0.55	0.45	0.46	0.54
21	4	12	50	2	6	4	2	0	10	0	216	79	80	69	67	7	7	6	5	0.54	0.46	0.5	0.5
22	4	0	24	0	1	1	0	0	64	5	93	85	79	64	66	7	6	6	5	0.56	0.44	0.51	0.49
23	5	0	36	0	4	0	4	0	13	2	163	97	77	50	78	8	6	5	5	0.58	0.42	0.58	0.42
24	5	1	72	24	2	0	0	2	1	4	190	59	98	77	56	6	6	8	4	0.54	0.46	0.4	0.6
25	4	0	38	0	2	1	0	0	61	4	117	77	81	67	63	7	7	5	5	0.55	0.45	0.49	0.51
26	4	20	16	0	6	6	0	0	0	0	156	80	89	69	63	6	6	6	5	0.56	0.44	0.47	0.53
27	4	2	18	0	2	2	0	0	73.5	4	121.5	88	72	51	70	7	8	4	5	0.57	0.43	0.56	0.44
28	5	0	23	0	6	4	2	0	18	0	181	90	80	61	58	7	6	7	5	0.59	0.41	0.51	0.49
29	4	0	32	0	6	0	6	0	39	0	251	82	83	67	69	7	7	6	5	0.55	0.45	0.5	0.5
30	5	19	18	0	4	4	0	0	58	2	169	93	72	54	68	8	5	6	5	0.57	0.43	0.56	0.44
31	5	0	34	0	4	0	4	0	31	2	179	75	94	59	62	7	7	5	4	0.58	0.42	0.47	0.53
32	4	0	32	0	6	5	1	0	70	0	232	68	74	79	84	5	5	7	6	0.47	0.53	0.5	0.5
33	4	0	63	15	1	0	1	0	18	5	126	83	69	57	85	6	5	6	7	0.52	0.48	0.57	0.43
34	4	0	62	14	6	3	0	0	6	0	186	108	76	51	57	10	6	4	4	0.63	0.37	0.56	0.44
35	4	0	20	0	6	6	0	0	42	0	182	77	87	66	67	7	5	7	6	0.55	0.45	0.48	0.52
36	4	17	11	0	6	0	0	0	67	0	155	76	87	76	68	8	7	6	3	0.53	0.47	0.47	0.53
37	4	12	21	0	6	5	0	0	71	0	214	89	86	58	64	8	7	5	4	0.59	0.41	0.52	0.48
38	4	0	23	0	2	2	0	0	0	4	51	87	92	56	66	6	6	8	4	0.6	0.4	0.51	0.49
39	4	0	18	0	5	5	0	0	50	1	165	79	74	77	76	5	5	8	7	0.5	0.5	0.51	0.49
40	5	0	61	13	3	0	0	3	7	3	205	98	78	54	70	7	5	7	5	0.59	0.41	0.56	0.44
41	5	0	52	4	3	0	0	3	16	3	187	84	81	60	75	5	5	7	6	0.55	0.45	0.53	0.47
42	4	4	30	0	6	0	6	0	30	0	244	89	72	49	80	7	5	7	6	0.56	0.44	0.58	0.42

Table 7.2 (Part 1) Table of Tower Building Experimental Scores with the averages of thinking preferences for the members of Teams 1-42

Team number	No of members	Saved minutes	Tower Length	inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	unused Cans	Score	A	B	C	D	A Adj	B Adj	C Adj	D Adj	Lt	Rt	Cr	Lm
43	5	0	12	0	6	6	0	0	53	0	185	98	90	60	53	8	7	7	2	0.63	0.37	0.5	0.5
44	5	0	12	0	6	6	0	0	50	0	182	86	81	58	66	7	6	8	3	0.57	0.43	0.52	0.48
45	5	0	24	0	2	0	2	0	50	4	122	79	86	78	58	6	6	8	4	0.55	0.45	0.46	0.54
46	4	0	39	0	2	0	2	0	45	4	132	82	64	72	79	7	5	8	5	0.49	0.51	0.54	0.46
47	4	7	33	0	5	0	5	0	4	1	191	109	65	41	66	9	5	4	6	0.62	0.38	0.62	0.38
48	5	5	27	0	6	6	0	0	19	0	171	83	98	65	54	8	7	6	3	0.6	0.4	0.46	0.54
49	5	4	21	0	6	6	0	0	18	0	163	82	80	56	92	7	4	5	7	0.52	0.48	0.56	0.44
50	5	6	18	0	6	6	0	0	30	0	174	84	80	72	65	7	5	8	4	0.55	0.45	0.5	0.5
51	4	0	25	0	6	2	4	0	50	0	235	99	90	45	53	7	6	6	5	0.66	0.34	0.53	0.47
52	4	1	56	8	6	0	4	0	26	0	239	72	84	75	71	6	5	8	6	0.51	0.49	0.47	0.53
53	4	7	12	0	6	6	0	0	52	0	191	103	78	51	57	8	7	5	5	0.63	0.37	0.55	0.45
54	4	0	42	0	1	0	1	0	57	5	114	91	104	62	53	6	8	7	4	0.63	0.37	0.47	0.53
55	5	0	70	22	6	0	6	0	29	0	323	68	78	74	80	6	4	7	6	0.49	0.51	0.49	0.51
56	4	8	15	0	6	2	0	0	41	0	144	75	82	78	61	6	5	9	4	0.53	0.47	0.46	0.54
57	5	0	43	0	4	0	4	0	58	2	215	64	91	75	63	6	6	6	5	0.53	0.47	0.43	0.57
58	4	1	26	0	6	5	1	0	51	0	208	74	74	74	70	6	5	8	5	0.51	0.49	0.49	0.51
59	4	5	55	7	5	0	0	5	45	1	316	71	95	63	62	5	9	5	6	0.57	0.43	0.46	0.54
60	4	3	28	0	6	2	1	0	59	0	190	87	70	71	75	8	5	6	7	0.52	0.48	0.53	0.47
61	4	0	56	8	1	0	1	0	79	5	166	87	78	64	74	8	5	6	5	0.54	0.46	0.53	0.47
62	5	0	32	0	0	0	0	0	65	6	79	92	88	53	54	8	6	5	4	0.63	0.37	0.51	0.49
63	5	0	24	0	3	3	0	0	24	3	99	68	99	64	67	6	7	6	5	0.56	0.44	0.45	0.55
64	5	0	39	0	2	2	0	0	34	4	101	61	84	91	63	5	5	10	4	0.48	0.52	0.41	0.59
65	5	0	63	15	2	0	0	2	42	4	203	79	73	63	67	6	6	6	6	0.54	0.46	0.52	0.48
66	5	0	43	0	3	1	0	0	68	3	142	81	84	67	62	7	5	7	6	0.56	0.44	0.49	0.51
67	4	0	62	14	6	0	6	0	7	0	277	57	73	82	77	5	5	8	7	0.45	0.55	0.46	0.54
68	5	10	10	0	6	0	0	0	44	0	124	53	104	83	46	6	8	6	3	0.55	0.45	0.35	0.65
69	4	1	10	0	6	0	0	0	48	0	119	61	84	87	63	7	6	10	2	0.49	0.51	0.42	0.58
70	5	0	70	22	6	6	0	0	47	0	281	53	76	82	88	5	4	9	6	0.43	0.57	0.47	0.53
71	5	0	18	0	0	0	0	0	30	6	30	72	81	77	69	8	7	6	4	0.51	0.49	0.47	0.53
72	4	8	0	0	1	0	0	0	18	5	21	70	91	72	58	7	7	7	4	0.55	0.45	0.44	0.56
73	4	5	26	0	4	0	4	0	20	2	165	63	71	79	69	7	5	8	5	0.48	0.52	0.47	0.53
74	4	6	39	0	6	0	6	0	20	0	245	80	96	66	57	6	6	8	4	0.59	0.42	0.46	0.54
75	4	5	63	15	6	0	2	4	29	0	347	117	85	40	51	8	7	5	5	0.69	0.31	0.57	0.43
76	4	4	57	9	6	1	5	0	22	0	271	82	104	66	44	7	9	6	3	0.63	0.37	0.43	0.57
77	4	0	21	0	2	2	0	0	60	4	109	73	97	66	64	6	8	6	4	0.57	0.43	0.46	0.54
78	4	15	10	0	6	0	0	0	52	0	137	99	76	56	77	8	7	4	6	0.57	0.43	0.57	0.43
79	4	5	15	0	6	6	0	0	53	0	193	84	75	66	65	6	7	7	4	0.55	0.45	0.52	0.49
80	4	0	42	0	6	2	4	0	41	0	243	95	86	52	63	9	7	4	4	0.61	0.39	0.53	0.47
81	5	10	30	0	6	6	0	0	10	0	170	68	83	75	64	5	6	7	6	0.52	0.48	0.45	0.55
Mean	4	35	4	5	2	2	0	39.5	1	190.5	82	82	64	66	7	6	6	5	0.56	0.44	0.5	0.5
SD	5	19	7	2	2	2	1	22.9	2	73.2	13	9.4	11	9	1	1	1	1	0.05	0.05	0.05	0.05
Median	1	31	0	6	1	0	0	42	0	187	82	81	64	66	7	6	6	5	0.56	0.44	0.5	0.5

Table 7.2 (Part 2) Table of Tower Building experimental scores with the averages of thinking preferences for the members of Teams 43-81

The columns of data show the number of members in the team, and their team performance score under the various criteria of the scoring system, *e.g.* tower length, and number of cans supported, and concludes with the total score achieved. The remaining columns show the average scores for the team on the HBDI measures (A, B, C, D preferences); the adjective pairs ratings and the Left/Right, Cerebral/Limbic average scores on these quadrants.

Under the criteria, each saved minute would add a score of one point to the team. Figure 7.4 shows that 44 teams (54% of the teams) used all the offered time of 40 minutes for building, but 27 teams (33%) saved from 1 to 10 minutes. Indeed, 10 teams saved from 12 to 20 minutes. Table 7.3 shows large differences in the towers produced and their use of resources. For instance, Team Number 26 saved 20 minutes, but achieved a tower length of only 16 inches and a final score of 156 points. In contrast, Team Nine saved 15 minutes yet achieved a Tower Length of 72 inches (and loaded 6 cans) giving them a score of 453 points. Figure 7.5 and Table 7.3 set out data showing Tower Length against saved minutes for the problem-solving teams whose scores were low.

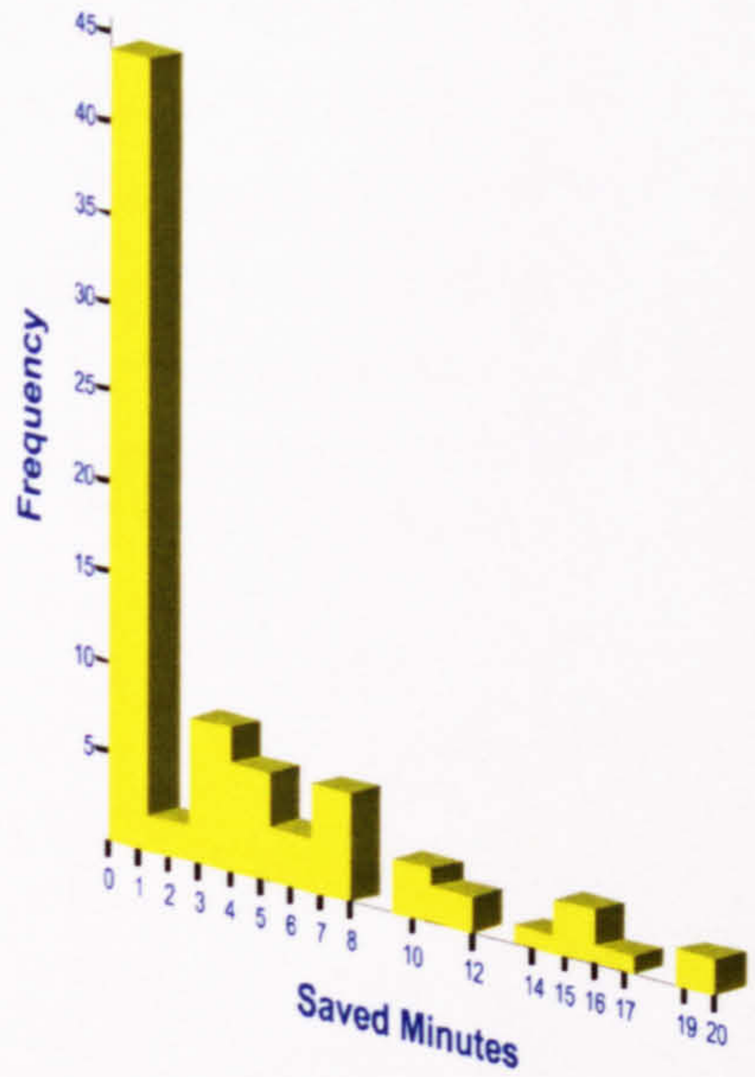


Figure 7.4 Histogram of Saved Minutes Frequencies

Team number	No. of members	Saved minutes	Tower Length	Final Score
26	4	20	16	156
30	5	19	18	169
36	4	17	11	155
78	4	15	10	137
81	5	10	30	170
68	5	10	10	124
56	4	8	15	144
15	4	8	11	161
72	4	8	0	21

Table 7.3 Table of teams which saved time while their tower length and score were low

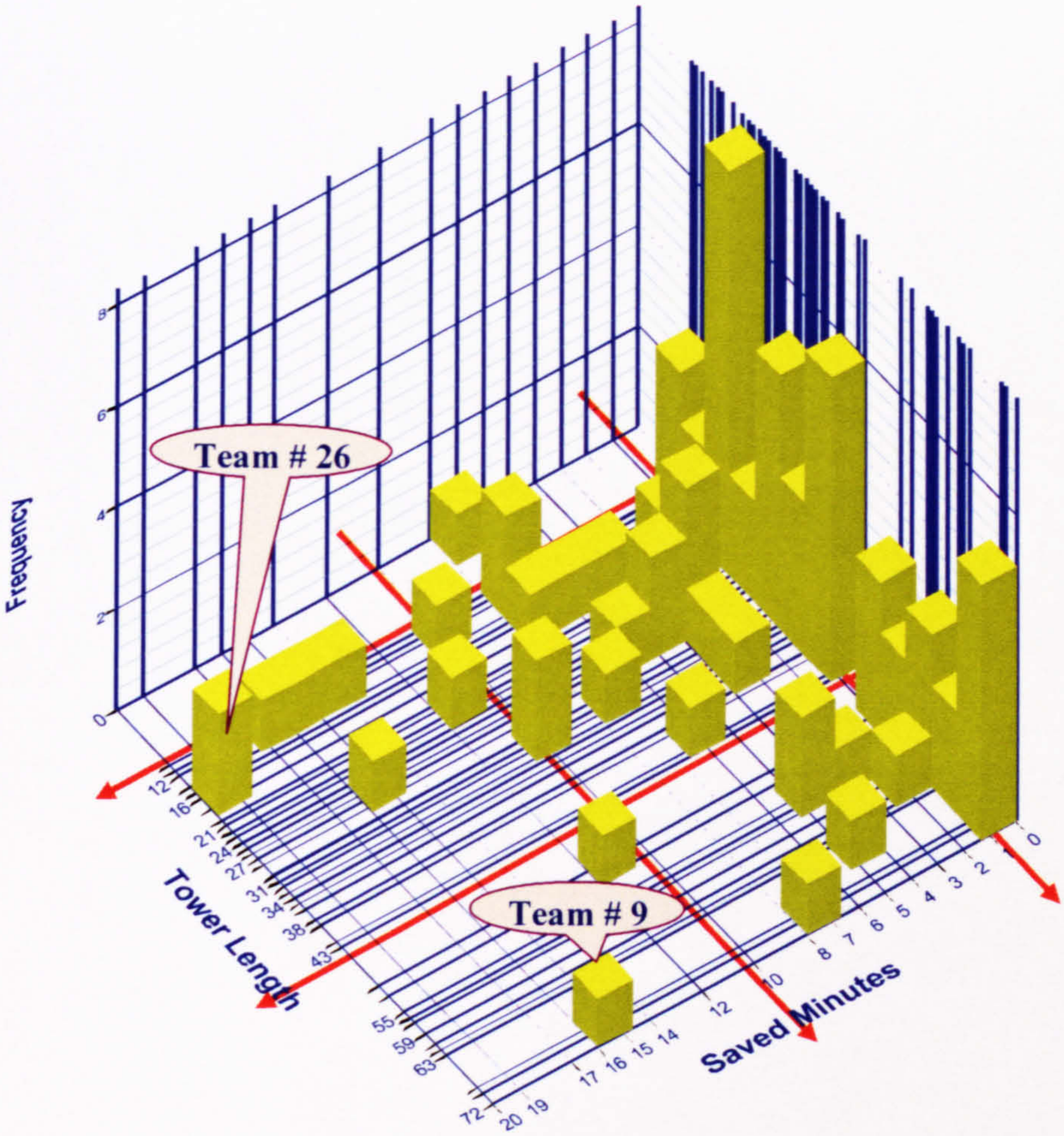


Figure 7.5 Histogram of the Tower Length against saved minutes

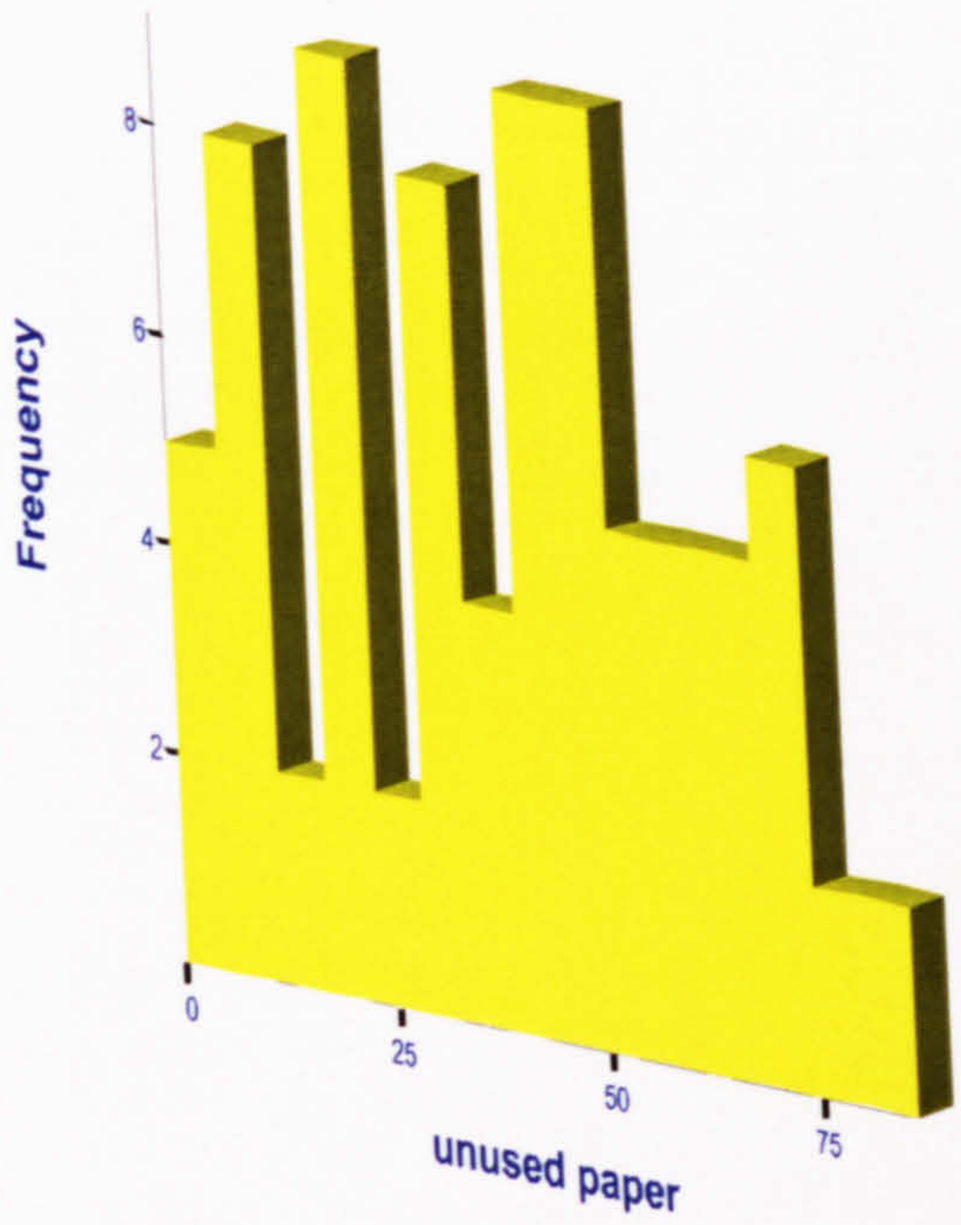


Figure 7.6 Histogram of unused paper

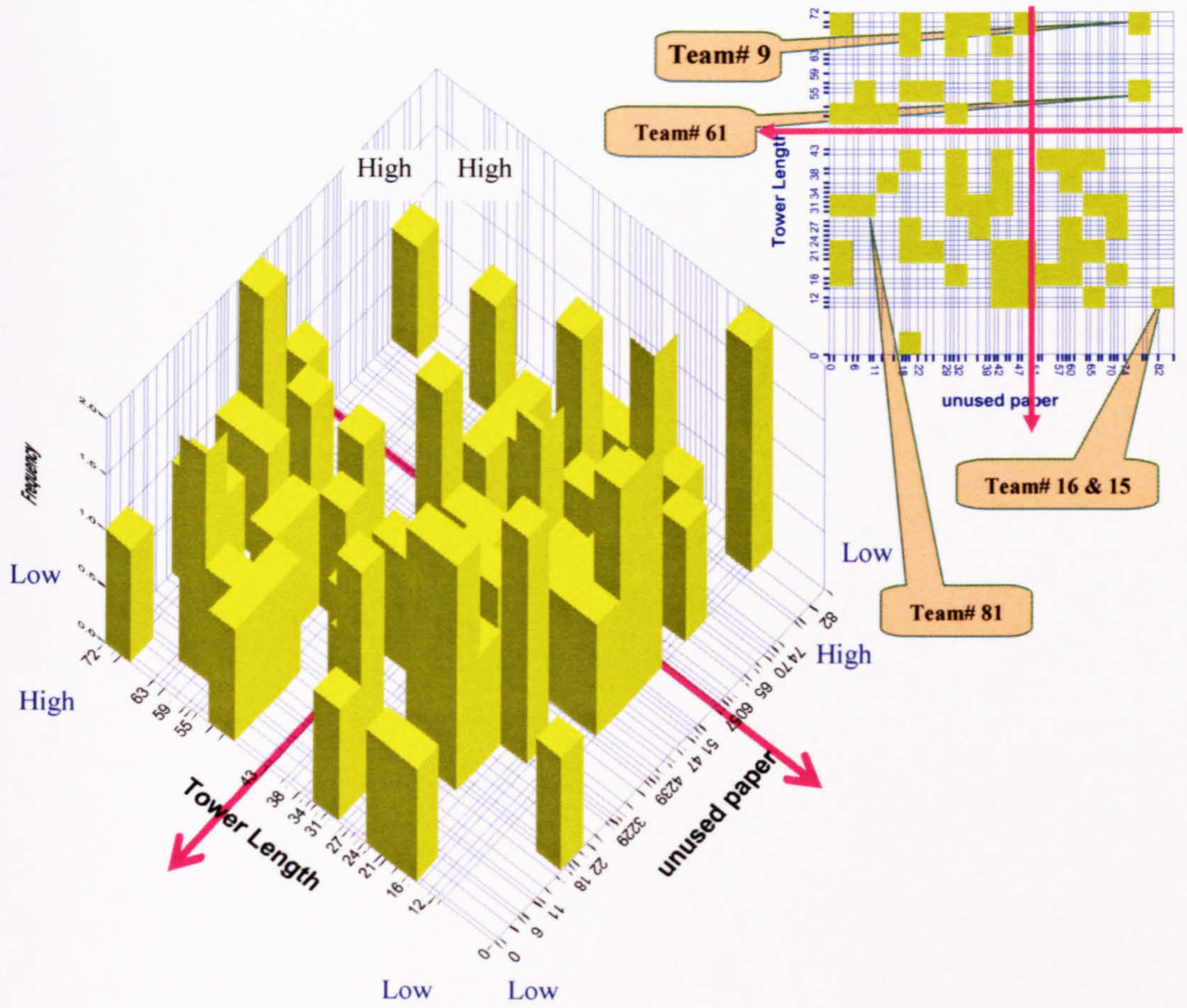


Figure 7.7 Histogram of saved paper against Tower Length

One relatively minor criterion for assessing problem-solving performance was the economic use of resources (*i.e.* the paper used for making tower pillars). Each piece of saved paper would add a score of one point to the team. A histogram of the saved paper is shown in Figure 7.6 where the mean of unused paper sheets for all the teams is 40, the standard deviation is 22.9 and the median is 42 sheets. Figure 7.7 shows the histogram of Tower Length against unused (*i.e.* saved) paper. Although there is a slight tendency for those saving paper to have lower tower height, this effect is slight. However there are marked variations. Two teams, *e.g.* 61 and 9, achieved a high tower length but saved much paper. On the other hand, Team 81 didn't save much paper and they

didn't build a high tower, and Teams 15 and 16 saved much paper but at the expense of a low tower.

As shown in Table 7.4, 48 out of 81 teams were able to load all the 6 cans successfully on the tower. However, only 3 of the 48 teams were able to load the cans on a level higher than four feet, 15 were between three and four feet, 283 between three and one foot, and 7 were only able to load their cans in a level less than or equal to one foot. Three teams were not able to build a tower to support any cans.

Cans	No of Teams	Total Cans	5, 6 ft	3, 4 ft	2 ft	1 ft
6	48	288	3	15	23	7
5	4	20	1	1	1	1
4	6	24	1	4	1	0
3	5	15	2	1	1	1
2	10	20	2	4	4	0
1	5	5	0	2	1	2
0	3	0	0	0	0	0

Table 7.4 A summary table of the can scores and can heights for all teams

Figure 7.8 gives a diagrammatic representation of these data, *i.e.* the distribution of Tower Height against Number of Cans Loaded. The figure shows something of the diversity in the tower building performances of teams, particularly in those teams supporting six cans (with a wide range in Tower Heights), and other teams focusing on Tower Height but only able to support a small number of cans.

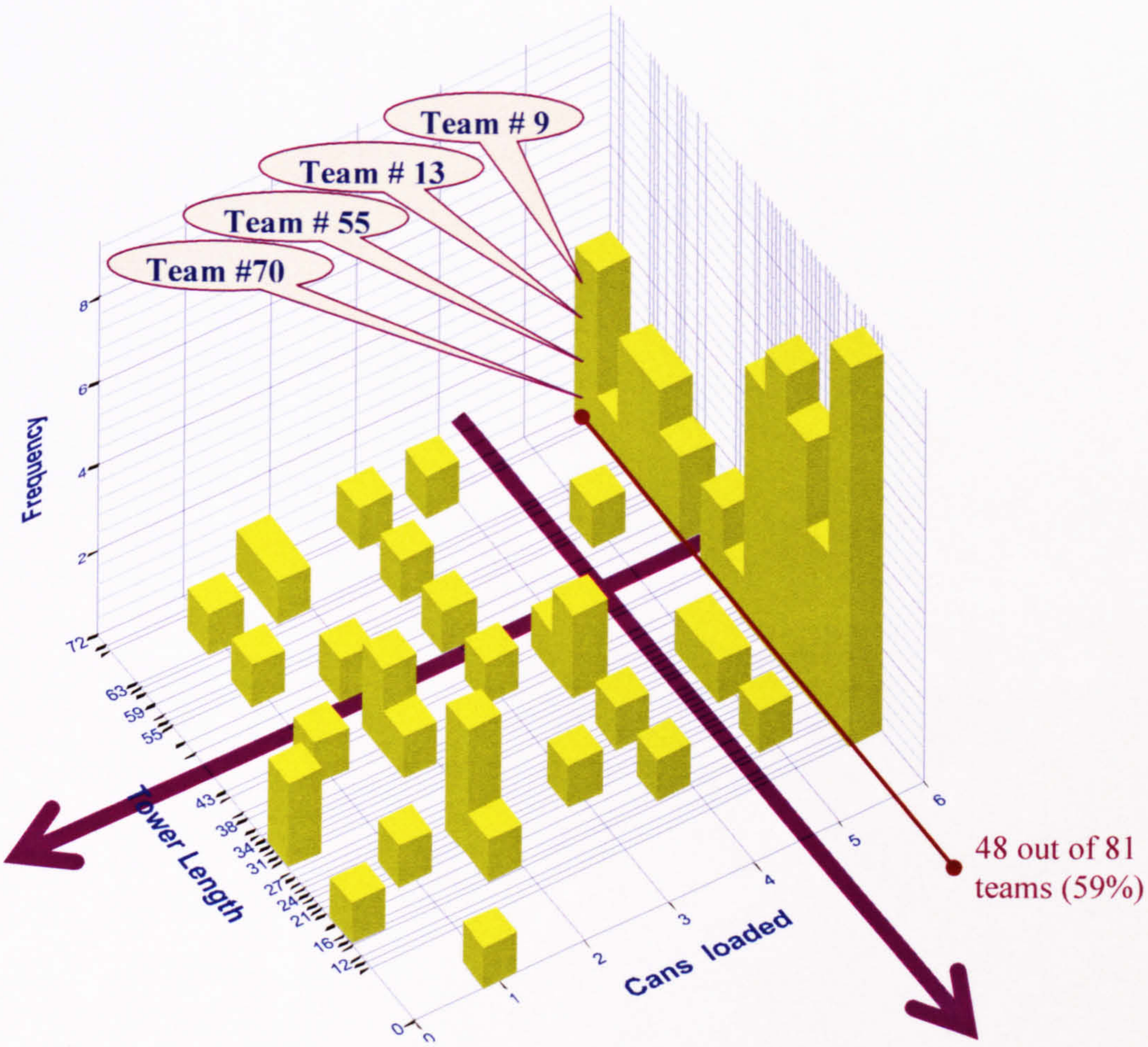


Figure 7.8 Histogram of the Tower Height against Cans Loaded

	Height *v* Final Score	Cans loaded *v* Final Score	Unused paper *v* Final Score	Time saved *v* Final Score	Quadrant "A" *v* Final Score	Quadrant "B" *v* Final Score	Quadrant "C" *v* Final Score	Quadrant "D" *v* Final Score
ALL 81 TEAMS	0.57	0.62	0.0	0.13	0.17	-0.17	-0.21	0.15

Table 7.5 Performance Correlations

Pearson Product Moment Correlations were calculated for the 81 teams between the final problem-solving score and the criteria of Tower Height, Cans Loaded, Unused Paper, and Time Saved. The results are also shown in Table 7.5. The highest correlations (statistically significant $p<0.001$) were between the Final Score and both Tower Height and Cans Loaded, *i.e.* these were the major differentiating factors affecting problem-solving performance. The other variables, Time Saved and Paper Unused were not significant and were less influential, though they indicated that high scoring teams tended to use the time and paper resources allocated. None of the correlations between the Final Scores and each team average Quadrant Score achieved significance, though the A (analytic) and D (creative) preferences gave positive values.

A *t*-test between the 41 highest scoring teams and the 40 lowest scoring teams (see Table 7.6) showed there were significant differences for both the Cans Loaded and the Tower Length. A correlation (for all teams) between Number of Cans Loaded above 3-feet and Tower height showed a positive correlation of $r=0.56$ $p<0.001$. Not surprisingly, the best teams were building higher towers and supporting cans at a greater height. However, the differences in

the mean scores between the top 41 and lowest 40 groups on the criteria of Time Saved and Unused Paper were not significant (see Table 7.6).

	Tower Length	Cans Loaded	Saved Minutes	Unused Paper
The 41 highest scoring teams	43.9	5.4	3.9	38.1
The 40 lowest scoring teams	26.3	3.7	3.6	41.0
p value	0.001	0.0001	0.79	0.59

Table 7.6 *t*-test comparison between high and lower scoring teams

These data also indicate that the problem task with its varied point gathering criteria was sufficiently challenging to draw a variety of performances from the teams.

Having commented on some of the general characteristics of the teams' problem-solving performances, certain teams were selected to examine features of interest. These will be discussed in more detail and related to the HBDI characteristics of the teams and reports on their working methods. However the data of the team performances in relation to their HBDI profiles is extensive, therefore comparative selections were made from the highest, lowest, and medium scoring teams. These data are discussed and comparisons are made in the Sections below, followed by a discussion of team interactions and perceptions as revealed in student questionnaires.

7.5 DISCUSSION OF TEAM PERFORMANCES

The 81 teams generated much data and the practicalities of the research analysis meant that selections had to be made. It was decided to consider in detail the five highest performing groups then, in contrast, six low performing groups, and to cover the remaining performance range through a random selection of six teams. The range of seventeen teams should enable interesting comparisons to be made, not only on performances and types of towers that were built, but on their methods and leadership, and on the perceived contributions made by the trainees. The last objective will be illuminated through self-report questionnaires given to trainees at the conclusion of the exercise. The composition of these questionnaires is described in Section 7.7.

THE HIGH PERFORMING TEAMS

High scoring teams are clearly of interest, not only in the types of towers built but in their working methods and other factors which might have influenced these performances. The data for the five highest scoring teams are shown below.

7.5.1 The Highest Scoring Team [Team 9: Score 453]

This team is composed of five members and Table 7.7 gives a summary of the team's tower building performance. The leader is Mr. Awadh F Al-Woridah (see Table 7.8) with the HBDI code of 1222; he is very strong in "A" (104), high/ moderate in "B" (59), "C" (63), and "D" (66). However, as it can be seen in the adjective pairs, he had a high preference in "C" (8) hence he may tend to be more emotional in his thinking preferences under pressure. The rest of the team is fairly strong in "A", with weaker preference scores in "B", "C" and "D". Overall the average thinking preferences for the team are very strong in "A" (108); low strong in "B" (69), fairly low moderate in "C" (47), and low strong "D" (69). In addition, the adjective pairs had shown high thinking preferences in "A" which confirms that this team is very strong in analytical, mathematical and logical thinking, even when under some pressure.

This team is composed of three Arabs and two Westerners, and the leader held a superintendent level position in the company. He helped the team to focus on a target and reach a consensus rapidly, and a special feature of this team's working was that they calculated the maximum

targeted score at the very beginning of the planning phase. In brief, they decided to achieve the highest length (72 inches) with the minimum paper possible (with only 22 sheets) and set about achieving this target. They also constructed the tower in an efficient way (as shown in Figure 7.9). Their tower was supported by three sloping columns. Each column was composed of 6 folded-sheets, and they linked the three columns by three beams in the middle—extra length for the tower. It was very clear that they were not rushed or under pressure as they built the tower. All went according to plan. They started from the top by sticking three folded-sheets ensuring the platform would support 6 cans, and they proceeded downward to gain tower height with a mid-tower support. Also, it was noticed that some of them spent some time watching and commenting, and there were no disputes or new thoughts during the building stage.

This planning and the working procedures match with their analytical thinking potential—as can be seen in Table 7.8 and Figure 7.10 which show that the team is dominant in "A" Quadrant, but also shows that the team was relatively homogeneous. The circular continuum of the HBDI profiles places each person's profile at the 'centre of gravity' of the HBDI scores, taking account of the strength of *pull* from each quadrant. Within each participant's circle the individual HBDI profile is drawn.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4Ft.	Cans loaded	Cans >1&<3ft	Cans >2&<5ft	Cans >4&<7ft	unused paper	Unused Cans	Score
9	5	15	72	24	6	0	0	6	78	0	453

Table 7.7 Tower data for the highest scoring team

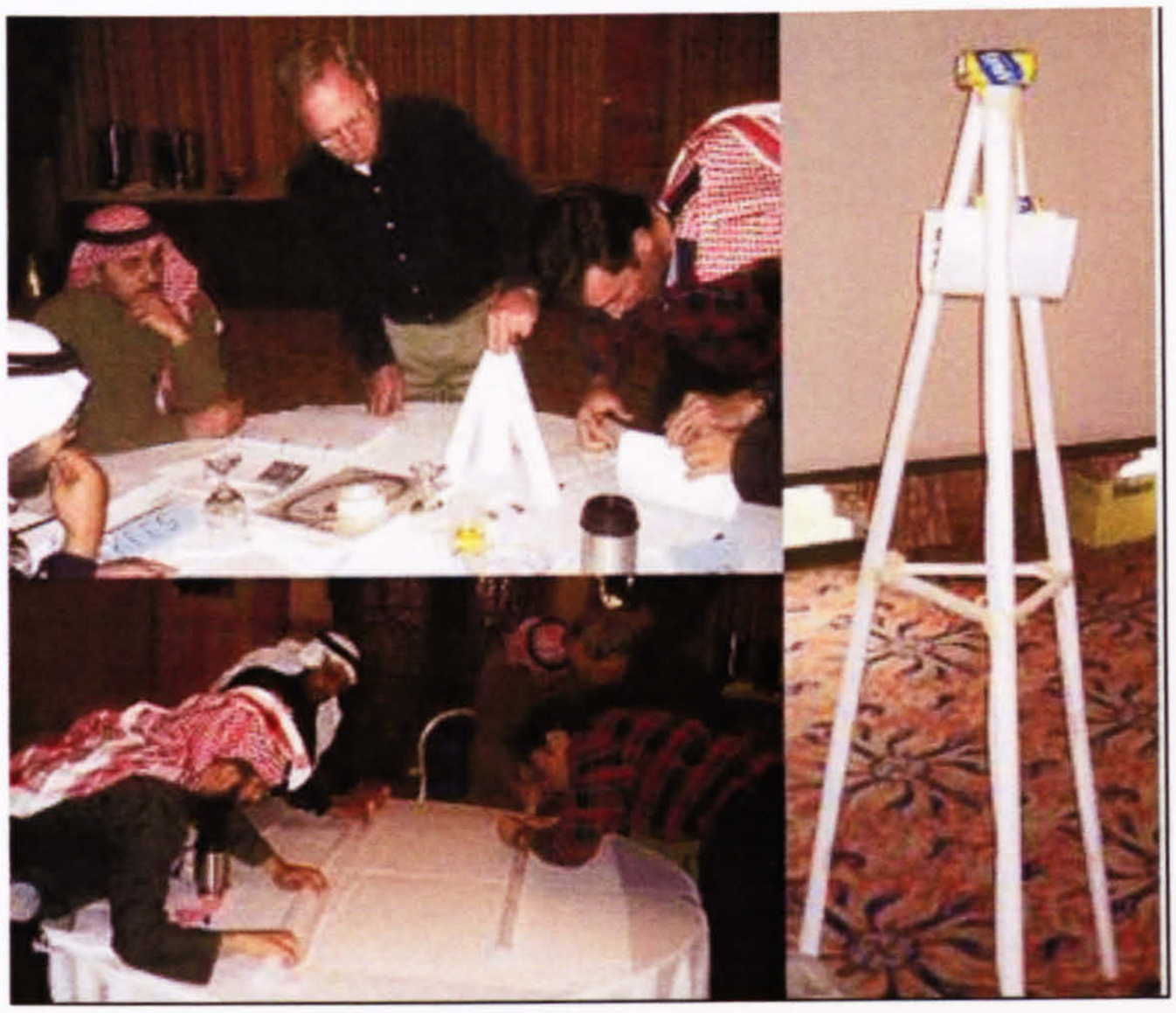


Figure 7.9 Photographs of the Highest Scoring Team

The photograph (Figure 7.9) shows Kees holding the top part of the tower, while Chris and Awadh were designing the sheet which would hold six cans. This is the only team that started building from the top in accordance with their planning.

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Abdulrahman A. Al-ghamdi	1122	116	84	42	53	9	6	3	6	68%	32%	57%	43%
Chris K. Morgan	1231	116	57	26	86	12	3	3	6	61%	39%	71%	29%
Kees Kijkuit	1121	110	74	38	68	11	6	2	5	63%	37%	61%	39%
Awadh F.Al-Waridah	1222	104	59	63	66	7	4	8	5	56%	44%	58%	42%
Ibrahim M.Al-Noshan	1121	95	69	65	72	6	8	7	3	54%	46%	55%	45%
Average	1121	108	69	47	69	9	5	5	5	60%	40%	61%	39%

Table 7.8 HBDI scores for the Highest Scoring Team

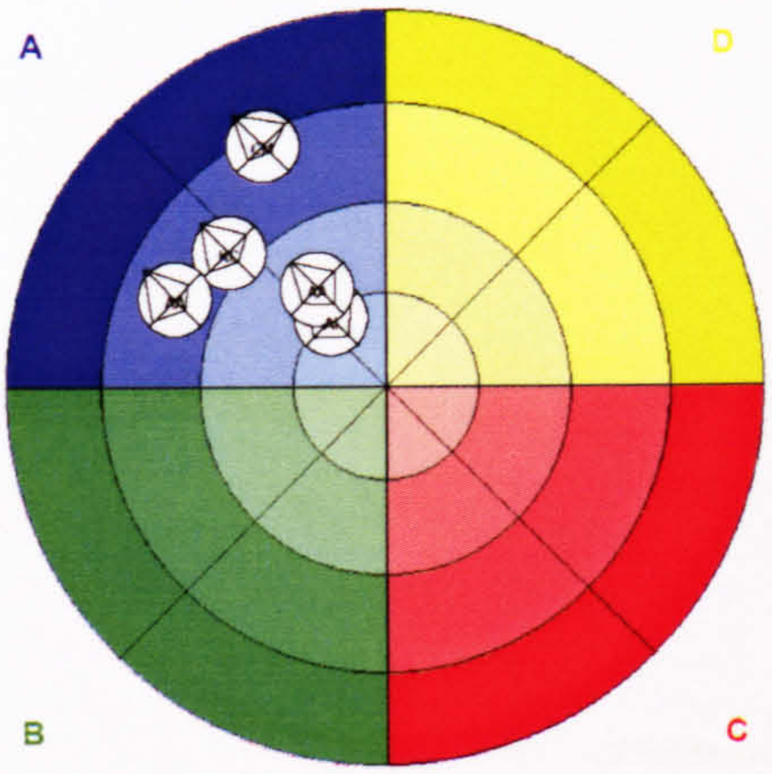


Figure 7.10 Circular continuum for the Highest Scoring Team

7.5.2 The Second Highest Scoring Team [Team 75: Score 347]

This team is composed of four members (see Table 7.10 which shows HBDI scores with their tower performance data shown in Table 7.9). The leader was Mr. Jonathan G Cole who had a strong personality and was practical in his approach. The HBDI code for the leader is 1132, *i.e.* he is extremely strong in "A" (134), high strong in "B" (90), extremely low in "C" (18), and moderate in "D" (56) which implies that although his thinking preferences are analytic, organisational and even somewhat creative, he tends to be less interpersonal in his interactions. Indeed, the average thinking preferences for the team were very strong in "A" (117), strong in "B" (85), fairly low in "C" (40) and moderate "D" (51) implying that this team is homogeneous, very strong in analytical, mathematical and logical thinking (see Figure 7.12). This team contains an American (leader), two Indians and one Philippino, which indicates a diversity of cultures. The leader also held a very high position (General Manager) and this helped the team to focus on a target and reach a consensus rapidly. [The teams, their tower and planning table are shown in the photograph featured in Figure 7.11.]

At the end of the project and after being shown their result, the team members were given an opportunity to comment on their methods. One of the team members noted that they had started with a clear proposed drawing for the project which they then proceeded to implement. This corresponds to their analytic and organisational styles. As shown in the photographs, they used eight columns in constructing the tower which consumed a lot of paper (71 sheets) and they used almost all the time. Although all cans were loaded, only 4 cans were placed between three and seven feet. Also, in comparison between this team and the previous winning team, this team is stronger in "B" thinking preference (average 85) but weaker in the "D" (creative) preference. However, both teams had strong HBDI profiles overall, and both were homogeneous with a strong "A" bias (see Figures 7.10 and 7.12).

[*Note:* In the circular continuum diagram (Figure 7.12) each participant is placed in a position which takes account of "A", "B" "C", and "D" scores, and then shows each person's Quadrant file at that position. So, for the leader very strong on "A" style, there was some *pull* (more than in the previous team) towards the "B" quadrant, but "C" and "D" had minor influence or *pull* on the strong "A" position.]

These differences perhaps influenced the shape and construction of the towers. This team tended to build a stronger (eight columns) tower—though it supported fewer cans at the top height—than the previous winning team which used the minimum possible three columns which led to a greater saving of time and paper resources.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4Ft.	Cans loaded	Cans >1&<3ft	Cans >2&<5ft	Cans >4&<7ft	unused paper	Unused Cans	Score
75	4	5	63	15	6	0	2	4	29	0	347

Table 7.9 Tower data for the Second Highest Scoring Team

Figure 7.11 Photographs of the Second Highest Scoring Team

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Jonathan G. Cole	1132	134	90	18	56	9	9	0	6	75%	25%	64%	36%
Zuzar S. Dhuliawala	1122	111	87	41	45	7	10	4	3	70%	30%	55%	45%
Arif Prakosa	1122	122	72	60	41	9	2	9	4	66%	34%	55%	45%
Aliyar M. Raghuman	1122	102	92	42	60	5	7	6	6	66%	34%	55%	45%
Average	1122	112	84	48	49	7	6	6	4	67%	33%	55%	45%

Table 7.10 HBDI scores for the Second Highest Scoring Team

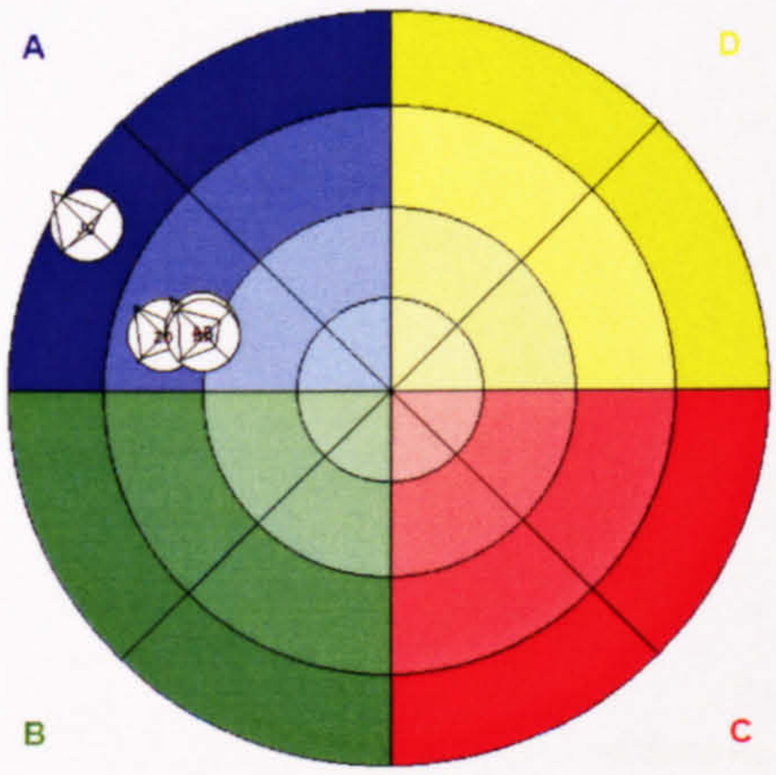


Figure 7.12 Circular Continuum for the Second Highest Scoring Team

7.5.3. The Third Highest Scoring Team [Team 13: Score 331]

This team was composed of five members and their performance data is summarised in Table 7.11. The leader is Mr Arshad Abed (see Table 7.12), well organised with the highest thinking preference in the "B" quadrant (90), then strong in "A" (77), but only high moderate in "C" and "D", although in the adjective pairs data he had a high preference in "C" (8), which suggests he might tend to be more emotional under pressure. The rest of the team were fairly- to very-strong in "B" and strong in "D" (the creative element) with variable strengths in "A" and rather low "C" scores, except for Mr Majed H Al-Subhi. The average thinking preferences for the team were strong in "A" (74), high strong in "B" (84), fairly high moderate in "C" (63) and strong in "D" (74). Although not reaching the highest levels, the team was well balanced in its thinking preferences (see Figure 7.14). In addition, the adjective pairs shows strong thinking preferences in "A" and "C" and lower in "B" and "D" which suggests that this team is strong in analytical and inter-personal preferences under pressure, but might tend to become less organized.

This team did not plan efficiently or in detail in order to load cans at a high level. Hence they built a high tower (70 inches). In fact they changed their plan before the end and decided to put the cans between two and five feet, and then, perhaps a creative thought, used the semi-vertical thin long column as antennae to gain height, as shown in the photograph (Figure 7.13). Also they saved paper (37 sheets) but argued about the column construction and used double-folded sheets resulting in the five thin columns. Altogether this was not a robust tower, though it supported the six cans.

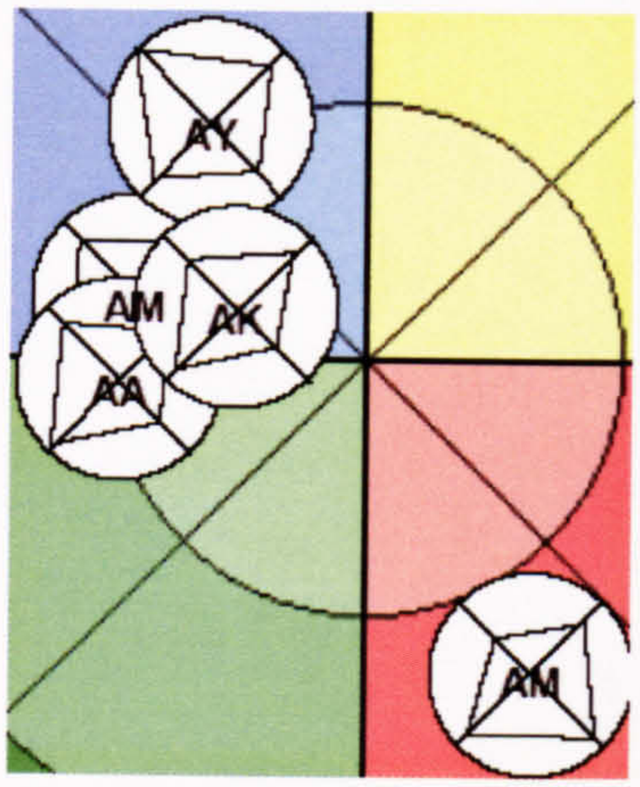
Team number	No. of members	Saved minutes	Tower Length	Inches > 4Ft.	Cans loaded	Cans >1&<3ft	Cans >2&<5ft	Cans >4&<7ft	unused paper	Unused Cans	Score
13	5	0	70	22	6	0	6	0	37	0	331

Table 7.11 Tower data for the Third Highest Scoring Team

Figure 7.13 Photographs of the Third Highest Scoring Team

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Arshad D. Abed	1122	77	90	57	66	7	4	8	5	58%	42%	49%	51%
Khalid S. Al-Sager	1121	69	84	53	77	6	5	7	6	54%	46%	52%	48%
Yaser A. Al-Hawi	1121	101	74	66	81	9	2	7	6	54%	46%	57%	43%
Mohammed H.Al-Huwaimal	1121	77	90	51	75	6	6	7	5	57%	43%	52%	48%
Majed H.Al-Subhi	2111	47	84	90	71	7	5	7	5	45%	55%	40%	60%
Average	1121	74	84	63	74	7	4	7	5	54%	46%	50%	50%

Table 7.12 HBDI scores for the Third Highest Scoring Team



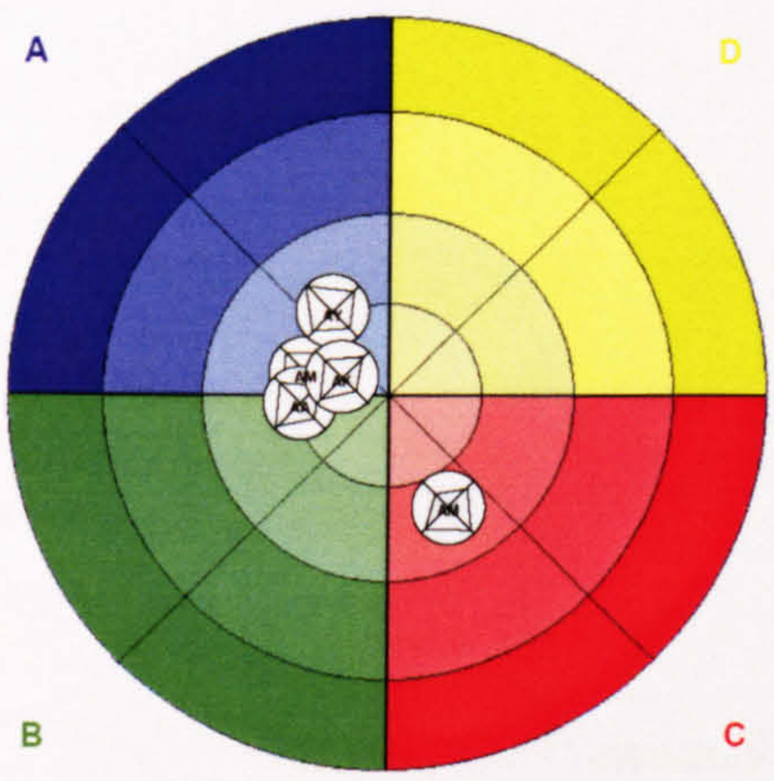


Figure 7.14 Circular Continuum for the Third Highest Scoring Team

The circular continuum (Figure 7.14) shows the differing profile for this team. Majed Al-Subhi is placed in the "C" quadrant with a *pull* towards the "B" quadrant. The fairly even distribution of quadrant scores for the other team members pulls them towards the centre, *i.e.* they show a

good balance, without a pronounced specialisation in their profile scores. Though they had a multi-dimensional team overall, and they did not plan well ahead, the leader had a strong personality and tried to keep on track the decisions which were being made. Thus the team performed creditably, using the antennae idea to gain points for height—a creative idea not anticipated by the researcher in forming the criteria for assessing tower building performance.

7.5.4 The Fourth Highest Scoring Team [Team 55: Score 323]

This team is composed of five members and represents a multi-dominant team (average profile code 1111) in terms of their thinking preferences (Table 7.14, and Figure 7.16). The leader is Mr Yaser Al-Ghamdi who has an active and open personality. His HBDI code is 2121, *i.e.* he is very strong in "D" (102) the creative element; strong in organisational "B" (81) moderate "C" (54); and fairly high moderate "A" (63); and, as it can be seen in the adjective pairs data, he has a very high preference in "D" (11), which confirms his main profile as being imaginative and intuitive thinking under pressure. The rest of the team are fairly strong in "D" with mixed strengths in "B", "C", and "D". The average thinking preferences for the team are low strong in "A" (68), strong in "B" (78), strong in "C" (74) with the highest thinking preferences being a strong "D" (80), *i.e.* creative/imaginative preference. Overall, the team shows a balance in thinking preferences in contrast to the first two teams received who had very high analytic capabilities (See Figure 7.16.).

The team contained two Arabs, one Westerner and two Indians, so the group has a diversity of cultural styles. The leader held a high position as a Manager of the Information Technology Department, and he had a challenging personality which helped the team to reach their target. Similar to the previous team, the tower length produced was 70 inches, as shown in Table 7.13 and, in the last moments of the build, they again came up with the idea of making a vertical thin column as (antennae) as shown in the photograph featured in Figure 7.15 to gain the height marks.

In the design phase they produced a proposal (without the antennae)—see Figure 7.15 which they attempted in the implementation phase. However the team was heterogeneous in its

thinking preferences with individual strengths in the quadrants, as shown in Figure 7.16. Perhaps because of this the discussion and ideas are many and various, but decision making in the implementation was slow which exercised the team leader as they were prone to come up with new ideas which changed their initial and current proposals. As shown in the photograph (Figure 7.15) that they made three levels of folded A4 sheets from the width side. Hence they consumed more than twenty sheets in each level of the tower. They built a strong tower which was not often focused on achieving the highest support level for the six cans which were loaded between 2 and 5 feet with the antennae achieving the height criterion.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4Ft.	Cans loaded	Cans >1&<3ft	Cans >2&<5ft	Cans >4&<7ft	unused paper	Unused Cans	Score
55	5	0	70	22	6	0	6	0	29	0	323

Table 7.13 Tower data for the Fourth Highest Scoring Team

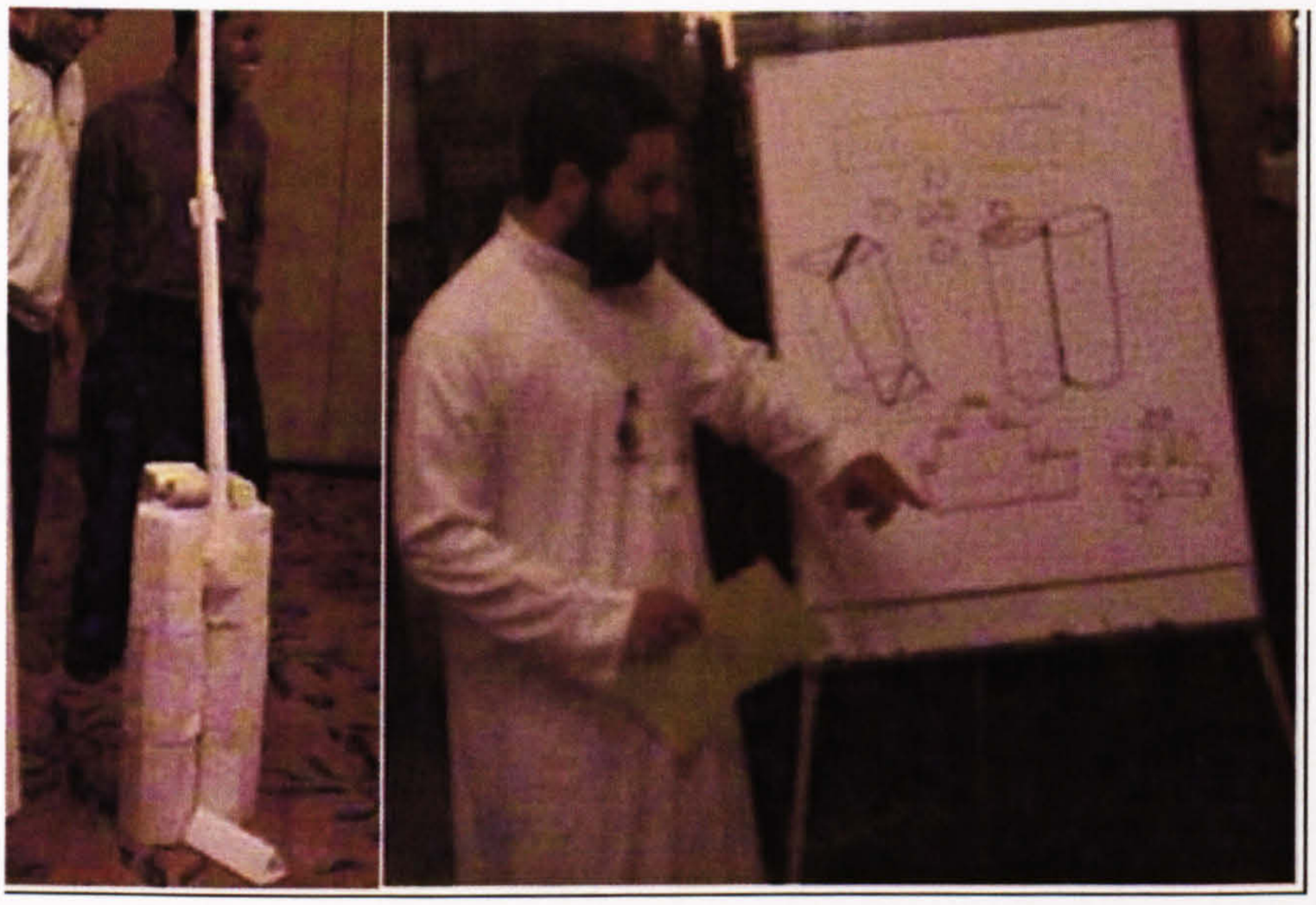


Figure 7.15 Photographs of the Fourth Highest Scoring Team

Individual's Name	Code	Quadrant Scores				Adjective Pairs				Lt	Rt	Cr	Lm
		A	B	C	D	A	B	C	D				
JAMES JOSEPH MCNALLY	1221	81	65	60	84	7	4	7	6	50%	50%	57%	43%
JALALUDEEN AJEEM	1212	80	63	96	57	7	3	10	4	48%	52%	46%	54%
MUQEEMUDDIN SYED	2111	65	81	96	68	5	3	8	8	47%	53%	43%	57%
YASER AL-GHAMDI	2121	63	81	54	102	6	4	3	11	48%	52%	55%	45%
SALIM M AL-AMMARI	2121	51	99	63	89	6	7	8	3	50%	50%	46%	54%
Average	1111	68	78	74	80	6	4	7	6	49%	51%	49%	51%

Table 7.14 HBDI scores for the Fourth Highest Scoring Team

Figure 7.16 indicates the diversity in the thinking preferences of team members—they are a heterogeneous group with strong representations in "B", "C" and "D", though relatively weaker in the "A" (analytic) preference. However the team performed very creditably producing a different type of tower.

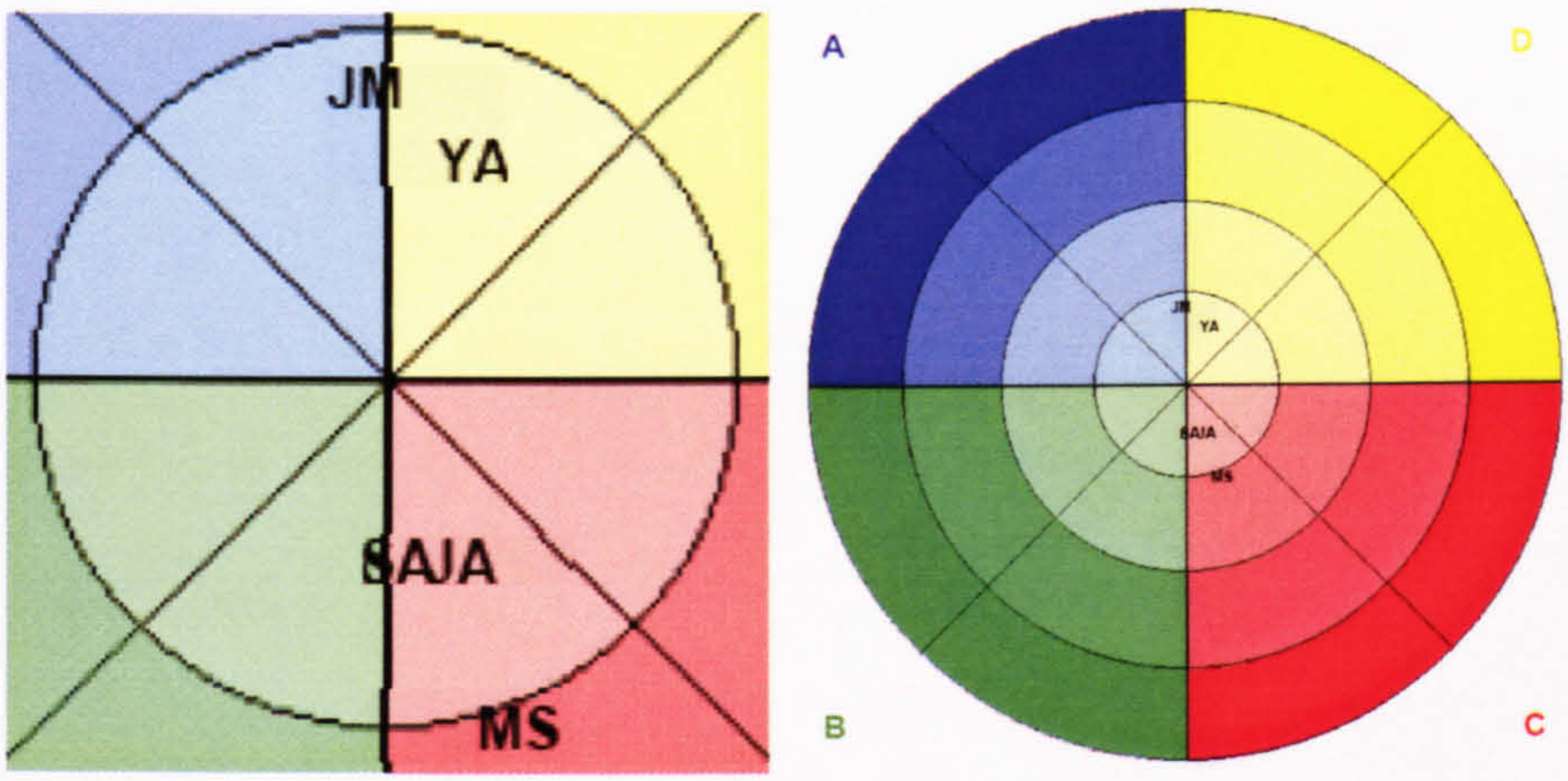


Figure 7.16 Circular Continuum for the Fourth Highest Scoring Team

7.5.5 The Fifth Highest Scoring Team [Team 59: Score 316]

This team achieved a high score (316 points) and their tower length was 55 inches with a long, strong shape (see Table 7.15 and Figure 7.17). In fact the team (though the tower only supported five cans), completed the task before the end of the building phase, and saved 5 minutes. Their performance data is summarised in Table 7.15. The team was composed of one Arab (the leader) and three Indians; they all work in the same department, and the leader holds a senior management position, namely Vice-President for Planning. All the team had management related backgrounds, and overall the team showed good comprehensive strength in the "B" (organisational) thinking preferences (see Table 7.16 and Figure 7.18). [The team members can be readily identified in Figure 7.18. By looking at the top thinking preference score of a person, then his profile/polygon will be placed in that quadrant, and the higher the score the more the profile will be placed on that axis towards the circumference though the other scores will exert their respective *pulls* on that positioning.] The leader's (Dr A Al Bhairi) main dominant thinking quadrants were "A" (93) and "B" (74), while he had a moderate (59) in both "C" and "D". In general, the leader was decisive in his leadership of the team, also he was familiar with the rest of the team as they worked under his supervision. Mr Mukesh Shah had a profile close to that of the

leader; Mr Shafik Thakur was stronger in "B" (99) and "C" (92); but was weaker in the analytic thinking preference, and finally Mr Milvin K Thattil was extremely strong in "B" (120) organisational thinking preference. The adjective pairs of the leader showed some variance, especially in "D" (8) which suggests that under pressure his thinking shifts more towards "D" (*i.e.* towards more innovative and imaginative ideas). But the others had higher adjective pair scores in the "B" quadrant indicating they would become more organisational in their thinking under pressure. These profile characteristics are reflected in the shape of the tower, *i.e.* a strong rectangular pillar, loading 5 cans at a high level (see Figure 7.17). Also, the researcher noted leadership was very clear, even dominant, and the group was motivated to follow the leader's suggestions with minimum comment. Hence they saved paper resources and time. The leader's career in Planning and his strong orientation in "A" thinking preference (95), along with Mr Shah also with a strong "A" profile, helped them to plan a clear and efficient proposal, and to stick with it, perhaps confirming the strong average organisational "B" preference of the group.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
59	4	5	55	7	5	0	0	5	45	1	316

Table 7.15 Tower data for the Fifth Highest Scoring Team

In summary these high achieving groups were all strong in their performances but were varied in their HBDI profiles and in the types of tower they built. The leaders were effective in their facilitative and leadership roles. These patterns of similarity and difference in profiles and performance are discussed later in this chapter.

Figure 7.17 Photograph of the Fifth Highest Scoring Team

Individual's Name	Code	Quadrant Scores				Adjective Pairs				Lt	Rt	Cr	Lm
		A	B	C	D	A	B	C	D				
ABDULATIF AL BAHIRI	1122	93	74	59	59	5	6	5	8	59%	41%	53%	47%
MUKESH N SHAH	1122	101	87	48	56	7	9	4	4	64%	36%	54%	46%
SHAFIK M THAKUR	2112	35	99	92	66	4	10	5	5	46%	54%	35%	65%
MILVIN K THATTIL	2122	54	120	53	65	5	9	4	6	60%	40%	41%	59%
Average	1122	71	95	63	62	5	9	5	6	57%	43%	46%	54%

Table 7.16 HBDI scores for the Fifth Highest Scoring Team

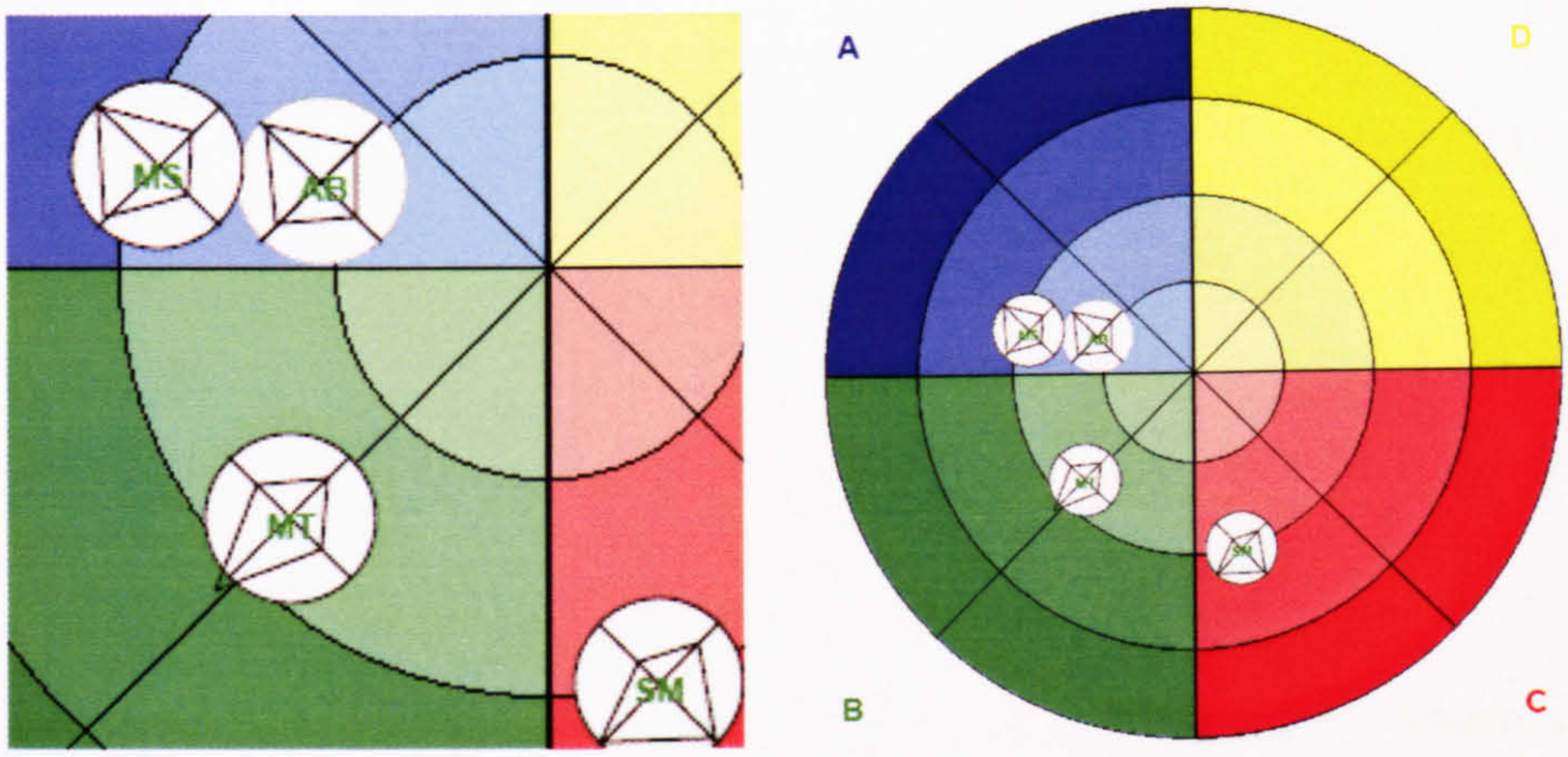


Figure 7.18 Circular Continuum for the Fifth Highest Scoring Team

THE LOW PERFORMING TEAMS

In contrast, it is of interest to consider the performances and conduct of low scoring teams, and these data are discussed below.

7.5.6 The first low scoring team [Team 61: Score 166]

This team, which is the best performing in this low scoring set of teams, is composed of four Indian members (Table 7.18) with the leader, Mr Venkata Ragham Raju Dantul (who held a responsible position in the company) showing strength in "B" organizational thinking preferences (108); strong in "A" (95); low moderate in "C" (47); and moderate in "D" (53); and the adjective pairs data also matches this profile. The rest of the team is mixed in its thinking preferences, with very strong "A" for Mr Lakshmi Makesh; very strong "C" and "D" for Mr Vijayaraghauan Sarangapani,; and high strong "D" for Mr Komaleswaran Arutselvan. Their averages were strong in "A" (87); strong in "B" (78); fairly high moderate in "C" (64); and strong in "D" (74). [These characteristics are shown in Table 6.18 and in Figure 7.19.] In addition, the adjective pairs data show a higher thinking preference in "A" "B" and "C". Thus the team is heterogeneous with strengths in all quadrants distributed in its members (see Figure 7.19).

The performance data (Table 7.17) show that they constructed their tower using only 21 sheets of paper and they were able only to load one can between 2 to 5 feet on a long thin tower. The team seemed to give priority to a conservative use of resources, and there was much discussion with the team expressing their strong preferences. In fact, in the design phase they were disputing very much on method which prevented them from understanding the whole exercise thoroughly and in the building phase they continued in an unfocused way, up to the last minute, continually suggesting new ideas. When they started putting the cans on the tower, the long tower started shaking and it was about to drop, and they had to accept that they could only load one can at a height of 25 inches. When they were asked to comment on their performance, they accepted that they didn't fully understand the problem and its criteria in the design phase. Then, in the building phase, they gradually started to understand the problem but the many suggestions and amendments made their tower weak, and there was no trialling during stages of the building process. The leader though strong in organizational thinking preferences gave rather weak directions, so the ideas remained relatively unfocused and not pointed at the major criteria of the task.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
61	4	0	56	8	1	0	1	0	79	5	166

Table 7.17 Tower data for Team Number 61

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Vijayaraghauan Sarangapani	2111	45	71	110	92	4	2	11	7	36%	64%	43%	57%
Komaleswaran Arutselvan	1221	84	56	53	96	9	4	7	4	48%	52%	62%	38%
Lakshmi Makesh Chellaram	1122	122	75	47	53	11	6	2	5	66%	34%	59%	41%
Venkata Raghan Raju Dantul	1122	95	108	47	53	7	8	4	5	67%	33%	49%	51%
Average	1121	87	78	64	74	8	5	6	5	54%	46%	53%	47%

Table 7.18 HBDI scores for Team Number 61

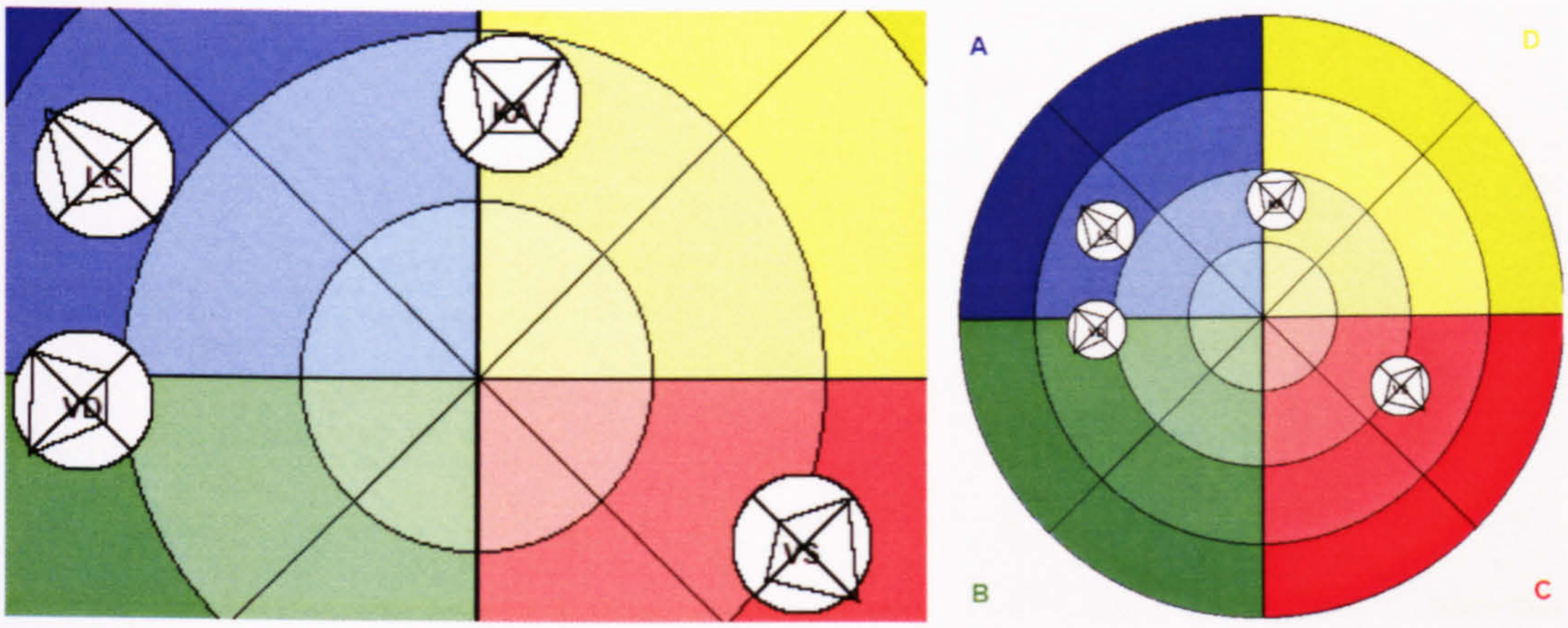


Figure 7.19 Circular Continuum for Team Number 61

7.5.7 The second low scoring team [Team 72: Score 21]

This is the lowest scoring team (21 points) and the performance data shows (Table 7.19) they consumed a lot of paper (82 sheets of the 103 available) in constructing the tower. However when they started loading the first can between 1 to 3 feet, the tower fell down. Thus, although the tower was of small size and shape, they lacked a plan of systematic building to provide a stable platform. The team was composed of four members (see Figure 7.20, Table 7.20, and Figure 7.21), and their leader was Mr Tariq Al-Ghamdi with a high thinking preference in "B" (93). His adjective pairs score notes a high "B" and suggests a higher "C" than his main profile which indicates that he may become more organizational and inter-personal in his dealings when under stress. The team as a whole was homogeneous without much diversity (see Figure 7.21). It was strong on "B" (organizational) thinking preferences, which suggests they would be efficient in the ways they attempted the problem-solving task, though the "A" (analytic) and "C" (interpersonal) profiles were moderate/strong, but the creative "D" preference was only moderate. But this did not happen. The team members were newly employed trainees in the company, and

they were also young and relatively inexperienced. Further, the leader was not well known to them, did not impose himself on the group, and they did not respond in coordinated ways.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
72	4	8	0	0	1	0	0	0	18	5	21

Table 7.19 Tower Data for Team Number 72

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Tariq Muhammed S. Al-Ghamdi	1122	74	93	63	51	4	8	7	5	59%	41%	44%	56%
Yousef Ahmad Al-Alshuhail	2112	57	93	72	65	6	6	10	2	52%	48%	43%	57%
Abdullah A. Al-Gwairi	1112	69	92	87	59	7	6	6	5	52%	48%	42%	58%
Faris Shayea Al-Khaldi	1122	81	84	65	56	9	6	6	3	58%	42%	48%	52%
Average	1112	70	91	72	58	7	7	7	4	55%	45%	44%	56%

Table 7.20 HBDI scores for Team Number 72

Figure 7.20 Photograph of Team Number 72

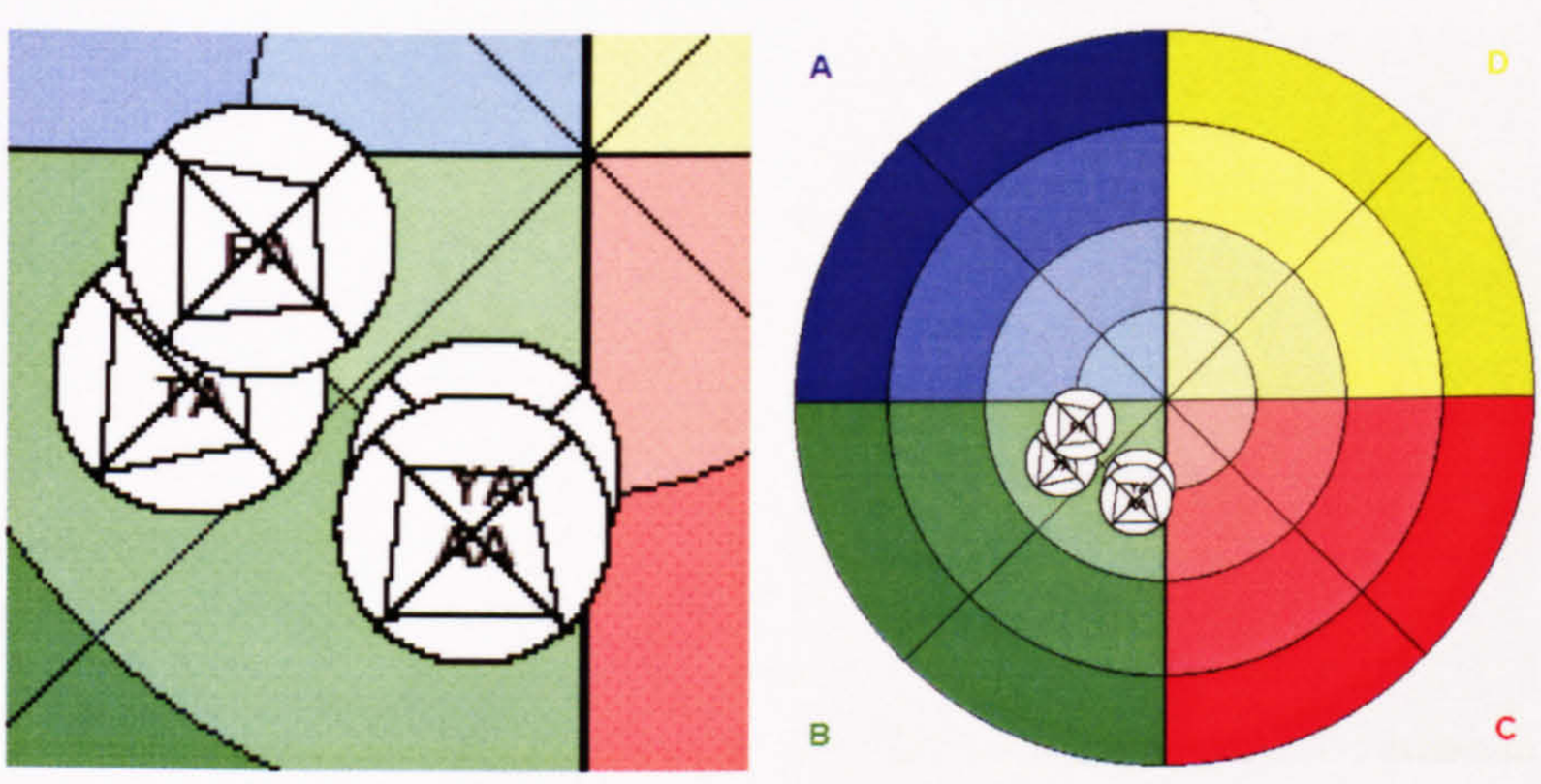


Figure 7.21 Circular Continuum for team number 72

7.5.8 The third low scoring team [Team 71: Score 30]

This team was the 80th out of the 81 teams in terms of final scoring. As shown in their performance data (Table 7.21) their tower height was only 18 inches and, although they used all the offered time allocation and adequate paper (71 sheets), they were unable to load any cans at all. They felt to be under time pressure and lost confidence that they would be able to achieve their final target.

The team was composed of five young Arab newly employed trainees (Table 7.22 and Figure 7.21); their leader was Mr Mohammed Al-Qahtani who was strong on "B" (89) organizational, and "C" interpersonal (87) thinking preferences, with lower "A" (60), and "D" (60) HBDI scores. In general, the leader was a typical limbic oriented thinker biased towards organizational and emotional thinking, and he was the lowest in the group on "A' and "D" scores. Two members (Mubarak Al-Marri and Abdulrahman Al-Ghamdi) had multi-dominant profiles (four strong preferences), and one had a triple-dominant profile (Mohammed Al-Yamani) with strong preferences in "A", "C" and "D". The other team member (Mr Nawaf Al-Dossary) double-dominant profile with strong preferences in "A" and "B". Overall, the average thinking preferences for the team were strong in "B" (81); "C" (77); "A" (72); and "D" (69). Their adjective pairs averages accord with their main profiles and the average distribution percentage of left and right hemispheres shows a fair balance. Figure 7.23 illustrates the diverse multi-dimensional character of their "A", "B", "C", and "D" thinking preferences, but the team is homogeneous in that there is a common "B" preference bias. But the *pull* from the other quadrants is not strong and so the group forms a central clump.

The team made no clear plan in the design phase, and in their working were slow and indecisive with the leader not having a dominant effect. They had not analysed the problem sufficiently, nor developed a clear understanding of the relative importance of the criteria. Their slow working caused more indecision as they realized they would not achieve their target and no cans were loaded.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
71	5	0	18	0	0	0	0	0	30	6	30

Table 7.21 Tower data for Team Number 71

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Mohammed A. Al-Qahtani	2112	60	89	87	60	6	8	8	2	50%	50%	41%	59%
Mubarak Rashid Al-Marri	1111	75	71	86	77	8	3	6	7	47%	53%	49%	51%
Abdurrhman Misir Al-Ghamd	1111	77	90	68	75	7	9	3	5	54%	46%	49%	51%
Mohammad Al-Yamani	1211	77	63	80	69	9	7	7	1	48%	52%	51%	49%
Nawaf Nasser Al-Dossary	1122	72	92	63	65	8	7	5	4	56%	44%	47%	53%
Average	1111	72	81	77	69	8	7	6	4	51%	49%	47%	53%

Table 7.22 HBDI scores for Team Number 71

Figure 7.22 Photograph of Team Number 71

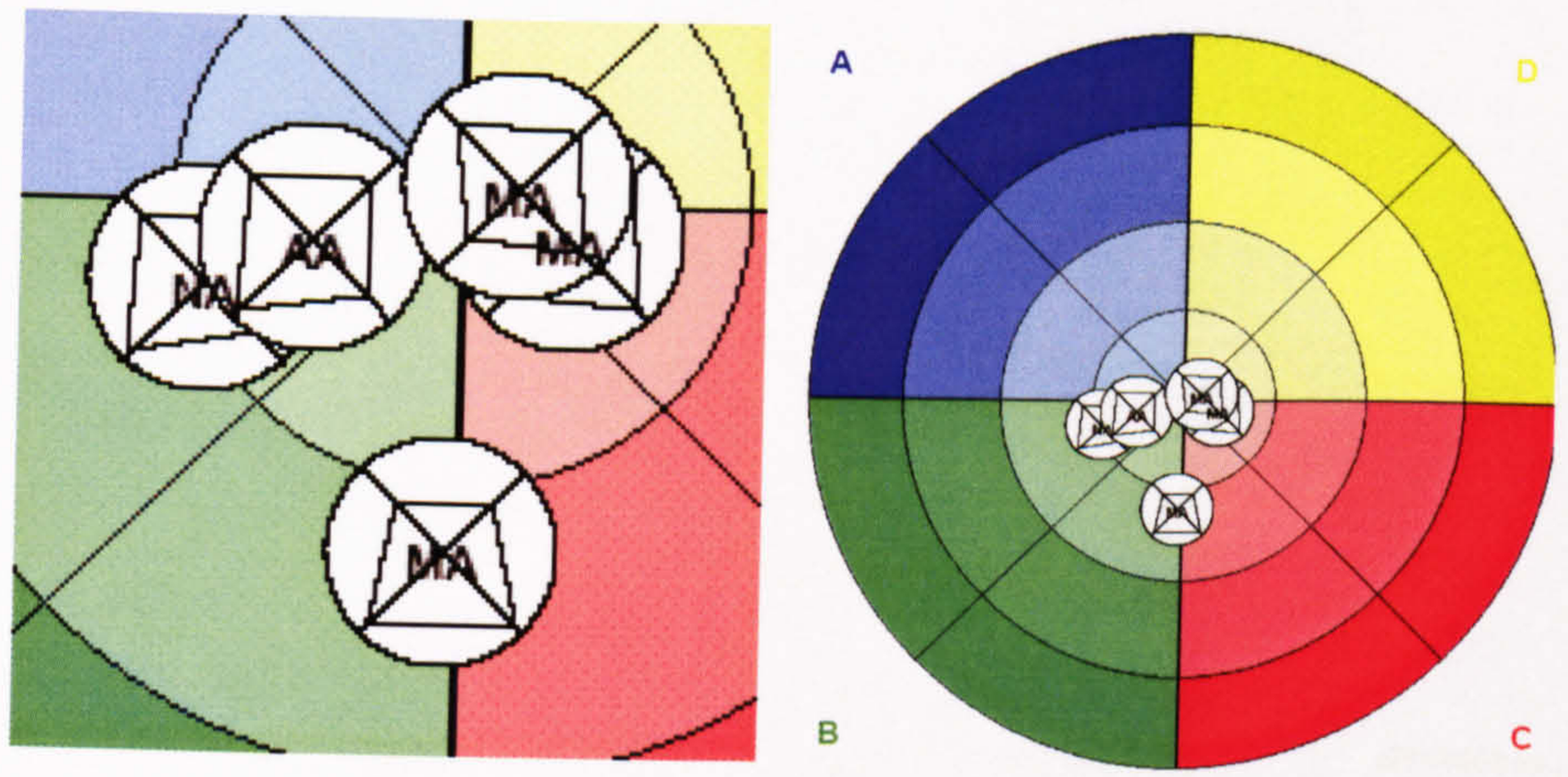


Figure 7.23 Circular Continuum for Team Number 71

7.5.9 The fourth low scoring team [Team 18: Score 82]

This team was the 77th out of 81 teams with a very low score (82 points). Their tower height was only 31 inches and they were not able to load any cans. Also, there was a large amount of unused paper (68 sheets): see Table 7.23. The team was concerned with the strength of the tower and spent their time in building a short tower (31 inches) of hollow construction (see Figure 7.24) which would save the paper resource. This became the focus of their work without considering the other, more important criteria.

The team was composed of four members (Figure 7.24 and Table 7.24); their leader was Mr Mansour Al-Otaibi who had a double-dominant profile with strong "B" (89) and strong "A" (74), and with a moderate "C" (59) and a high moderate "D" (66) profile. The adjective pairs of the leader show a high "C" (9) suggesting that under pressure he might shift towards C (emotional) thinking preferences though, in the working of the team, there was little sign of stress. As shown in Table 7.24 and Figure 7.25, the team averages were very strong in "B" (93) and strong in "A" (79), with high moderate in "C" (62), and moderate in "D" (55). In fact these figures show the team was fairly balanced but homogeneous without very strong variation between the profiles of group members. (The profiles in Figure 7.24 are placed in the "B" quadrant but near the centre).

In summary, the team concentrated on a strong tower, economic in paper, but paid scant attention to the main criteria of supporting cans on a high tower. In brief the team became focused on its own objective and the leader made no strong attempt to divert them from this aim.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
18	4	1	31	0	0	0	0	0	68	6	82

Table 7.23 Tower Data for Team Number 18

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Salem M Al-Khanfer	1122	87	90	66	56	10	5	8	1	59%	41%	48%	52%
Mousa K Al-Shaikhi	1112	87	98	71	48	9	5	6	4	61%	39%	44%	56%
Aziz Obaid Al-Enazi	1122	77	92	57	51	8	8	4	4	61%	39%	46%	54%
Mansour F Al-Otaibi	1122	74	89	59	66	5	6	9	4	57%	43%	49%	51%
Average	1122	79	93	62	55	7	6	6	4	59%	41%	46%	54%

Table 7.24 HBDI scores for Team Number 18

Figure 7.24 Photograph of Team Number 18

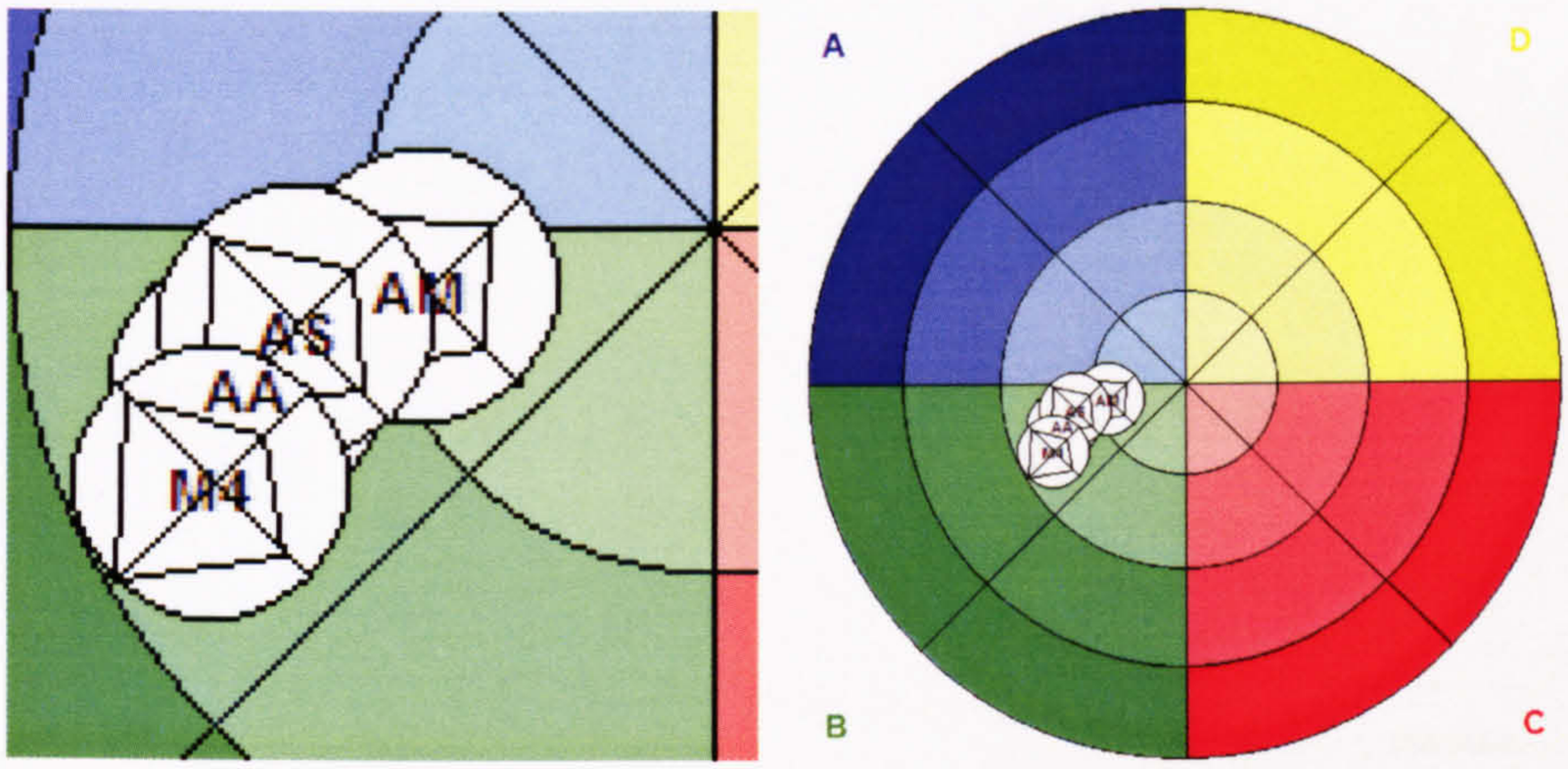


Figure 7.25 Circular Continuum for Team Number 18

7.5.10 The fifth low scoring team [Team 12: Score 134]

This team achieved only a low final score (134). Their tower height was 50 inches, they saved 32 sheets of paper but loaded only two cans between 3 to 4 feet (see Table 7.25). The team was composed of five members, four Arabs and one Indian (Figure 7.26); their leader was Mr Jarallah Al-Qahtani who had a double-dominant profile with high strong "B" (98) and "C" (95), but only a moderate "A" and high moderate "D" thinking styles (see Table 7.26). The adjective pairs of the leader accord with his main profile. Three members (Alaa, Bashar and Subbanna) had triple-dominant profiles (three strong preferences), and Mr Al-Ghamidi had a profile very similar to the leader.

This was a homogeneous team with some balance, and their profiles are close together towards the centre with a "B" bias. [See Table 7.26 and Figure 7.27.] The average thinking preferences were high strong in "B", fairly strong in "C", low strong in "A", and moderate in "D". Their adjective pairs show higher thinking preferences in "C" which indicates that a level of emotion might come into play under pressure.

The team did not analyse the problem deeply in the planning phase noting criteria but not analyzing their significance, and focusing on having a strong structure. In building the tower this concern about a strong structure continued (they used 68 sheets by folding a lot of paper into the main column of the tower). This took time and, towards the end of the building period they realized their difficulty and tried to alter the design to support cans, but were only partially successful. Again this was a team that concentrated on a single criterion (tower strength) design, and the members were unable to change their ideas until too late.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
12	5	0	50	2	2	0	2	0	32	4	134

Table 7.25 Tower data for Team 12

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Jarallah H.Al-Qahtani	2112	53	98	95	63	3	6	8	7	49%	51%	38%	62%
Alaa S. Al-Hamal	1112	80	87	84	42	9	5	7	3	57%	43%	42%	58%
Bashar M. Asiri	1112	86	96	68	38	8	5	10	1	63%	37%	43%	57%
Mohamed S. Al-Ghamdi	2112	51	98	89	53	6	8	9	1	51%	49%	36%	64%
Subbanna Balepur	1112	92	84	69	53	6	7	6	5	59%	41%	49%	51%
Average	1112	72	93	81	50	6	6	8	3	56%	44%	41%	59%

Table 7.26 HBDI Scores for Team Number 12

Figure 7.26 Photograph of Team Number 12

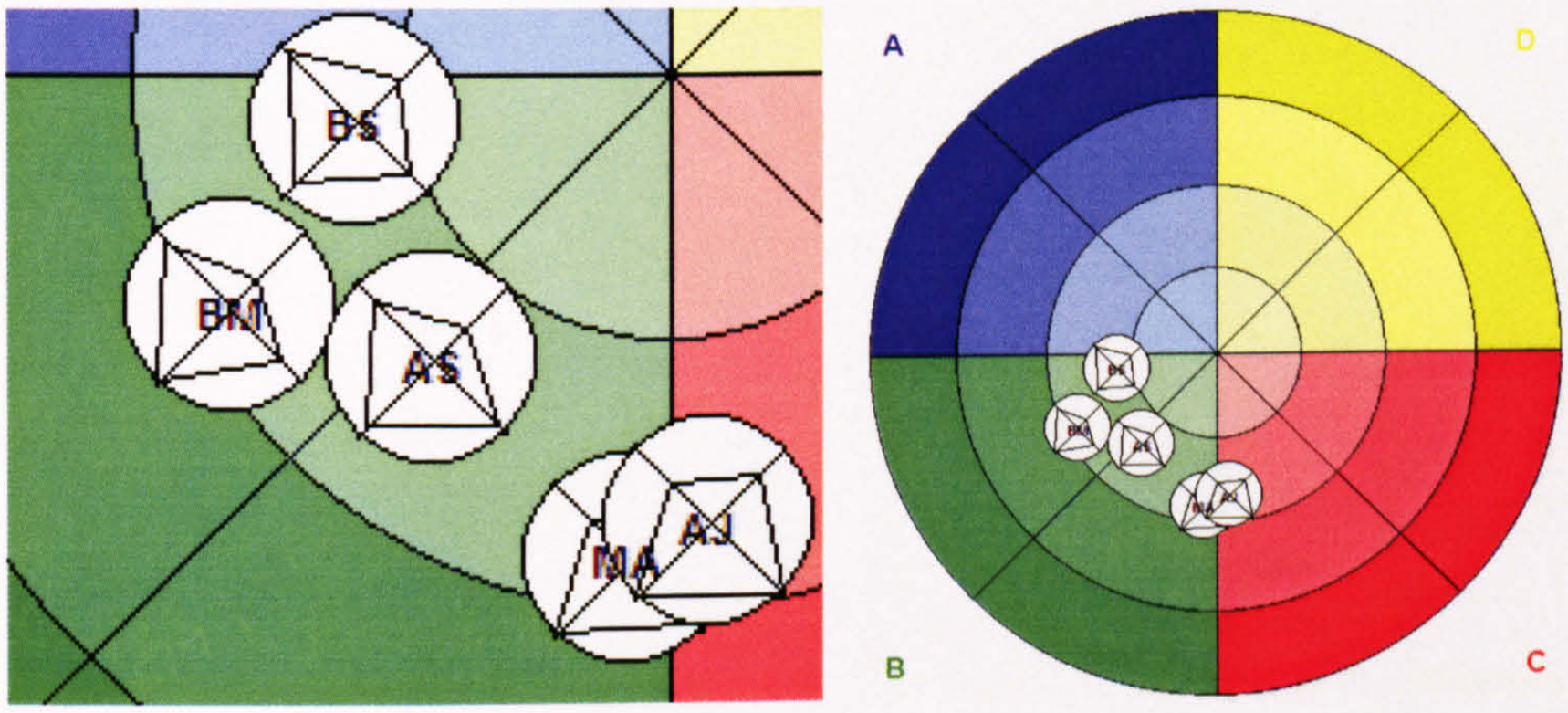


Figure 7.27 Circular Continuum for Team Number 12

7.5.11 The sixth low scoring team [Team 15: Score 161]

This team only built a short tower (11 inches) in height and saved the second highest number of sheets of paper (82 sheets) as well as completing their attempt eight minutes from the finishing time. Hence the team was not under pressure of time and intentionally decided to build their tower to a particular rectangular platform shape (Table 7.27 and Figure 7.28) and so they paid little attention to tower height and the support of cans, which carried the most points. The team seemed to have misunderstood or misjudged the important factors in the problem.

The team was composed of four members (Figure 7.28; Table 7.28); their leader was Mr Abdulla Bin Jalal who had a double dominant profile in the thinking preferences, being strong in "A" (83), strong in "B" (90), but only moderate in "D" (62), and fairly low in "C" the interpersonal preferences (41). His adjective pairs score supports his main profile with some dominance towards "B" (see Table 7.28). The rest of the team were fairly strong in "A" and "B" with moderate strengths in "C" and "D". The average thinking preferences were strong in "A" (88), and "B" (85), while the right hemisphere had lower averages, *i.e.* moderate "C" (51), and "D" (62). These data features are shown in Table 7.28. The team has close similarity between its members, *i.e.* homogeneous, but their profiles are towards the centre in their placings (Figure 7.29). This indicates an "A"-"B" bias, but a reasonable multibalance between the thinking preferences.

The main aim of the team was to build a very strong tower but to save paper, to work efficiently and to save time. However, they found it difficult to build a platform of the shape they had decided which was strong enough, and so they didn't load any cans to a height that gained points. The team members were all Arabs occupying similar positions of responsibility in the company, and their experience was within the Operations Department.

[Patterns of similarity and difference in profile and performance between the six low scoring teams are discussed in a later section of this Chapter.]

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
15	4	8	11	0	0	0	0	0	82	0	161

Table 7.27 Tower data for Team Number 15

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Fayez M Al-Dausari	1121	95	81	56	69	8	8	2	6	58%	42%	54%	46%
Ahmed Y Al-Thawadi	1112	83	86	71	50	7	7	7	3	58%	42%	46%	54%
Majed A.Al-Naeem	1121	92	84	36	68	9	8	1	6	63%	37%	57%	43%
Abdulla Ali Bin Jalal	1122	83	90	41	62	6	9	5	4	63%	37%	53%	47%
Average	1122	88	85	51	62	8	8	4	5	61%	39%	53%	47%

Table 7.28 HBDI scores for Team Number 15

Figure 7.28 Photograph of Team Number 15

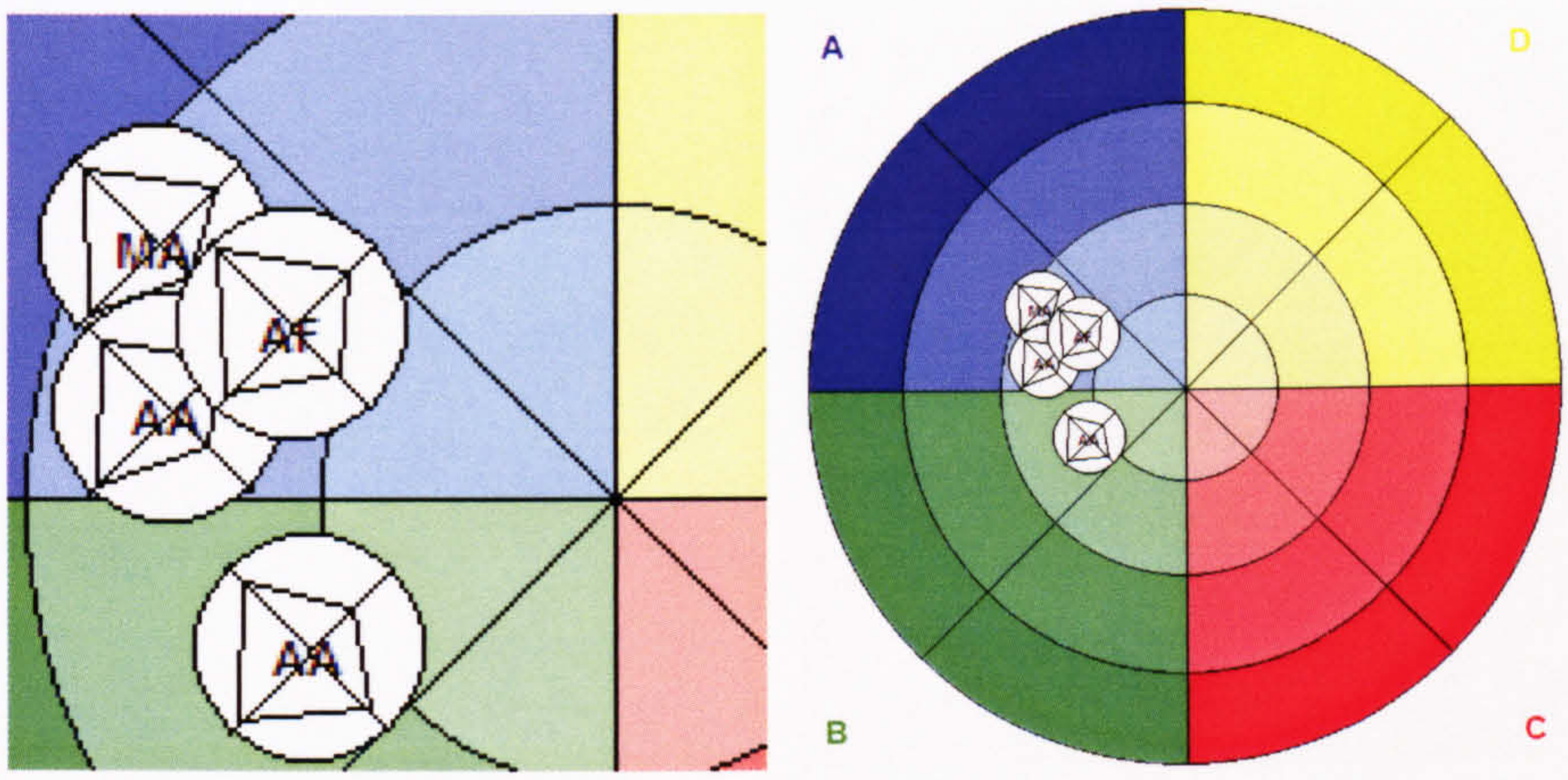


Figure 7.29 Circular Continuum for Team Number 15

A SAMPLE OF AVERAGE SCORING TEAM PERFORMANCES

A random sample of six teams reflecting the levels between the high scoring and low scoring teams was chosen, and their performances and their methods of working, taken from the researcher's notes and observations, are discussed below.

7.5.12 The first chosen team [Team 81: Score 170]

As shown in Table7.29 the performance of this team is a low average. They achieved a score of 170 points with a moderate tower length of 30 inches and with 6 cans loaded but at a low height. The team was not under time pressure since they saved 10 minutes and their tower shape of rectangular design, is shown in Figure 7.30.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
81	5	10	30	0	6	6	0	0	10	0	170

Table 7.29 Tower data for Team Number 81

Figure 7.30 Photographs of Team Number 81

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Jamal N. Al-Fehaid	2112	65	81	83	66	4	5	7	8	49%	51%	44%	56%
Syed R. Ahmed	1111	74	87	68	71	8	5	8	3	54%	46%	48%	52%
Bedah Al-Dissary	1112	81	84	75	57	5	5	7	7	56%	44%	46%	54%
Sa'ad F. Al-Hajri	1112	68	84	72	65	6	6	8	4	53%	47%	46%	54%
Rahmatullah Bin Mahfud 569	2112	51	78	77	62	3	8	5	8	48%	52%	42%	58%
Average	1112	68	83	75	64	5	6	7	6	52%	48%	45%	55%

Table 7.30 HBDI Scores For Team Number 81

The team (see Table 7.30) was composed of three Arabs, one Indian and one Indonesian, all of them occupying relatively the same level of responsibility in the Operations Department. The team leader was Mr Jamal Al-Fehaid whose main dominant thinking quadrants were "B" (81) and "C" (83), while "A" (65) and "D" (66) were high moderate. In general, these indicate the leader is stronger on organizational with interpersonal/emotional thinking characteristics. The rest of the team were very similar to each other in terms of their profiles (Table 7.30 and Figure 7.31) and were placed close to the center towards "B" and "C" in the inner smallest circle.

In brief, the group is a homogeneous team with more strength in the "B" (organizational) quadrant but with some strength in the other quadrants. Their main aim noted in the design discussions was to build a very strong tower; there was little disagreement in their working and they tended to agree with suggestions that were made. The photograph (Figure 7.30) shows the team at work. Although of only moderate height, the team was content with their tower and its support of the cans. It was cautious in design—not aiming for tower height, even though a lot of paper was used. Hence the cans were not loaded to a height that merited many points.

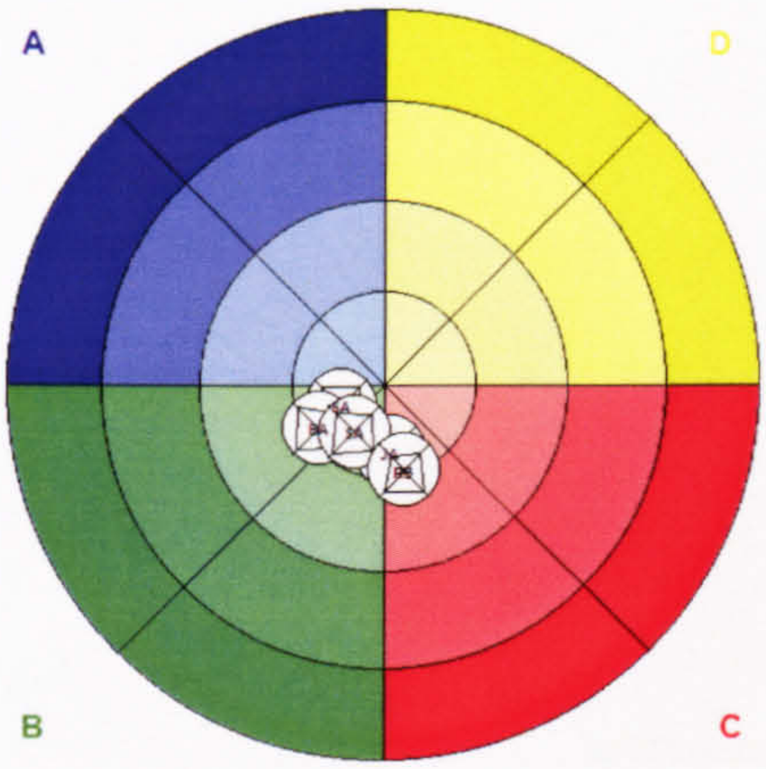


Figure 7.31 Circular continuum for Team Number 81

7.5.13 The second chosen team [Team 14: Score 207]

As shown in Table 7.31, the performance of this team was average. They achieved a score of 207 points building a tower of only moderate height (32 inches). The team loaded 6 cans; but 2 of them were under 12 inches; two of them between 1 and 3 feet; and two of them between 3 and 5 feet. The team was not under time pressure (they saved 10 minutes) and intentionally they decided to build their tower in a torpedo-like shape (see Figure 7.32) with a larger base and side bands to add strength. The photograph shows they were satisfied with their performance.

As seen in Figure 7.32, the team was composed of four Arabs, all of them were engineers occupying middle management posts in the Manufacturing Division. The team leader was Mr Gasim Al-Joufy who had dominant thinking quadrant in "A" (87), while the other quadrants were strong "C" (69) and high-moderate "B" (65) and "D" (60) (see Table 7.32). Hence the leader has analytic characteristics with an emotional tendency, and his adjective pairs data reinforces these characteristics.

The team profile placings are shown in Figure 7.33 and indicate a homogeneous team, but all of their preferences do not exceed 87 so there is no very high score for any quadrant. Conversely there are no particularly weak quadrant scores either.

The characteristics of their general profile were reflected in their performance. Average in tower height and can support, but they were interactive showing interest and even excitement (see Figure 7.32—top right). They made continual suggestions in the building phase but were concentrating on the strength of the tower and its straightness. This emphasis curtailed their ambitions.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
14	4	10	32	0	6	2	2	0	45	0	207

Table 7.31 Tower data for Team Number 14

Figure 7.32 Photographs of Team Number 14

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Gasim M Al-Joufy	1212	87	65	69	60	8	6	8	2	54%	46%	52%	48%
Ayman M Amoudi	1112	83	80	68	60	5	7	5	7	56%	44%	49%	51%
Husam Ashmawi	1211	83	51	84	80	7	2	10	5	45%	55%	55%	45%
Saad A.Al-Ghamdi	1122	81	77	56	50	9	7	5	3	60%	40%	50%	50%
Average	1112	84	68	69	63	7	6	7	4	54%	46%	51%	49%

Table 7.32 HBDI Scores for Team Number 14

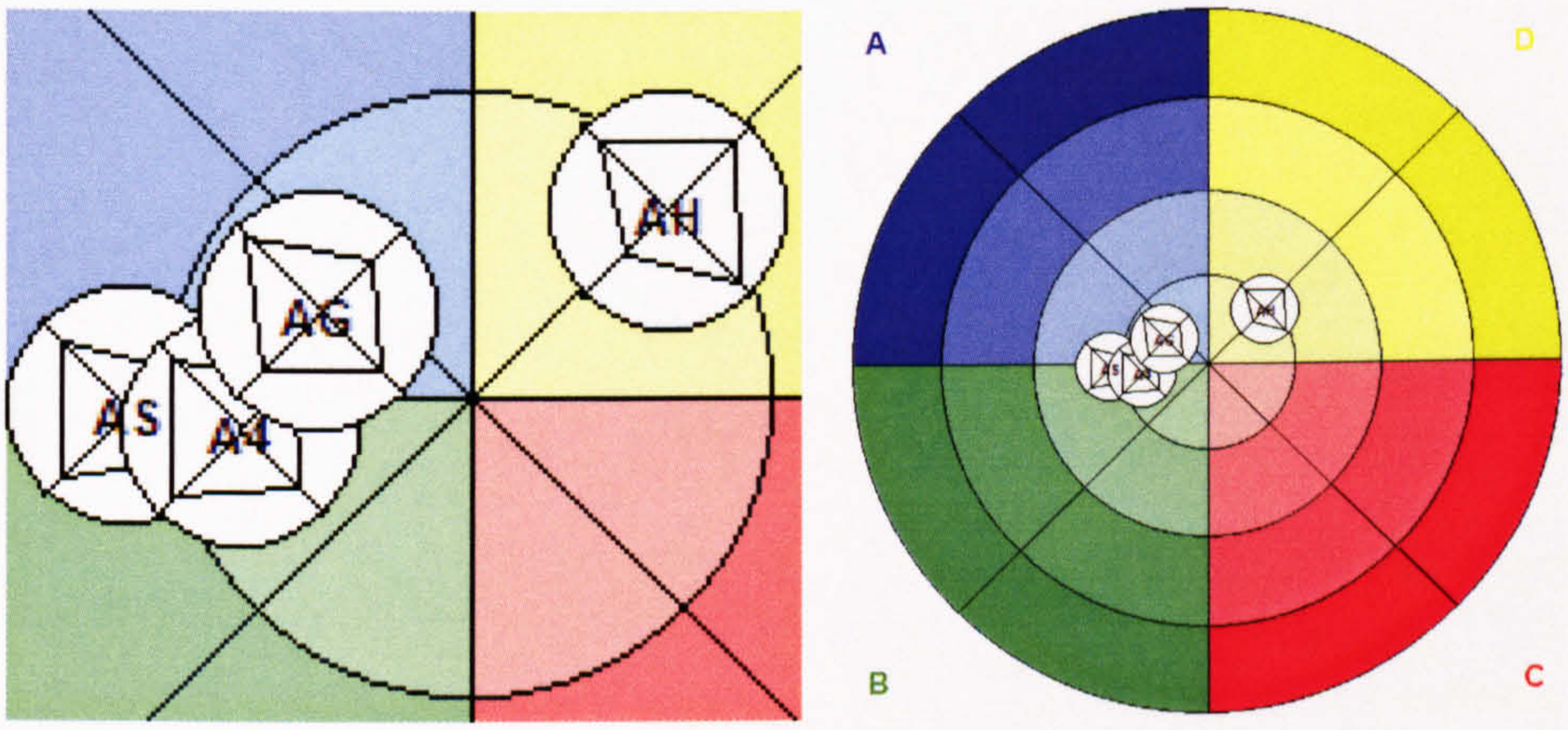


Figure 7.33 Circular continuum for Team Number 14

7.5.14 The third chosen team [Team 8: Score 221]

This team built a high tower (69inches), but did not achieve a very high score (221) because the members loaded only 3 cans between 2 and 5 feet. The team saved 7 minutes (see Table 7.33) which indicates that they were not under pressure, and the team was reasonably satisfied with the tower it had built and its performance. The shape of the tripod tower—an interesting design—is shown in Figure 7.34.

The team was composed of five Arab members occupying relatively similar levels of responsibility in the company, except Mr Sami Al-Warthan who was placed in this team because of his strong preference in the "A" and "D" quadrants (see Table 7.34). The leader was Mr Salamah Al-Nazzal who was a duple Dominant in two thinking preference, being very strong in "B" (107) and strong "A" (89) while very low in "C" (38) which indicates that he was analytic and organizational in his thinking preferences, but weaker in his interpersonal capabilities. For the rest of the team Almukhtar had a very strong "A" (119), but was weaker in the other quadrants. Mr Adel Al-Hamad was strong in "A" and "B", Mr Sami Al-Warthan was very strong in "A" and "D", and finally Mr Ahammed Al-Shammari was very strong in "C" (101). As a result this was a diverse team (see Figure 7.35) with a general strength in the "A" (analytic) quadrant. The adjective pairs of the leader shifted toward "A" (10) more than "B" (7) which suggests that he tends to become more analytical under pressure. The average thinking preferences for the team were very strong in "A" (95), strong in "B" (73) and "D" (72) with the quadrant "C" having the lowest average "C" (57). Overall it was a heterogeneous team (see Figure 7.35).

This diversity was clear in the working of the team. The tripod shape of their tower was useful in giving height, but meant that the tower unable to load more than three cans at middle level. There were many suggestions and much discussion but the leadership style, was unable to establish a clear vision on how to deal with this difficulty, and much of the discussion contained ideas but was focused on less important points.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
8	5	7	69	21	3	0	3	0	22	3	221

Table 7.33 Tower data for Team Number 8

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Salamah S. Al-Nazzal	1122	89	107	38	54	10	7	3	4	68%	32%	50%	50%
H.H. Al-Mukhtar	1221	119	57	57	71	9	3	8	4	58%	42%	63%	38%
Adel A.Al-Hamad	1121	86	74	62	83	3	6	8	7	52%	48%	55%	45%
Sami Mohd.Al-Warthar	1231	107	47	26	101	8	5	3	8	55%	45%	74%	26%
Ahammed S.Al-Shammari	1112	74	81	101	51	6	5	9	4	50%	50%	41%	59%
Average	1121	95	73	57	72	7	5	6	5	57%	43%	56%	44%

Table 7.34 HBDI Scores for Team Number 8

Figure 7.34 Photographs of Team Number 8

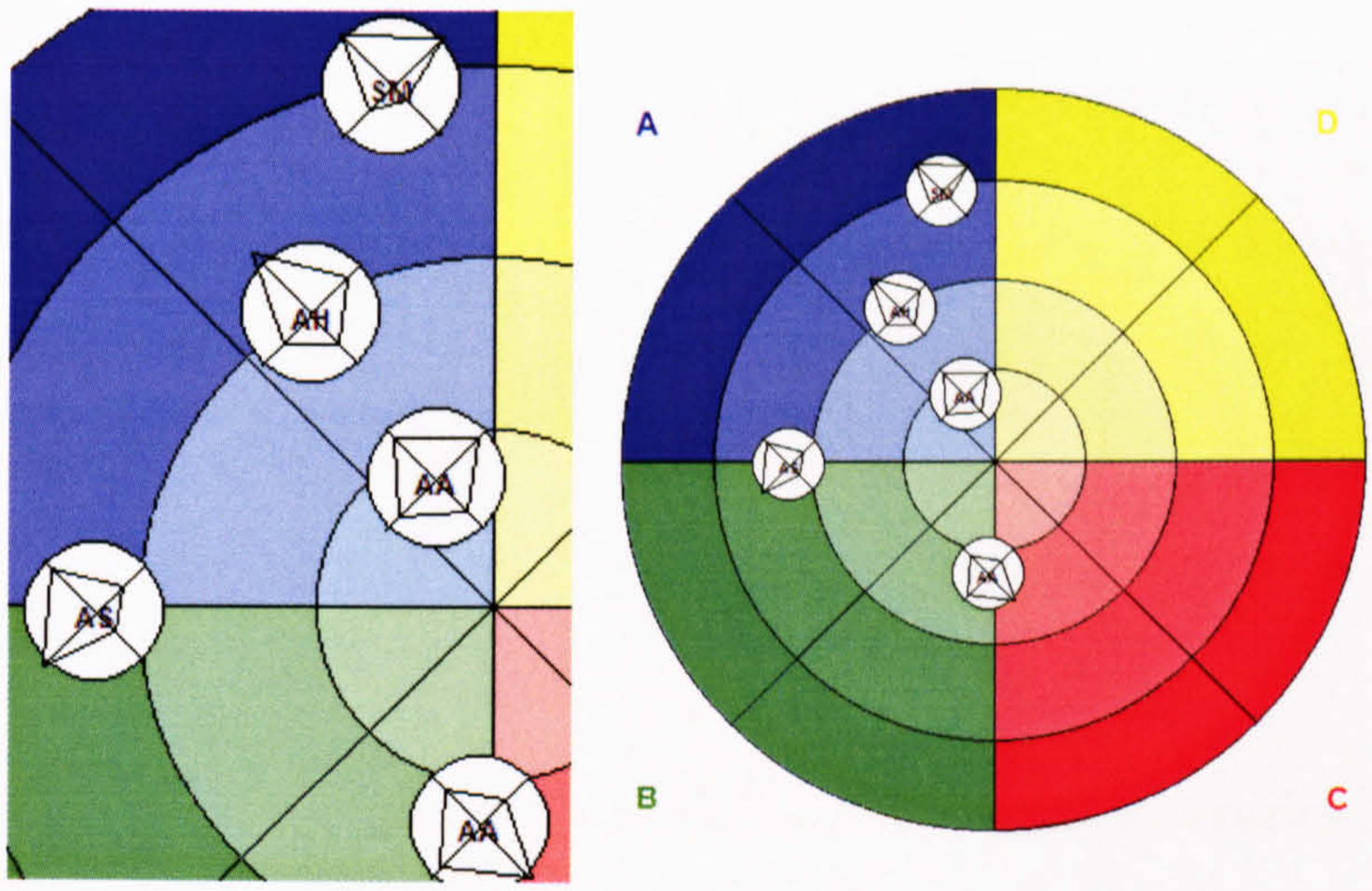


Figure 7.35 Circular Continuum for Team Number 8

7.5.15 The fourth chosen team [Team 16: Score 234]

As shown in Table 7.35, this team built a tower of only 14 inches in height, and no cans were loaded to a height which gained significant points (see Figure 7.36). The team's performance was unusual; it saved the largest amount (86 sheets) of paper amongst all teams, as well as saving 14 minutes in time. This is how they achieved their score of 234.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
16	4	14	14	0	6	6	0	0	86	0	234

Table 7.35 Tower data for Team Number 16

This team is composed of four members and their leader was Mr Abdulla Al-Meatiq and his profile shows two strong thinking preferences, "A" (89) and "D" (89) while the "B" (48) and "C" (51) scores were relatively low. This suggests he is an analytic thinker, but with creative styles of working. In fact the leader was an engineer engaged in research and development. The rest of the team is fairly strong in the "A" quadrant with lower strengths in "B", "C" and "D". In fact, thinking preferences of the team members are close to each other (see Table 7.36 and Figure 7.37) with the exception of Mr Mohd S Al-Ameiri who had very strong thinking preferences in "B". With this exception, the team was homogeneous with the average thinking preferences being strong in "A" (87); low strong in the rest "B" (69), "C" (68), and "D" (74) and note that the team's profiles are shown close to the centre (see Figure 7.37). This team was composed of all Arabs occupying relatively similar positions of responsibility within the company.

The team worked quickly and was respectful of each other's opinions. The emphasis was on building a tower to hold the cans, but the important criteria of tower height and loading cans at a high level were not often referred to. Their ambition was limited, though the small tower was

built economically—so paper was saved, but the design had limitations and in the last stages of the building phase the team was not capable of extending its height.

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Mohd.A Al-Bagawi	1221	95	62	66	80	8	8	6	2	52%	48%	58%	42%
Mohd.S Al-Amieri	1122	69	107	66	65	7	8	8	1	57%	43%	44%	56%
Abdullah A Al-Hamad	1212	93	57	87	63	8	3	7	6	50%	50%	52%	48%
Abdulla M Al-Meatiq	1221	89	48	51	89	7	2	6	9	49%	51%	64%	36%
Average	1111	87	69	68	74	8	5	7	5	52%	48%	54%	46%

Table 7.36 HBDI Scores for Team Number 16

Figure 7.36 Photographs of Team Number 16

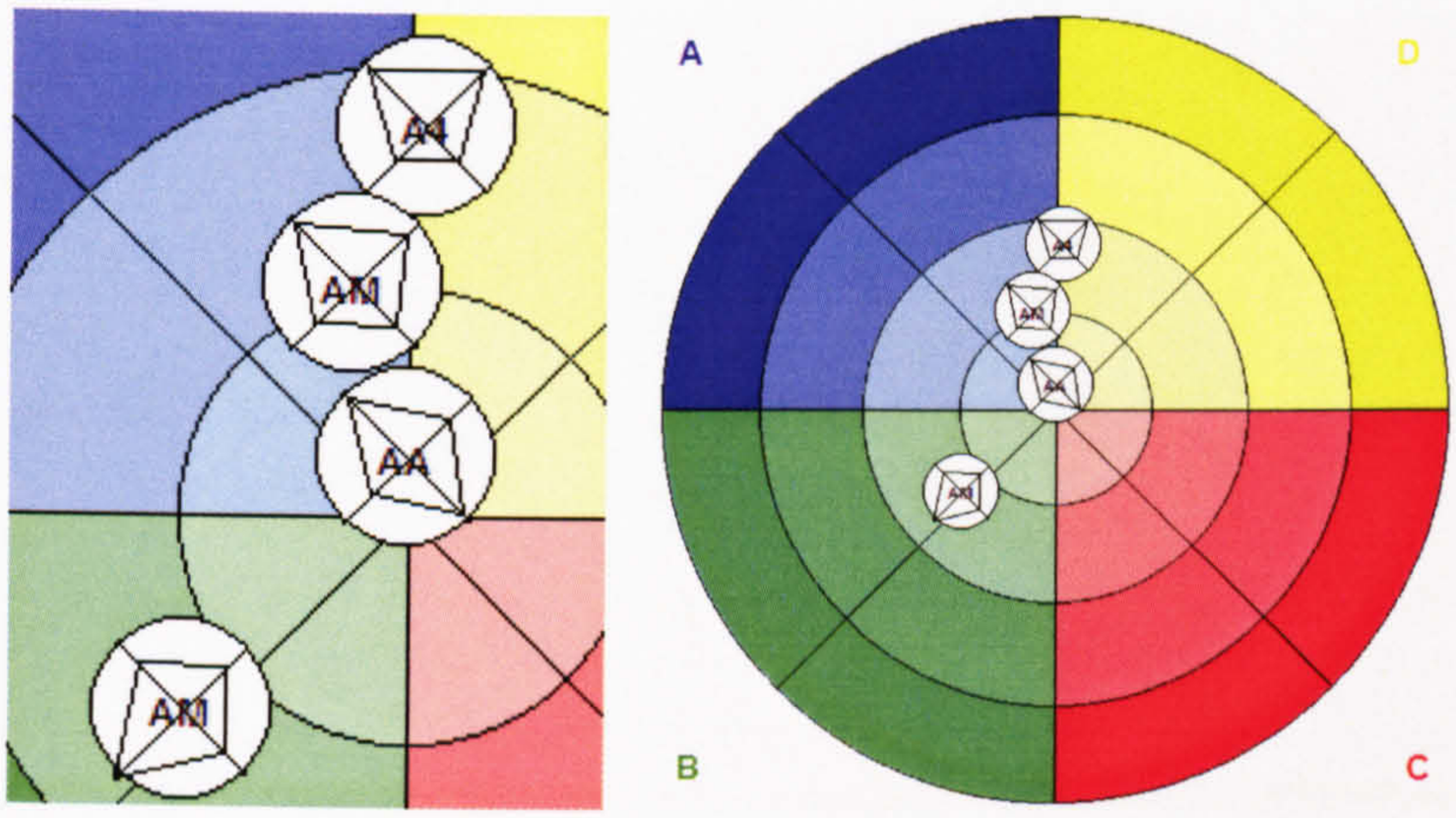


Figure 7.37 Circular continuum for Team Number 16

7.5.16 The fifth chosen Team [Team 76: Score 271]

This team is composed of four members (Table 7.38). The leader was Mr Mohammed Ibrahim and his HBDI profile shows he is very strong in "B" (104), strong in "A" (84) and "C" (86), but low in "D" (35) the creative thinking preference. Also, his adjective pairs results matched the thinking preferences profile. The profiles of the team members showed similar features, *i.e.* on average very strong "B" (104) with some strengths in "A" (82), high moderate in "C" (66) and low moderate in "D" (44). The data suggest this team is strong in analytical, procedural and organizational thinking, but weaker in creative thinking (see Table 7.38). Figure 7.39 shows these characteristics in the placing of the personal profiles in the "B" quadrant with a *pull* from the "A" (analytic) quadrant. The team was composed of two Arabs and two Indians, and the

leader held a higher position in the company. He was a new graduate and very motivated to ensure his team competed well against the other groups.

This team constructed a strong base to the tower which had a length of 57 inches and supported 5 cans between 2 and 5 feet. They were economical in their use of paper resources and well organized, systematic in their tower building and finished before time. Also, they used an antenna to give greater height to the tower (see Figure 7.38). Overall a competent performance achieving a high average score.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4Ft.	Cans loaded	Cans >1&<3ft	Cans >2&<5ft	Cans >4&<7ft	unused paper	Unused Cans	Score
76	4	4	57	9	6	1	5	0	22	0	271

Table 7.37 Tower data for Team Number 76

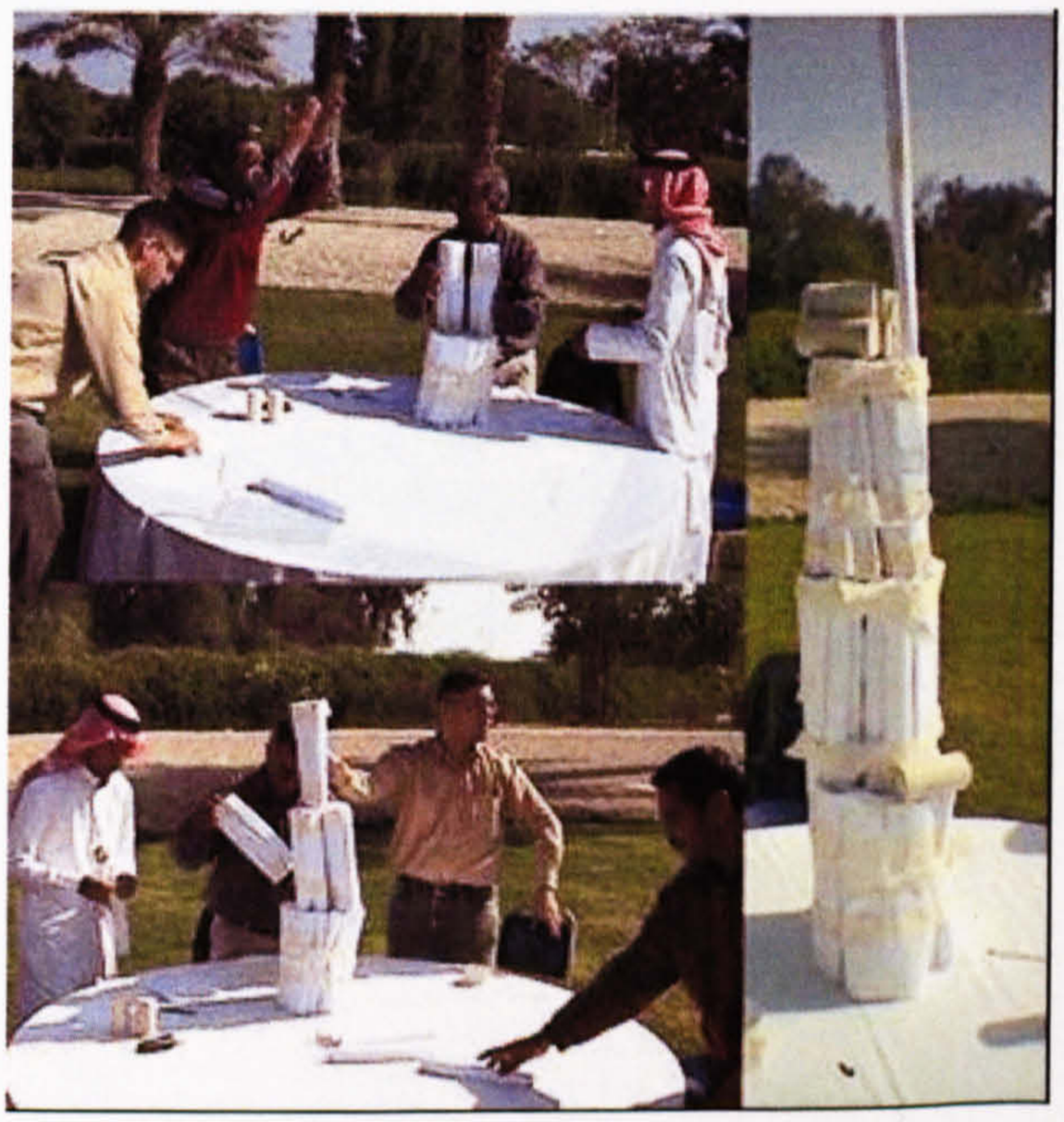


Figure 7.38 Photographs of Team Number 76

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Naif M. Al-Osaimi	1112	68	111	72	41	5	10	8	1	61%	39%	37%	63%
Mohammed Asifuddin	1122	83	90	60	50	9	7	5	3	61%	39%	47%	53%
Mohammad Ibrahim	1112	84	104	86	35	6	10	8	0	61%	39%	39%	61%
Nanduri Sitaram	1122	92	111	44	51	7	7	4	6	68%	32%	48%	52%
Average	1122	82	104	66	44	7	9	6	3	63%	37%	43%	57%

Table 7.38 HBDI scores for Team Number 76

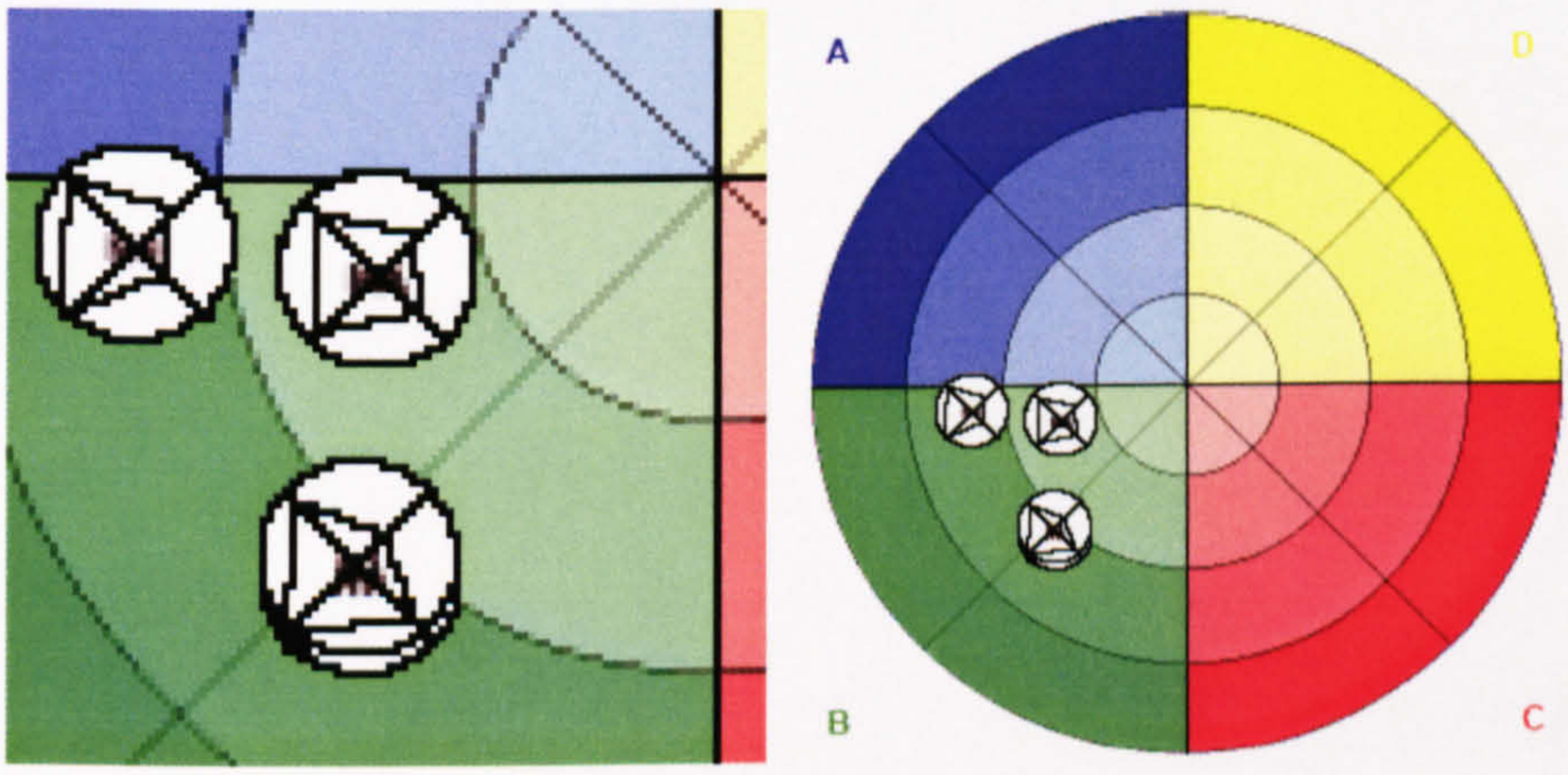


Figure 7.39 Circular continuum for Team Number 76

7.5.17 The sixth chosen Team [Team 70: Score 281]

As shown in Table 7.39, this team achieved a high average score (281 points) and built a very high tower (70 inches)—see Figure 7.40. However, it really is a short tower with a high thin stick/antenna. It was a smart idea decided in the final minutes of the building phase. They were planning and starting to build a solid short tower when it occurred to them that, although the cans could only be supported at a low level (1-2 feet), they could gain points by constructing an antenna.

The team was composed of five young Arab employees, all of them in the Operations Department occupying the same level of responsibility. All team leaders were chosen by the team members and, for this group, the team leader was Mr Mohammed Saud Al-Enizi (see Table 7.40) who had relatively strong thinking preferences in "C" (84) and "D" (80), and low strong in "A" (74) and "B" (72). The adjective pairs of the leader show a very high preference in "C" (10), which means that the leader might shift to "C" under pressure and be more emotional in his decision making. The rest of the team was very close to each other in profile (see Table 7.40 and Figure 7.41) on average being strong in "B" (78), "C" (82), and "D" (90), while the "A" quadrant (analytic thinking preference) had a moderate average (48). Again, their adjective pair averages showed a high thinking preference in "C" and Figure 7.41 reflects this placing of all the personal profiles in the "C" quadrant with a *pull* from the "D" (creative) quadrant.

Their method of working matched these HBDI profiles. It was animated and cooperative with, towards the end, the creative idea of bringing in the antenna to add to their points core. Their design was also economical in the use of paper but, as noted the design could only support cans at a low height.

Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
70	5	0	70	22	6	6	0	0	47	0	281

Table 7.39 Tower data for Team Number 70

Figure 7.40 Photograph of Team Number 70

Individual's Name	Code	Quadrant Scores				Adjective Pairs							
		A	B	C	D	A	B	C	D	Lt	Rt	Cr	Lm
Ali Hamad Nasser Al-Mufarej	2111	45	68	80	98	4	3	10	7	39%	61%	49%	51%
Adnan Abdulrahman Al-Alian	2211	65	56	81	95	6	2	9	7	41%	59%	54%	46%
Mishal Fahad Bosodh	2111	41	96	87	86	5	7	6	6	44%	56%	41%	59%
Mohammed Saud Al-Enizi	1111	74	72	84	80	6	3	10	5	47%	53%	50%	50%
Hizam Abdullah Al-Dossary	2111	42	90	78	80	3	5	9	7	46%	54%	42%	58%
Average	2111	53	76	82	88	5	4	9	6	43%	57%	47%	53%

Table 7.40 HBDI scores for Team Number 70

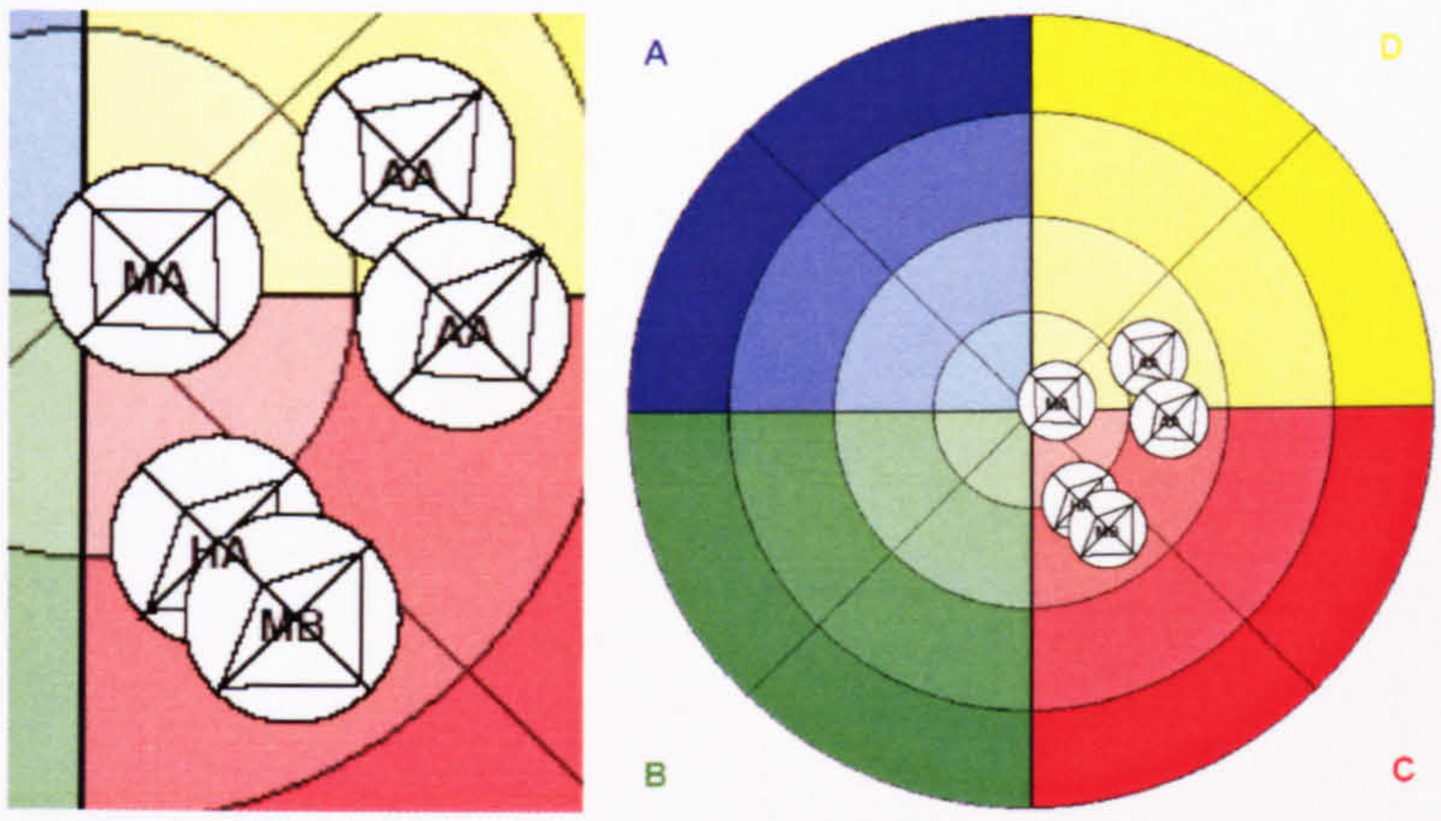


Figure 7.41 Circular continuum for Team Number 70

7.6 A COMMENTARY ON TEAM PERFORMANCES

It is useful to comment on the characteristics of the performances of the groups of teams, pointing to similarities and differences between them. The commentaries will focus on the types of tower built and the relations (if any) of the HBDI characteristics of the teams. Also, the researcher's observations of group leadership and methods of team working, though limited, are of interest particularly in relation to the dispersion of the team members' HBDI profiles in the Quadrants and the leaders' own profile placements in relation to them.

7.6.1 The five highest teams

The performance of the teams in tower building is summarized in Table 7.41 below.

Team Acheivment Level / F. Score	Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Final Score
1st	9	5	15	72	24	6	0	0	6	78	0	453
2nd	75	4	5	63	15	6	0	2	4	29	0	347
3rd	13	5	0	70	22	6	0	6	0	37	0	331
4th	55	5	0	70	22	6	0	6	0	29	0	323
5th	59	4	5	55	7	5	0	0	5	45	1	316

Table 7.41 The five highest teams' data for the Tower experiment

The towers of the first and the second teams had many similarities. They were both built top-down with the first team using a three-pillar pyramid with a small base, while the second team used a rectangular shape base, but used more sloping pillars with three level cross-supports. Table 7.41 also shows both teams had strong main dominant preferences in the "A" quadrant, while the second dominant preferences of the first team were "B"(69) but at a lower level. The second team also had a strong "B" preference, and both teams had low "C" scores. Hence both teams had a strong analytic orientation that was reflected in clear planning with a focus on structure, with the highest group being very economical with their use of paper resources. All high scoring teams will have built a high tower capable of supporting cans at a relatively high level since these criteria gained the most credit. However the third and fourth highest scoring teams had a different design, used the "antenna" idea to gain extra points for tower height. These ideas are creative and require the team to be open to these ideas. Table 7.42 shows that these teams were more balanced across the quadrant scores, and had the highest "D" (creative) average scores. Finally, the fifth team had a strong organisational "B" (95) score, and a secondary strong dominant analytic preference of "A" (71). The shape of their five level solid tower tends to reflect these characteristics.

Team Acheivment Level / F. Score	Team number	A	B	C	D	A Adj	B Adj	C Adj	D Adj	Lt	Rt	Cr	Lm
1st	9	108	69	47	69	9	5	5	5	60%	40%	61%	39%
2nd	75	117	85	40	51	8	7	5	5	69%	31%	57%	43%
3rd	13	74	84	63	74	7	4	7	5	54%	46%	50%	50%
4th	55	68	78	74	80	6	4	7	6	49%	51%	49%	51%
5th	59	71	95	63	62	5	9	5	6	57%	43%	46%	54%

Table 7.42 Thinking preferences averages for the highest five teams

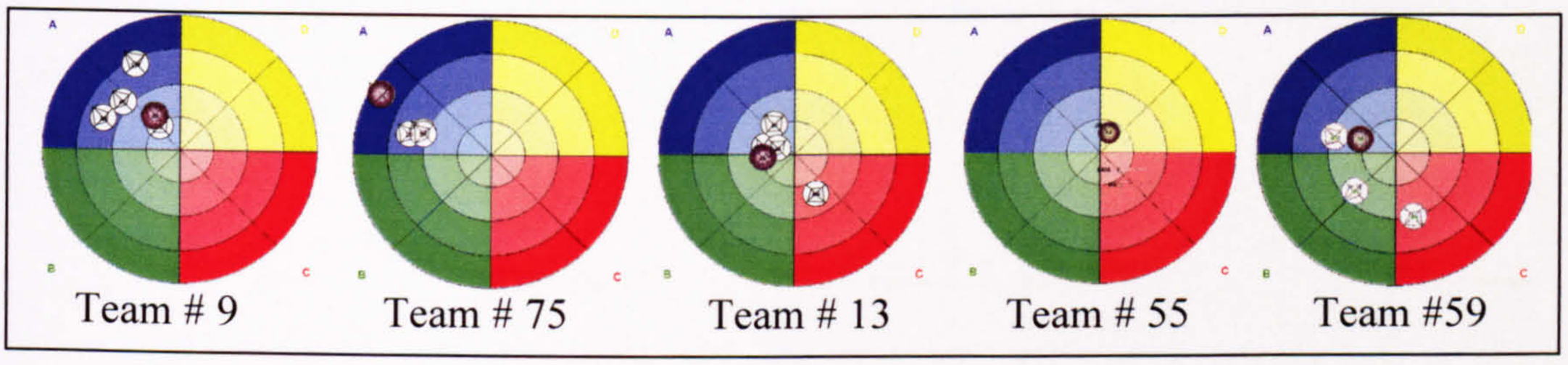


Figure 7.42 Circular continuums for the highest five teams

Team leadership is important in assisting the team to have a clear vision, to resolve differences and to stimulate team members to reach the best possible achievement. The top team was led by Awadh Al-Wariedah who had a Superintendent position, and had strong leadership experience in the company. The second team was led by Jonathan Cole who had the position of General Manager, was experienced in leadership and had a very strong personality. The third team was led by Arshad Abed who (the researcher noted) had to struggle to drive his team. The fourth

team was led by Yaser who held a Managerial position in the company and had a high reputation in the field of IT. Also, the fifth team, led by a very strong leader Dr Al-Bahiri who held the position of Vice President for Planning.

Figure 7.42 shows the placing of the individual team member profiles within the quadrant (*i.e.* the *centre of gravity* as it were of the individual profiles) with the leader's placing shown in black. This clearly shows the top two teams (reading left to right) were strong in the "A" quadrant, as were the leaders, and these teams were homogeneous (with this bias) in their placing. Teams 3 and 5, in contrast, were more heterogeneous, showing greater diversity in the quadrant placings of the profiles. This may have some advantages of greater balance in thinking preferences, but may be more difficult to maintain the group focus. This was the case with Team 3, though the final result was very successful. The strong personality and experience of the Team 5 leader (Vice-President of Planning) again resulted in a strong performance, though the team was quite heterogeneous. The profile of Team 4 shows a balance among the profiles, and the Team Leader was strong in the "D" creative category—and this was a team which produced the antenna solution to gain tower height.

It is also of interest to note that four of the top teams included various nationalities, and all had team members of different ages who came from different departments in the company.

In brief, these data show:

(i) Although all the five teams were high scoring, the characteristics of the towers (under the same criteria) were different. The first team used a top-down building approach with a three pillar pyramid type base; the second used a rectangular base with cross supports; and the fifth team used a solid multi-pillar approach to the building. However the third and fourth teams had differing types of design, using antenna to gain points under the height criteria. This is evidence that the task with its range of criteria could stimulate discussion and enable different designs and tower building.

(ii) An examination of the HBDI profiles suggests that their team characteristics are reflected in the features of their tower building. The first two teams had strong A profiles (analytical preferences) with considerable homogeneity among the team members (see Figure 7.42), whereas the third and fourth teams were more heterogeneous showing a balance between preferences but with strength in the D (creative) quadrant. These were the teams using unconventional antenna to achieve the height criterion. The fifth team was also

heterogeneous but strong in the B (organisational) quadrant, and their solid tower design perhaps reflected this in its conventional but well constructed design.

(iii) A common characteristic of the teams (which had participants who varied in age, nationality and working departments in the company) was good leadership—often reflecting senior positions and experience in KEMYA. This seems important with homogeneous teams, to ensure that biases (*e.g.* analytic strength) are directed or turned to the task objectives in ways which give room for creativity, and for strong heterogeneous teams (*e.g.* Team 3) to ensure that differing views and ideas are brought to an agreed focus.

7.6.2 The six low scoring teams

As Table 7.43 shows, the sample of six low scoring teams experienced problems in designing towers to hold cans at even medium heights: the three lowest teams in the Table only loaded one can between them. Team 61 built a high tower (56 inches) that would only support one can; in contrast, Team 15 supported six cans, but in a tower that was only 11 inches high. In brief, the teams showed poor planning and an implementation that used relatively few paper resources and supported few cans.

Team Acheivment Level / F. Score	Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
52nd	61	4	0	56	8	1	0	1	0	79	5	166
57th	15	4	8	11	0	6	0	0	0	82	0	161
63rd	12	5	0	50	2	2	0	2	0	32	4	134
77th	18	4	1	31	0	0	0	0	0	68	6	82
80th	71	5	0	18	0	0	0	0	0	30	6	30
81st	72	4	8	0	0	1	0	0	0	18	5	21

Table 7.43 Performance scores of six low scoring teams

The summary of the teams' thinking preferences shown in Table 7.44 indicates that although teams (*e.g.* Teams 61, 15 and 18) had some preferences in the "A" and "B" (analytic and organisational quadrants), these were not pronounced and overall these teams had relatively well balanced profiles, though with no very high preference scores. Perhaps more important was the relative lack of experience and leadership in these teams. In fact none of the leaders held high managerial positions in the company (in contrast to the top high scoring teams), and the two lowest performing teams were trainee employees, *i.e.* well qualified but of limited experience within the company. Further, all the low scoring teams were local nationals—with the exception of Team 12 which had one Indian. Hence, in this respect the composition of the teams was homogenous, a feature which is illustrated in Figure 7.4.3.

Team Acheivment Level / F. Score	Team number	A	B	C	D	A Adj	B Adj	C Adj	D Adj	Lt	Rt	Cr	Lm
52nd	61	87	78	64	74	8	5	6	5	54%	46%	53%	47%
57th	15	88	85	51	62	8	8	4	5	61%	39%	52%	48%
63rd	12	72	93	81	50	6	6	8	3	56%	44%	41%	59%
77th	18	81	92	63	55	8	6	7	3	59%	41%	47%	53%
80th	71	72	81	77	69	8	7	6	4	51%	49%	47%	53%
81st	72	70	91	72	58	7	7	7	4	55%	45%	44%	56%

Table 7.44 The average thinking preferences for the six low scoring teams

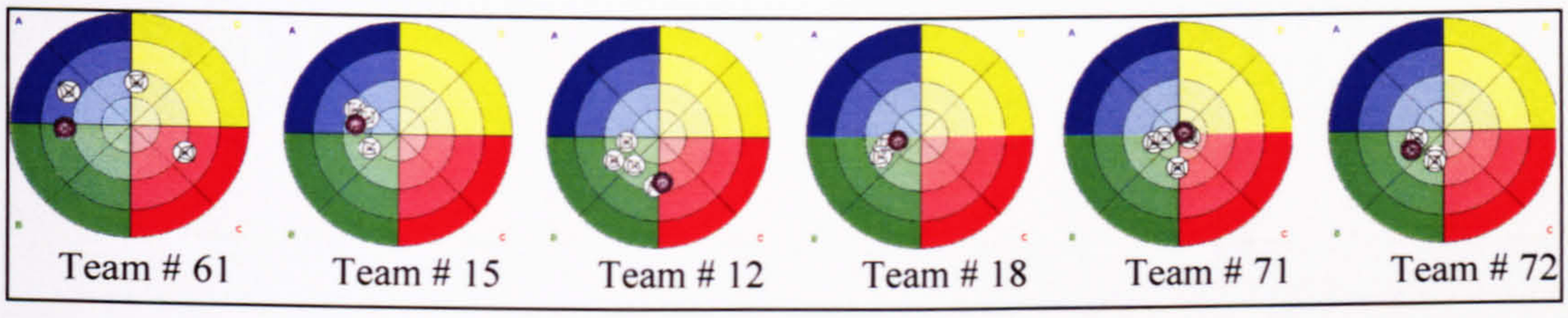


Figure 7.43 Circular Continuum Profiles for the six low scoring teams

Figure 7.43 is interesting. It shows the placing of the team profiles, and that of the leader in relation to the group. With the exception of Team 61 (the highest of the low scoring sample) which had a heterogeneous distribution of the group, all the remaining teams had homogeneous distributions, but with. the team members' profiles were placed relatively close together, including the team leader. There were differences within this generalization, for example, Teams 15 and 18 showed some "A"-"B" bias, Teams 12 and 72 a slight "B" bias, with Team 72 having a profile centrally placed with no clear defining characteristic. Perhaps then such homogeneous teams tend to be more restricted in the range of their ideas and viewpoint, and when leadership is not strong the direction of the discussion and the work can become diffuse. For these groups, the researcher noted a lack of urgency and competitive interest in their conduct.

In brief, the results show:

(i) The performances of tower design and building were low, and made relatively poor use of resources. The teams either produced towers that would support very few cans or, if cans were supported, the tower was low. The one high tower could only carry one can.

(ii) Although showing some slight bias in the A and B quadrants, the HBDI profiles showed no score was in the very high category and, as Figure 7.3 indicates, the team profiles tend to cluster around the centre. They are homogeneous (composed of local nationals) but with no pronounced strength in any quadrant.

(iii) The other noticeable feature of the low scoring teams was the absence of strong and experienced leaders. This seems to be influential, particularly when the teams have no strong bias to generate ideas and give direction to the thinking approach, and where the leadership seems to have difficulty providing this stimulation and progression.

7.6.3 The six medium performing teams

Table 7.45 shows that five of the six medium performing teams had loaded the six cans, but these were at a low height and only Teams 76, 8 and 14 placed cans between 3 to 4 feet. Also, all the teams did not use all the paper resources; indeed, Teams 70 and 14 saved over forty sheets, and Team 16 saved over eighty sheets—the highest among all the 81 teams. Three teams had very long towers (Team 70 had a tower length of 70 inches but could only support cans at a low height. Team 8 had a tower length of 69 inches but supported only three cans at a moderate height. Team 76 had a tower length of 57 inches but again only supporting the five cans at a moderate height.) There were three teams had the "antenna" idea. In contrast, the shortest tower was only 14 inches in height which accounts for the large amount of unused paper resources. It is worth noting also that five of teams all completed the building, presumably to their satisfaction or capacity, before the allotted time.

In brief, the weaknesses of the medium performing teams were an inability to produce a strongly built tower that would support cans at a high level. They were not able, in their planning and implementation, to make good use of all the resources, and produced towers which were not easy to improve or redesign (an important factor), hence not all the resources or the time available were used.

Team Acheivment Level / F. Score	Team number	No. of members	Saved minutes	Tower Length	Inches > 4[Ft.	Cans loaded	Cans b/ 1-2 ft	Cans b/ 3-4 ft	Cans b/ 5-6 ft	unused paper	Unused Cans	Score
8th	70	5	0	70	22	6	6	0	0	47	0	281
10th	76	4	4	57	9	6	1	5	0	22	0	271
20th	16	4	14	14	0	6	6	0	0	86	0	234
24th	8	5	7	69	21	3	0	3	0	22	3	221
33rd	14	4	10	32	0	6	2	2	0	45	0	207
50th	81	5	10	30	0	6	6	0	0	10	0	170

Table 7.45 Summary of performance scores for the six medium performing teams

Table 7.46 summarises the thinking preferences of the groups and shows that they had diverse profiles. Although Teams numbered 76 and 8 showed strong "A"-"B" scores, Team 8 had a strong "D" preference and, in general, the teams tended to show a balance across the thinking preference scores, with few instances of a pronounced focus within a particular preference quadrant. Figure 7.44 provides a graphical representation of the team placings, with the leader being shown as a small black circle. It should be noted that none of the leaders held a high management position within the company so, in this respect, their experience was limited; also, Team 70 included people who were trainees in the company.

Table 7.46 and Figure 7.44 show Team 70 was a homogeneous team tending towards "C" (interpersonal) and "D" (creative) quadrants, and their tower was tall with an antenna, but lacked strength in the supporting levels. Team 76 was homogeneous with a bias towards the "B" (organisational segment); Team 16 was again homogeneous with the leader stronger in the "A" and "D" quadrants.

Team Acheivment Level / F. Score	Team number	A	B	C	D	A Adj	B Adj	C Adj	D Adj	Lt	Rt	Cr	Lm
8th	70	53	76	82	88	5	4	9	6	43%	57%	47%	53%
10th	76	82	104	66	44	7	9	6	3	63%	37%	43%	57%
20th	16	87	69	68	74	8	5	7	5	52%	48%	54%	46%
24th	8	95	73	57	72	7	5	6	5	57%	43%	56%	44%
33rd	14	84	68	69	63	7	6	7	4	54%	46%	51%	49%
50th	81	68	83	75	64	5	6	7	6	52%	48%	45%	55%

Table 7.46 The average thinking preferences for the six medium performing teams

Teams 14 and 81 (the lowest of the six teams) were again homogeneous and centrally placed with very little quadrant bias, as were the leaders. In contrast, Team 76 was a better performing group—heterogeneous but with the leader tending towards the "B" thinking preference though low in the "D" quadrant, and Team 8, again a better performing group was also heterogeneous (see Figure 7.44).

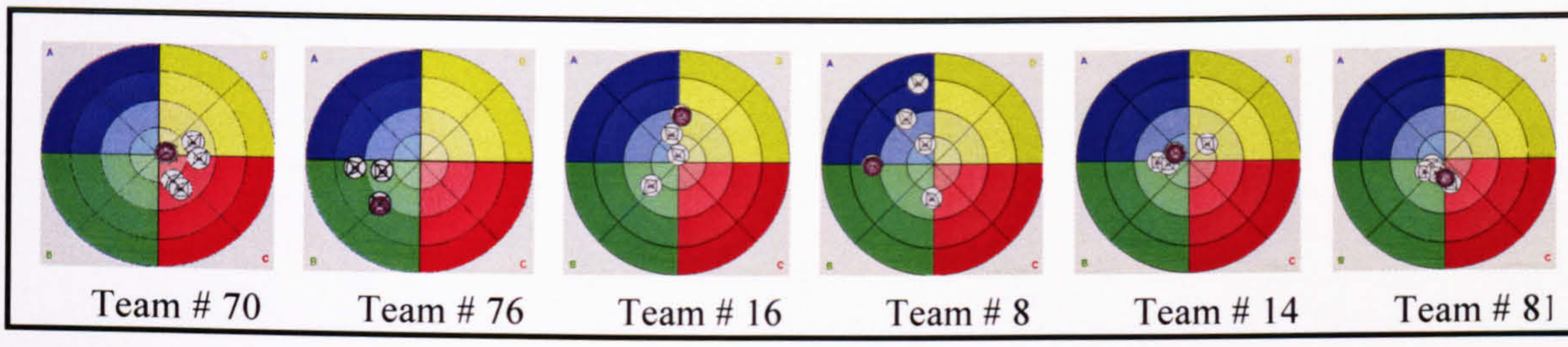


Figure 7.44 Circular Continuum profiles for the six medium performing teams

The deficiencies of the medium scoring teams have been noted and, in general, the leadership of these teams lacked experience. Also, the teams (with two exceptions) tended to be homogeneous without pronounced bias towards a particular quadrant, and this also applied to the leaders' profiles. In these respects, these teams tended towards the characteristics of the low performing, rather than the high performing groups. Perhaps, though, this tentative conclusion should be treated with some caution; leadership is important and the types of groups performing well seem to be those which are homogeneous (including the leader) but with a strong bias in thinking preferences which can be turned or focused to suit the problem (*i.e.* either analytic or creative) or heterogeneous (with strong values in the thinking preferences) and where the leader is experienced and can fuse and direct these qualities to the problem. Where leadership is weaker, or inexperienced, and the team is homogeneous but without strong preferences (*i.e.* the profiles are centrally placed) performances tend to be weaker.

In summary, these data show:

(i) The tower building performances tended to produce towers that supported cans, but only at moderate heights. A further point of interest was that the teams tended to finish before time, and did not use all available resources. This suggests they placed greater importance on the minor criterion (*i.e.* bonus points for economical use of time and paper resources) but also that they produced towers which were not easy to amend and improve.

(ii) In relation to the HBDI profiles, the two lowest scoring teams in the group were homogeneous with moderate levels in all quadrants. Of the other teams two were also

homogeneous in character, though Teams 76 and 8 were more heterogeneous in their make-up.

(iii) Leadership seems important and, in general, leaders in these teams lacked experience. Where leaders' profiles showed no strong bias, and this was reflected in the teams' HBDI scores, then teams seemed to lack direction and a focus to the tower designs (*e.g.* not sufficient prioritising of criteria) and in the building (*e.g.* not easy to incorporate improvements when the tower was built and when time and paper resources were still available).

7.7 THE TRAINEE QUESTIONNAIRES

Since they were taking employees away from the workplace, the training schemes had to have the agreement of, and fit within, the organizational priorities of the company. Hence, training time had to be used efficiently. Following the conclusion of the problem-solving exercise, at the end of the course, it was possible to give the team their performance marks and hold a brief discussion. In addition, and for some teams it was possible to give participants a self-report questionnaire. This asked a series of rating questions with space for brief commentaries: *(i)* on their perceptions of the success of the team; *(ii)* the difficulties they experienced in tower design and building; *(iii)* their successes and difficulties in working as a team; *(iv)* how they viewed their dominant thinking style in the problem solution; and *(v)* the types of contributions and interactions within the working group.

Eight of the seventeen teams reviewed in the previous section were able to complete these questionnaires and these results are discussed below. Note that in completing the questionnaires, the participants were asked to give their frank and honest opinions. The researcher reminded them that all the information would be regarded as confidential.

7.7.1 The Highest Scoring Team: Team 9

The responses of the team members to the first five questions have been summarized in Table 7.47. Reading down the columns gives the ratings and responses of each individual member of the teams

Sl.#	Questions	Team Members					Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	Kees Kijkuit	A. Al-Ghamdi	Chris K.Morgan	Leader Awadh Al-Waridah	Ibrahim Al-Noshan	
1	How successful was your group in the problem-solving task?	5	5	5	5	5	5.0
2	What were the difficulties your group experienced in doing the task?						
	Lack of enough time	X					20%
	Lack of implementation abilities						
	Lack of creative ideas						
	Other reason		NA	Should have talked one last time to maximize every area	It was very smooth,we didn't test it with six can	NA	
3	How successful was your group in working as a team?	5	5	5	5	5	5.0
4	What were the difficulties your group experienced in working as a team?						
	Lack of consensus						
	Lack of listening to each other						
	Lack of effective participation	X					20%
	Other reason		NA	None	Good	NA	
5	What do you consider to be your main dominent thinking preference in solving the task?						
	Analytical thinking	X	X	X	X	X	
	Organizational Thinking						
	Emotional Thinking						
	Visionary Thinking						

The Highest Scoring Team (Team Number 9) scored 453

Table 7.47 Summary data on the first five questions of the survey sheet for Team 9

Table 7.47 shows that, in general, the feedback was very positive. In the Question 1 all of them rated the group problem-solving of the task as "excellent", which was certainly correct. With regard to Question 2, there were comments on lack of time with suggestions that the design could have been further checked and tested, even though they had submitted their final work 15 minutes before the end. Concerning Question 3, all of them rated their team working as "excellent", again a true statement. In Question 4 under "difficulties" Kees Kijkuit selected *"lack of effective participation"* but this opinion was not shared, and the team leader (Awadh Al-Waridah) gave this assessment as "good" indicating there were no difficulties in his opinion. Finally, in Question 5, all of them chose "Analytical Thinking" as their main dominant thinking preference in solving the task, which was accurate in their analysis and implementation of the problem, and which also coincided with the dominant HBDI preference scores of the team.

The last two items of the questionnaire addressed the team members' perceptions of their own and other members' contributions and interactions within the group. The results are summarized in Table 7.48.

Q #	Name	Team Members				
		Kees Kijkuit	**A.Rahman Al-Ghamdi**	**Chris K.Morgan**	**The Leader Awadh Al-Waridah**	**Ibrahim M.Al-Noshan**
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?					
Team Members	Kees kijkuit	4	5	5	4	5
	Coments			Challenged to improve		
	A Rahman Al-Ghamdi	2	4	5	3	5
	Coments			Questioned to verify		
	Chris K Morgan	5	5	5	5	5
	Coments			Conveyed knowledge,tried to pull team together		
	Awadh F Al-Waridah	4	5	5	5	5
	Coments			Keep Focus		
	Ibrahim Noshan	2	5	5	3	5
	Coments			Team player		
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?					
Team Members	Kees kijkuit	4	5	5	4	5
	Coments			Kept design discussion going for continued improvement		
	A Rahman Al-Ghamdi	4	5	5	4	5
	Coments			Team Player		
	Chris K Morgan	5	5	5	4	5
	Coments			Conveyed several ideas,but willing to optimize from suggestion		
	Awadh F Al-Waridah	4	5	5	4	5
	Coments			Keep focus-Pushed to parallel the task for faster time		
	Ibrahim Noshan	4	5	5	4	5
	Coments			Performer of the task agreed upon		

Table 7.48 Survey sheet for the level of contribution and the interaction of team members (Team 9)

In (Table 7.48) Question 6, the first team member—Kees Kijkuit—had rated his contribution and level of interaction as *"good"* but gave lower ratings to A Rahman Al-Ghamdi and Ibrahim M Al-Nosham. But these judgements, although receiving some support from the team leader, were not confirmed by the other members. Chris K Morgan rating Al-Ghamdi "Questioned to verify" and described Al-Nosham as a "Team player". Morgan himself was highly rated and his perceptive comments and his all-round contribution reflect not only his strong "A" HBDI profile, but his strong scores on the other quadrants—namely, organizational and imaginative.

Reading down the columns, in Question 7 all members gave "good" or "excellent" ratings of their cooperative interactions, and these judgements were confirmed by the other team members. This was clearly a successful team that worked well together, and recognized this. Again, Chris Morgan gave useful comments and insights into some of the features of their working. Note also that the leader, and Kees Kijkuit tended to be slightly more conservative in the ratings of their own and other contributions.

7.7.2 The third highest scoring team: Team 13

Sl. #	Questions	Team Members					Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	Leader Arshad	Khalid S.Al-Sager	Yaser Al-Hawl	Mohd. Al-Huwaimal	Majed Al-Subhi	
1	How successful was your group in the problem-solving task?	4	5	5	4	4	4.4
2	What were the difficulties your group experienced in doing the task?						
	Lack of enough time		X	X	X		60%
	Lack of implementation abilities	X				X	40%
	Lack of creative ideas						
	Other reason		Not enough time during implementation				
3	How successful was your group in working as a team?	5	5	5	3	4	4 4
4	What were the difficulties your group experienced in working as a team?						
	Lack of consensus						
	Lack of listening to each other						
	Lack of effective participation	X			X		40%
	Other reason		Too many ideas in short time	Arabic		None	
5	What do you consider to be your main dominent thinking preference in solving the task?						
	Analytical thinking	X	X	X			
	Organizational Thinking				X		
	Emotional Thinking						
	Visionary Thinking	X		X		X	

Table 7.49 First five questions of the survey sheet for Team 13

Table 7.49 shows their feedback was generally positive. For example, two members rated their problem-solving of the task as "excellent" and the other three (including the leader) rated it as "good" which accurately reflects the team's performance. However, in Question 2, three of the team members selected "lack of enough time" as one of the difficulties they faced in doing the task, and the researcher noted the team tended to discuss suggestions, comments, and ideas, and

this impeded implementation to some extent. This was noted earlier in Section 7.5.3 of this Chapter where it was stated that the plan was changed and an antenna hastily put in to gain the height points. Note also that the team had multi-dominant thinking preferences. Concerning Question 3, three participants (including the leader) rated "excellent" the work as a team, but Mohd Al-Huwaimal only gave a "Satisfactory" grade; and in Question 4, about the difficulties that the group experienced in working as a team, the leader and Al-Huwaimal selected "lack of effective participation". Mohd Al- Huwaimal also made the same selection, and Khalid Al-Sager commented that there were too many ideas presented in too short a time.

Perhaps this reflects the heterogeneous multi-dominant thinking preferences of the group and relates to the selections made in Question 5 which noted "Visionary" as well as analytical thinking.

Q #	Name	Team Members				
		The Leader Arshad D Abed	Khalid S.Al-Sager	Yaser A.Al-Hawi	Mohd. Al-Huwaimal	Majed H.Al-Subhi
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?					
Team Members	Arshad D Abed	4	4	5	3	5
	Coments	Leader	Bossy,an initiative to take lead & guide them to certain way	Ideas,discussion		Leading
	Khalid S Al-Sager	5	4	5	5	5
	Coments	Implementor		Ideas		Ideas,hands on
	Yaser Al-Hawi	3	3	4	4	3
	Coments	Quiet		Building,Drawing the design,Ideas for the tower,Listening from others		Hands on
	Mohd Al-Huwaimal	4	5	5	4	3
	Coments	Ideas, Implementor		Ideas		Hands on
	Majed H Al-Subhi	5	5	5	5	4
	Coments	Ideas		Ideas		Ideas,hands on
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?					
Team Members	Arshad D Abed	4	4	4	3	5
	Coments					
	Khalid S Al-Sager	5	4	5	4	4
	Coments					
	Yaser Al-Hawi	3	4	4	3	3
	Coments					
	Mohd.Al-Huwaimal	4	5	5	4	3
	Coments					
	Majed H Al-Subhi	5	5	5	4	5
	Coments					

Table 7.50 Survey sheet of the level of contribution and the interaction of team members (Team 13)

In the questions related to team contributions summarised in Table 7.50, the leader (Arshad Abed) rated his contribution and interaction level as "*good*". Other team members had rated him "good" or "excellent", except Al-Huwaimal who gave him "satisfactory". He was perceived as leading with ideas and discussion (he considered himself an analytic and visionary thinking), but also as being "bossy".

The second member (Khalid Al-Sager) rated his contribution and interaction level as "*good*", team members also rated him highly, describing him as having "ideas", and "being an implementer".

Regarding the third member (Yaser Al-Hawi); he had rated his contribution and interaction levels as "*good*". Some team members (reading across the row) gave him slightly lower ratings. In addition, he was described as "Quiet", but—"Building, drawing the design, contributing ideas for the tower, listening to others"—hardly seems to be quiet.

The fourth team member (Mohd. Al-Huwaimal) rated his contributions and interaction level as "*good*", and two team members gave him slightly higher ratings. In addition, he was described as "good on ideas" and a "hands-on implementer".

The fifth team member (Majed H.Al-Subhi) also rated his contribution and interaction level as "*good*", but all of the team members rated him as "excellent". In addition, three members described his contribution as providing "ideas" but also being "hands on". For this person and other team members, these ratings and comments seem in line with their HBDI thinking performances. The team was multi-dimensional in these preferences and the strong leadership (though attracting a comment of bossy) led the team which generated many ideas "in a short time" to a very good performance.

7.7.3 One of the lowest scoring teams: Team 15

Sl. #	Questions	Team Members				Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	Fayez Al-Dausari	Ahmed Y Al-Thawadi	Majed Al-Naeem	The Leader Abdulla Bin Jalal	
1	How successful was your group in the problem-solving task?	4	4	4	4	4.0
2	What were the difficulties your group experienced in doing the task?					
	Lack of enough time	X	X	X	X	100%
	Lack of implementation abilities					
	Lack of creative ideas				X	25%
	Other reason		The score criteria was not revised well to define priorities in getting maximum points			
3	How successful was your group in working as a team?	4	4	5	4	4 3
4	What were the difficulties your group experienced in working as a team?					
	Lack of consensus					
	Lack of listening to each other					
	Lack of effective participation					
	Other reason	In Arabic	The concentration of what the agreed upon	lack of emotional	In Arabic	
5	What do you consider to be your main dominent thinking preference in solving the task?					
	Analytical thinking	X	X			
	Organizational Thinking		X	X	X	
	Emotional Thinking					
	Visionary Thinking		X			

Table 7.51 Summary data on the first five questions of the survey sheet for Team 15

Table 7.51 shows that all the team members rated their problem-solving performance as "good" which may indicate that they performed as well as they expected given the task and their abilities. All the team considered "lack of enough time" as a difficulty with a comment that the planning did not focus well enough on the criteria to obtain maximum points, and the leader also noted that "lack of creative ideas" was another difficulty. These comments reflect the fact that the team did not focus on the structure of a high tower but on other low scoring issues, such as saving unused sheets of paper (they saved 82 sheets). However, in the Question 3, three of them (including the leader) rated their team working as "good", and one rated it "excellent" and without any selection of the main types of difficulty encountered.

This seems to imply the team listened to each other in a harmonious way, but there were comments about the Arabic language and a lack of concentration on what they agreed, *i.e.* making changes and following through agreed ideas and Majed also noted a "lack of emotional participation". In Question 5, Fayez and the leader chose the same dominant preference as their main dominant HBDI thinking preference, but Al-Thawadi had selected analytical, organizational and visionary thinking as his main thinking preferences in solving the task but, referring to his HBDI profile details, we see that he didn't mention his third strong preference "C" (interpersonal). Majed selected his second thinking preference "B" on his HBDI profile as his main dominant thinking preference in solving the problem. So, in general, these choices of their perceptions of thinking preferences in the collaborative problem-solving exercise were fairly well in line with their HBDI data.

Q #	Name	Team Members			
		Fayez M Al Dausari	Ahmed Y Al-Thawadi	Majed A Al-Naeem	The Leader Abdulla Ali Bin Jalal
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?				
Team Members	Fayez M Al-Dausari	4	4	5	4
	Coments		Good in criticizing	He is good in construction	he contributed in the work
	Ahmed Y Al-Thawadı	4	4	5	3
	Coments		Almost everybody's participation based on his background.	He is very patient	His contribution was partial
	Majed A Al-Naeem	5	4	5	4
	Coments		Good in Engineering		He was initiative in proposing the design
	Abdulla Alı Bın Jalal	5	4	5	3
	Coments		Major role in design concept.	He is excellent in management	As a team leader
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?				
Team Members	Fayez M Al-Dausari	5	3	5	4
	Coments			No engineering science	Contributed effectively
	Ahmed Y Al-Thawadi	4	3	4	4
	Coments			Out of the box	Contributed effectively
	Majed A Al-Naeem	5	4	5	4
	Coments				Contributed effectively
	Abdulla Ali Bin Jalal	5	4	5	4
	Coments			Not emotional	Contributed effectively

Table 7.52 Survey sheet of the level of contribution and the interaction of team members (Team 15)

Table 7.52 shows that the first team member (Fayez-Duasari) rated his contribution as "good" and level of interaction "excellent". Reading across the row, we see that other team members also rated his contribution as "good", except Majed who rated him as "excellent", though in the interaction level data he is generally given lower ratings. The comments indicated Fayez was "good in criticizing" and in "construction" (although he was not an engineer), but the leader considered him a good and effective contributor—though the leader made the same comment about all his team.

The second member (Ahmed Y Al-Thawadi) rated his contribution as "good", and his level of interaction as "satisfactory". In general, team members agreed with Al-Thawadi, noting that other interactions came from or were stimulated by his viewpoints. Al-Nazeem rated him excellent and "patient", though the leader only considered his contribution as "partial". Regarding Al-Thawadi's level of interaction, all of them rated him as "good", except himself who gave a grade of "satisfactory".

The third member (Majed A Al-Naeem) rated his contribution and level of interaction as "excellent". Others rated him slightly lower but commented he was "a good engineer and showed initiative". Similar gradings were given for group interactions and cooperation.

The team leader rated his contribution as "satisfactory" and levels of interaction as "good". Al-Thawadi noted he took a "major role in the design concept"; Al-Naeem rated him "excellent in management" which run counter to the leader's more modest self-assessment.

Overall, compared with the higher performing groups, the assessments tend to be a little lower, but generally were judged to be "good"—perhaps indicating the group made its best efforts, but there were recognized errors in design and occasional differences in the perceptions of participants' contributions and interactions.

7.7.4 One of the lowest scoring teams: Team 12

Sl. #	Questions	Team Members					Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	The leader Jarallah Al-Qahtani	Alaa S.Al-Hamal	Basher M.Asri	Mohd. Al-Ghamdi	Subbanna Balepur	
1	How successful was your group in the problem-solving task?	3	2	3	3	3	2.8
2	What were the difficulties your group experienced in doing the task?						
	Lack of enough time						
	Lack of implementation abilities	X				X	40%
	Lack of creative ideas		X	X	X		60%
	Other reason			Analysis was not enough	Not enough analysis		
3	How successful was your group in working as a team?	5	3	5	5	4	4 4
4	What were the difficulties your group experienced in working as a team?						
	Lack of consensus						
	Lack of listening to each other						
	Lack of effective participation						
	Other reason	Didn't understand the scope of the project from the first time	The selection of the idea for design was not good	There was not a person to create/analysis the design selected	NA	Constructive ideas were missing for a final decission	
5	What do you consider to be your main dominent thinking preference in solving the task?						
	Analytical thinking				X		
	Organizational Thinking		X	X			
	Emotional Thinking	X	X			X	
	Visionary Thinking						

Table 7.53 Summary data on the first five questions of the survey sheet for Team 12

In the first question (see Table 7.53) all the team members rated the problem-solving of the task as "*satisfactory*", except Alaa who rated it as "*moderate*" which is a more realistic appraisal of their performance. In listing difficulties the team experienced, two members noted "*Lack of implementation abilities*", and the other three members "*Lack of creative ideas*" (which matched their HBDI profiles), together with the comment that there was not enough analysis. On the other hand, the team considered they were very successful (with high excellent/good ratings) in working together as a team. However, although the group feelings were positive, they noted difficulties of not understanding the scope of the problem, in constructing and selecting ideas for design, and there not being a person to develop the ideas selected. A comment here on a lack of leadership—and note that in the HBDI data on thinking preferences this was a clustered heterogeneous multi-dimensional team. In the fifth question, which asked about perceptions of their thinking preferences employed on the task, the leader chose his second dominant HBDI preference "C"; Alaa chose his first and second dominant HBDI preferences "B" and "C". Basar also chose his main dominant preference "B", but Al-Ghamdi and Sabbanna chose their third and

fourth dominant preferences. Some suggestion therefore that some team members were not effectively using their strong preferences in terms of the HBDI data,but they could be adjusting their contributions to the requirements of the problem. Overall (see Question 5), the distribution among the preferences reflected the HBDI placings in the B and C quadrants (see Figure 7.27).

Q #	Name	Team Members				
		The leader Jarallah Al-Qahtani	Alaa S.Al-Hamal	Basher M Asri	Mohd.S.Al-Ghamdi	Subbanna Balepur
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature					
Team Members	Jarallah Al-Qahtani	4	4	4	4	4
	Coments		in implementation			
	Alaa S.Al-Hamal	3	3	3	3	4
	Coments	Trying to come up with new idea	Brainstorming was not effective must to have more ideas			
	Basher M.Asri	5	4	3	3	4
	Coments	Working very efficient	in implementation			
	Mohd,S.Al-Ghamdi	5	4	3	3	4
	Coments	Working very efficient & Productive	in implementation		I feel was not providing enough idea	
	Subbanna Balepur	4	3	3	4	4
	Coments	Working with time & What effective they like he did	Bring Ideas			
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?					
Team Members	Jarallah Al-Qahtani	4	4	4	4	5
	Coments					
	Alaa S.Al-Hamal	4	4	4	4	5
	Coments					
	Basher M.Asri	5	4	4	3	5
	Coments					
	Mohd,S.Al-Ghamdi	5	4	4	5	5
	Coments				I was very excited to achieve the goal	
	Subbanna Balepur	5	4	4	2	5
	Coments					

Table 7.54 Survey sheet of the level of contribution and the interaction of team members (Team 12)

In Table 7.54, which summarises data on group contributions and interactions, the team leader (Jarallah Al-Qahtani) rated his contributions and level of interaction as "*good*". All team members agreed with this assessment. Although this matches with the leader's HBDI profile

codes (strong in "B" and "C") and with his own perceptions, in practice the difficulties noted in Question 4 do not show a stimulating and strong leader. The second member (Alaa Al-Hamal) only rated his contribution as "*satisfactory*" and level of interaction as "*good*"; and again all team members rated him almost the same: the leader noted he tried *"to come up with new ideas*". However, his level of interaction within the group was rated higher, which matched his strong HBDI "C" thinking preference.

Regarding the third member (Basher Asri), he rated his own contribution as "*satisfactory*" and level of interaction as "*good*" but the team members rated him higher than this as he was involved in the implementation issues (though the tower design/implementation was weak) and the leader rated his contribution and his level of interaction as "*Excellent*". With regard to the fourth team member (Mohd Al-Ghamdi), he rated his own contribution as "*satisfactory*" (with the comment that he felt he was not contributing enough ideas), and his level of interaction as "*excellent*". Again, team members tended to give him higher ratings.

Finally, the fifth member (Subbanna Balepur) rated his contribution as "*good*" and his level of interaction as "*excellent*", but team members on average gave him lower ratings which showed some variability in the interaction assessments.

This team was multidimensional and homogeneous with a "B" bias, and the researcher noted that decision making was difficult for the leader, with the team appearing to come to the problem from different perspectives. The overall result was a poor performance, but the group feeling was positive and interaction good, even if not well focused and lacking in direction.

7.7.5 One of the lowest scoring teams: Team 18

Sl. #	Questions	Team Members				Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	Salem Al-Khanfer	Mousa Al Shaiki	Aziz Al-Enazi	The Leader Mansor Al-Otaibi	
1	How successful was your group in the problem-solving task?	5	5	2	5	4.3
2	What were the difficulties your group experienced in doing the task?					
	Lack of enough time	X	X	X	X	100%
	Lack of implementation abilities					
	Lack of creative ideas					
	Other reason					
3	How successful was your group in working as a team?	5	4	5	5	4.8
4	What were the difficulties your group experienced in working as a team?					
	Lack of consensus		X			25%
	Lack of listening to each other			X		25%
	Lack of effective participation					
	Other reason	Time & we started			Arabic	
5	What do you consider to be your main dominent thinking preference in solving the task?					
	Analytical thinking		X		X	
	Organizational Thinking	X				
	Emotional Thinking					
	Visionary Thinking			X		

Table 7.55 Summary data on the first five questions of the survey sheet for Team 18

Table 7.55 shows that all the team members rated the problem-solving of the task as *"excellent"* with the exception of Aziz who rated it as *"moderate"*. Objectively the Aziz comment is the most accurate since the team obtained a low score; perhaps then—in rating the success of the team—other factors such as a good team spirit might be influencing the judgements. In the second question, all team members selected *"Lack of enough time"* as a source of difficulty, but the researcher noted that their team plan was not well formed or focused on priorities, so progress was moderate inducing some time pressure. In Question 3, all but one of the participants rated their success in working as a team as *"excellent"*, and Mousa rated it as *"good"*, but against that were comments that a lack of consensus and lack of listening to each other caused difficulties, which hints at a lack of leadership.

Finally, regarding Question 5, Salem chose his first HBDI dominant preference "B" in solving the task; Mousa chose his second dominant preference "A" as did the leader , but Aziz selected his fourth dominant preference as "D". Perhaps this preference (visionary thinking) reflected his attempt to meet the difficulties the group experienced. In fact the HBDI scores showed the group was clustered and homogeneous with a bias to the "B" quadrant, so these perceptions in Question 5 show some variance against HBDI data.

Q #	Name	Team Members			
		Salem M.Al-Khanfer	Mousa K.Al-Shaiki	Aziz Al-Enazi	The leader Mansor Al-Otaibi
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?				
Team Members	Salem M.Al-Khanfer	5	5	3	5
	Coments		He give the idea		
	Mousa K.Al-Shaiki	3	4	2	5
	Coments	He was doing his best to fix the supports	plan to do the job		
	Aziz Al-Enazi	4	4	4	5
	Coments	We used his idea for middle support	He provide the tool		
	Mansor F.Al-Otaibi	5	5	5	3
	Coments	He was the focal leader & advisor of the team	he did the sticking		
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?				
Team Members	Salem M.Al-Khanfer	5	5	4	5
	Coments				
	Mousa K.Al-Shaiki	4	5	3	5
	Coments				
	Aziz Al-Enazi	4	5	4	5
	Coments				
	Mansor F.Al-Otaibi	5	5	5	3
	Coments				

Table 7.56 Survey sheet of the level of contribution and the interactions of team members (Team 18)

In Table 7.56 regarding the first team member (Salem M Akl-Khanfer) rated his contribution and level of interaction as *"excellent"*. This rating was largely confirmed by the team with the exception of Aziz. The second team member (Mousa Al-Shaiki) rated his contribution as "*good*" and level of interaction as "*excellent*" but, although the leader had rated him highly, Salem and

Aziz gave him lower ratings. These judgements were slightly higher for group interactions which gave some matching support for his strong "C" HBDI preference. The third team member (Aziz Al-Enazi) rated his own contribution and level of interaction as "*good*". Others agreed with this and the leader gave him excellent grades. Also, there were two comments from participants: "*We used his idea for middle support*"; and "*He provided the tools*" which primarily relate to implementation issues and matched his main strong HBDI dominant preference of "B". The leader (Mansor Al-Otaibi) rated his contribution and level of interaction as "*satisfactory*", but all the other team members rated him as "*excellent*". This suggests his leadership was appreciated regardless of the low final score.

The next examples discuss the ratings and comments of three medium scoring teams

7.7.6 One of the medium scoring teams: Team 16

Sl.#	Questions	Team Members				Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	Mohd.A Al-Bagawi	Mohd.S Al-Amieri	Abdulla A Al-Hamad	The Leader Abdulla M Al-Meatiq	
1	How successful was your group in the problem-solving task?	4	4	3	5	4.0
2	What were the difficulties your group experienced in doing the task?					
	Lack of enough time		X	X	X	75%
	Lack of implementation abilities		X			25%
	Lack of creative ideas					
	Other reason	Stopping the creative ideas				
3	How successful was your group in working as a team?	4	4	4	5	4.3
4	What were the difficulties your group experienced in working as a team?					
	Lack of consensus				X	25%
	Lack of listening to each other	X				25%
	Lack of effective participation					
	Other reason		The good thing is they worked as a team	No Problem		
5	What do you consider to be your main dominent thinking preference in solving the task?					
	Analytical thinking	X		X	X	
	Organizational Thinking		X			
	Emotional Thinking					
	Visionary Thinking				X	

Table 7.57 Summary data of the first five questions of the survey sheet for Team 16 members

In this medium scoring team, Table 7.57 shows the leader rated the problem-solving success of the team as *"excellent"* but the rest of the team members rated it as *"good"* or merely *"satisfactory"* so, in objective terms, these ratings are slightly optimistic. In response to the second question, *"Lack of enough time"*, was noted as a difficulty even though the team *"saved"* fourteen minutes, and Al-Amieri also selected "*Lack of implementation abilities*" perhaps because Al-Amieri was not satisfied with the small tower the team had built, and Al-Bagawi also noted there was a "*stopping to the creative ideas"*. However in Question 3, all team members rated their work as a team as *"good"* with the leader giving an "*excellent*" rating but, in the next question "*lack of consensus"* and *"lack of listening to each other"* were noted, though in contrast the other two team members commented they *"worked as a team"* and there were no problems.

In Question 5, all team members chose their main dominant HBDI preference as the one they used mainly in solving the problem; in fact the leader selected his main and his second dominant thinking preferences. Note that Al-Amieri, who had a strong organizational thinking preference, commented that the group worked as a team. The leader (Al-Meatiq) also noted his visionary thinking approach, although one team member had commented on his *"stopping the creative ideas"*.

Q #	Name	Team Members			
		Mohd.A Al-Bagawi	Mohd.S Al-Amieri	Abdulla A Al-Hamad	The leader Abdulla M Al-Meatiq
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?				
Team Members	Mohd A Al-Bagawi	4	5	5	5
	Coments	In design the tubes	very good contributor	Very Co-operative & trying the their best to get the best result	Thinking & Imaginative
	Mohd.S Al-Amieri	4	3	5	5
	Coments	In managing	very good contributor	Very Co-operative & trying the their best to get the best result	Support & Provide tools
	Abdulla A Al-Hamad	4	5	4	5
	Coments	General design & to meet the requirement	very good contributor	The group listen to each Other	Give ideas & support implementation
	Abdulla M Al-Meatiq	4	5	5	5
	Coments	In leading & Thinking & gathering ideas	very good contributor	Very Co-operative & trying the their best to get the best result	
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?				
	Mohd.A Al-Bagawi	5	5	5	5
	Coments		Team Work	Very Co-operative & trying the their best to get the best result	Ideas
	Mohd. S Al-Amieri	5	4	5	4
	Coments			Very Co-operative & trying the their best to get the best result	Good in co-ordination & support
	Abdulla A Al-Hamad	5	5	4	5
	Coments		Team Work	The group listen to each Other	Implementation
	Abdulla M Al-Meatiq	5	5	5	5
	Coments		Team Work	Very Co-operative & trying the their best to get the best result	

Table 7.58 Survey sheet of the level of contribution and the interactions of team members (Team 16)

Table 7.58 shows that all the evaluation ratings were between "*excellent*" and "*good*", except the rating of Al-Amieri who noted his contribution as "*satisfactory*". These high evaluations show that team members were happy about their contributions and level of interaction, and this was also reflected in the comments. Mohd Al-Bagawi, commented on the leader "*Thinking and being Imaginative*", and, on his level of interaction he wrote the word "*ideas*". He himself noted design contributions which matched his HBDI profile of strong "A" and "D" preferences. For Mohd Al-Amieri the comments were "*In managing*", and in "*supporting and providing*

tools", with the additional note by the leader that (in interactions) he was "*good in coordination and support*". These comments match his very strong "B" HBDI thinking preference.

In summary, in spite of a medium result in tower building, the general impression is of a team cooperative and interactive in their approach but not producing ideas that were directed at the principal criteria of the task.

7.7.7 One of the medium scoring teams: Team 8

Sl. #	Questions	Team Members					Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	The Leader Salamah S.Al-Nazzal	H.H.Al-Mukhtar	Adel A.Al-Hamad	Sami Mohd.Al-Warthar	Ahmed Al-Shammari	
1	How successful was your group in the problem-solving task?	4	4	3	2	3	3.2
2	What were the difficulties your group experienced in doing the task?						
	Lack of enough time						
	Lack of implementation abilities		X	X		X	60%
	Lack of creative ideas		X				20%
	Other reason	Time was limiting us & was used as measure			No Leadership		
3	How successful was your group in working as a team?	4	3	4	2	4	3 4
4	What were the difficulties your group experienced in working as a team?						
	Lack of consensus		X				20%
	Lack of listening to each other	X	X		X	X	80%
	Lack of effective participation			X			20%
	Other reason						
5	What do you consider to be your main dominent thinking preference in solving the task?						
	Analytical thinking	X	X		X		
	Organizational Thinking				X		
	Emotional Thinking						
	Visionary Thinking			X	X	X	

Table 7.59 Summary data of the first five questions of the survey sheet for Team 8 members

Table 7.59 shows that although the leader and Al-Mukhtar had rated the problem-solving of the task as "*good*", the rest of the team only rated it as "*satisfactory*" or "*moderate*". The reasons given by three team members was "*Lack of implementation abilities*", while Al-Mukhtar noted a "*Lack of creative ideas*". Further comments also concerned leadership, and the leader himself noted that *"time was limiting"*, perhaps showing he was aware of this factor in the difficulties of leadership. There was similar unevenness in opinions on successful team working. Three team members (including the leader) rated teamwork as *"good"*, but the other two again only rated it

as "*satisfactory*" and "*moderate*". In Question 4, about the difficulties that the group experienced in working as a team, Al-Mukhtar noted a "*Lack of consensus*", and four team members selected "*Lack of listening to each other*" with Al-Hamad commented on a "*Lack of effective participation*". These comments point to a team dynamic that was experiencing difficulties in management. In Question 5, Al-Mukhtar and Al-Warthar showed their main HBDI dominant preference (analytic thinking) as the ones they considered they mainly used in the problem-solving, though Al-Warthar also selected his other strong (but weaker) preferences, while the leader and Al-Hamad selected their second strong preferences. However, Al-Shammari selected his fourth and weakest preference "D" (visionary thinking). It is clear from these data, also noted in the team's analysis in the previous section of this thesis, that this was a heterogeneous team in terms of thinking preferences, but where the leader had some difficulties in coordinating engagement between team members.

Q #	Name	Team Members				
		The leader Salamah S.Al-Nazzal	H.H.Al-Mukhtar	Adel A.Al-Hamad	Sami Mohd.Al-Warthar	Ahmed Al-Shammari
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?					
Team Members	Salamah	4	4	4	4	4
	Coments	I was giving ideas with explanation & leisten to others & then discuss consequences		Trying to change the subject in end		Execution of plan & Supervision
	Mukhtar	3	4	4	3	3
	Coments	He was objecting other ideas & assisting his ideas.		Trying to change		Execution & Concerns are good
	Adel	4	3	4	4	3
	Coments	he was accepting any idea &elaborating one each idea.		The contribution is medium & want low team work		Execution
	Sami	4	4	4	3	
	Coments	He was listing & Recommending		Comunicator		Advisory, team encouragement
	Al-Shammari	4	4	4	3	3
	Coments	He was giving ideas & accepting other ideas		Has his own to implement		Initial Plan
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?					
Team Members	Salamah	4	4	4	4	4
	Coments	I was accepting other ideas		Same as above		Took execution
	Mukhtar	4	4	4	4	3
	Coments	He do accept if we explain for him		Same as above		Prepration
	Adel	4	4	4	4	3
	Coments	He was accepting other idea		Same as above		Formalisation,execution
	Sami	4	4	4	3	3
	Coments	He was waiting for final result & recommending		Same as above		Formalization
	Al-Shammari	4	4	4	4	3
	Coments	He was working with the team & recommending		Same as above		Work scope,review,execution.

Table 7.60 Survey sheet of the level of contribution and the interaction of team members (Team 8)

In Table 7.60, the leader (Salamah Al-Nazzal) rated his contribution and level of interaction as "*good*", and this judgement—supported by comments—was confirmed by other team members,

so the difficulties noted earlier on time management and leadership were not raised. In fact the comments gave a good idea of his efforts at leadership. Regarding the second team member (H. Al-Mukhtar), he rated his contribution and level of interaction as "*good*", but other team members tended to give slightly lower ratings on average, and the leader noted, *"He was objecting to other ideas and assisting* (*i.e.* putting forward) *his idea"*, though Al-Shammari noted his "*Execution and concerns are good*" and, in a comment about his interaction (Question 7), the leader noted, "*He accepts after we explain to him*".

The third team member (Adel Al-Hamad), rated his contribution and level of interaction as "*good*" with the team members giving him a slightly lower rating on average. There were two comments on his contribution where the leader noted "*he was accepting any idea and elaborating on each idea*". Note that Adel also commented on himself, "*The (my) contribution was medium as we had a low team work*". Similar ratings and two comments were made about his level and type of interaction. The fourth team member (Sami Al-Warthan) rated his own contribution and level of interaction as "*satisfactory*", but three other team members rated him as "*good*". The leader noted that Sami "*was listing and recommending*", and other comments were about his style as a Communicator, giving "*advisory, team encouragement"*. The last team member (Ahmed Al-Shammari) rated his contribution and level of interaction as "*satisfactory*", but three other team members (and four in the interaction question) rated him as "*good*". The leader noted "*He was giving ideas and accepting other's ideas*". "*He was working with the team and recommending*". Al-Shammari described his own contribution as being directed at "*Work scope, review and execution"*.

The ratings and comments were full, and give some insights into the working of a team that was heterogeneous in terms of the HBDI profiles of its members. Overall, the team felt their cooperation and interactions were satisfactory/good, but there are indications that although the leader tried hard, the team was not easy to manage.

7.7.8 One of the medium scoring teams: Team 14

Sl. #	Questions	Team Members				Mean
	Excellent(5) Good(4) Satisfactory(3) Moderate(2) Poor(1)	The Leader Gasim M Al-Joufy	Ayman Amoudi	Husam Ashmawi	Saad Al-Ghamdi	
1	How successful was your group in the problem-solving task?	3	3	3	3	3.0
2	What were the difficulties your group experienced in doing the task?					
	Lack of enough time			X		25%
	Lack of implementation abilities				X	25%
	Lack of creative ideas				X	25%
	Other reason	We were not very serious & team work was not there at the point.	No Agreement			
3	How successful was your group in working as a team?	3	2	2	3	2.5
4	What were the difficulties your group experienced in working as a team?					
	Lack of consensus			X	X	50%
	Lack of listening to each other	X	X		X	75%
	Lack of effective participation					
	Other reason					
5	What do you consider to be your main dominent thinking preference in solving the task?					
	Analytical thinking				X	
	Organizational Thinking				X	
	Emotional Thinking					
	Visionary Thinking	X	X	X	X	

Table 7.61 Summary data of the first five questions of the survey sheet for Team 14 members

In Table 7.61 all team members, including the leader, rated their problem-solving performance only as "*satisfactory*", which shows they were not well pleased with the team's achievement. "*Lack of enough time*", "*Lack of implementation abilities*", and "*Lack of creative ideas*" were noted as difficulties, and the leader commented that "*We were not very serious and teamwork was not there*". In brief, the team was lacking in creative ideas, implementation directives, and time management. Not surprisingly, in the third question, two team members (including the leader) rated their work as a team as "*satisfactory*", and the other two down-rated it to "*moderate*". These fairly low ratings reflect a lack of group coherence and, in response to the fourth question, Ashmawi and Al-Ghamdi noted a "*Lack of consensus*". Also, two team members and the leader commented on the "*Lack of listening to each other*". In contrast to other groups in the fifth question, all team members selected "*Visionary Thinking*" as the preference

they mainly used in the problem-solving, while Al-Ghamdi selected in addition "*Analytical Thinking*" and "*Organizational Thinking*". However, *Visionary Thinking* was the fourth lowest HBDI preference for all these participants in what was a heterogeneous HBDI team. If all were visionary thinkers in team working, it is not surprising perhaps that coherence in purpose and implementation were difficult to achieve.

Q #	Name	Team Members			
		The Leader Gasim M Al-Joufy	Ayman M Amoudi	Husam H Ashmawi	Saad A Al-Ghamdi
6	How do you assess the contributions of your group members to the problem-solving task? What was the nature of this contribution?				
Team Members	Gasim M Al-Joufy	4	3	4	4
	Coments	I agreed to their ideas without discussion			
	Ayman Amoudi	5	4	4	4
	Coments	Was giving every one time to think			
	Husam H Ashmawi	4	3	4	3
	Coments	Changed his idea			
	Saad A Al-Ghamdi	4	5	3	3
	Coments	Did not understanding the task well			
7	How much do you assess the level of interaction of your group members to the working practices and co-operative social feeling in the group?				
Team Members	Gasim M Al-Joufy	4	5	4	3
	Coments	I agreed to their ideas without discussion			
	Ayman Amoudi	3	5	4	3
	Coments	Listening to everyone and giving him the time to try			
	Husam H Ashmawi	3	5	4	3
	Coments	Gave the final idea to support the task			
	Saad A Al-Ghamdi	3	5	4	3
	Coments	Extended his support		Agreed about every thing	

Table 7.62 Survey sheet of the level of contribution and the interaction of team members (Team 14)

In Table 7.62, dealing with team participation and interactions, the leader (Gasim Al-Joufy) rated his contribution as *"good"*, and two of the team members also rated him the same with Ayman

reducing the rating to *satisfactory"* His own rating of interaction was "*good*", and the other three team members had rated him as "*excellent*", *"good"* and "*satisfactory*". But notice that the leader also admitted, "*I agreed to their ideas without discussion*".

The second team member (Aymen Amoudi) also rated his own contribution as "*good*". Two other members had rated him the same, while the leader rated him as "*excellent*". He also considered his interactions as excellent, but the team gave him lower ratings with the leader making the comment *"He was listening and giving everyone time to think"*.

Husam Ashmawi rated his contribution as "*good*" but, although the team leader agreed, the rest rated him as "*satisfactory*". Also, his level of interaction was self-rated as "*good*", but the other ratings were more variable from "*excellent*" to "*satisfactory*", with the leader making the comment *"He changed his idea but* gave *the final idea to support the task*".

The fourth team member (Saad Al-Ghamdi) rated his contribution as "*satisfactory*"; Ashmawi rated him the same, but the leader considered him as "*good*", and Aymen rated him as "*excellent*". Saad also rated his level of interaction as "*satisfactory"* and, although the leader rated him the same, the rest of the team rated him as "*excellent*" and "*good*". The leader's comments about his contribution noted that he "*Did not understand the task well"*, and Ashmawi had written a comment about his level of interaction as "*He agreed about everything*".

In brief, these data show a heterogeneous HBDI team, perhaps generating ideas but lacking focus and direction in implementation. The levels of interaction and cooperation tended to be rated good/satisfactory rather than excellent, and overall the team produced a moderate performance.

7.7.9 A concluding comment

The questionnaire data is small and expresses opinions, so conclusions must be interpreted with caution, but some differences and patterns of response between the teams are worthy of comment.

In assessing their team performances in the tower building activity, the high scoring groups rated their performances highly but realistically. However the lower performing groups, in general, tended towards optimistic evaluations of good/satisfactory. Perhaps this was because they took a broader view of performance to include team working where genuine efforts were made in a cooperative way and, given all the circumstances, they may have considered that they accomplished what could be expected of them. However, some teams, for example in the medium performing teams, were more realistic in their assessments and tended to note lack of ideas, and weak implementation with some comments that hinted at difficulties in leadership, particularly where groups were heterogeneous in their thinking preferences. This trend was also perceived in some of the difficulties noted by the low performing groups. In contrast, the high scoring teams recorded few problems, and these usually noted lack of time rather than weaknesses in ideas or leadership.

In general, when selecting their types of contribution within teams, participants tended to choose the options which matched their dominant or strong HBDI thinking preferences. However, there were individuals, for example, in Team 14 (a moderate performing group) who chose options that were linked to their weakest preference (typically *visionary thinking*). Perhaps these team members adjusted their contributions to meet what they considered to be the needs of the team, even though this was not their preferred thinking style as recorded by the HBDI assessments.

Overall, groups showed in their comments that they interacted and worked well together, and there were few critical comments. However, some groups did point to difficulties in generating ideas, bringing them to a chosen focus in implementation which underline the responsibilities (and abilities) of the team leaders. These comments, *e.g.* in the Moderate and Low Scoring Teams) seem to hint at, or support, conclusions noted in Section 7.6, namely that where team members are heterogeneous (*i.e.* multidimensional) in their HBDI profiles, but similar to each other, or cluster, in showing no strong level or bias (including the leader)—a homogeneous-

heterogeneous group, as it were—then difficulties in leadership and performance can arise. Perhaps they are too moderate and alike so that their views don't readily find and develop a focus. Hence a strong leader, with a distinct HBDI is needed to stimulate and sharpen their approach. Teams which are homogeneous but with a strong HBDI bias (*e.g.* the high performing teams with high A, or high C bias) can perform effectively if the leader can turn and harness this direction to the task objectives. So too can heterogeneous teams (*i.e.* with high biases among the participants) which will have a wider balance and capability that can be used to good effect, provided there is some authority in the leadership that can move the teams to a coherent and agreed view.

7.8 Conclusions

It is useful at this stage to summarise the interpretations and conclusions which arise from the data of the collaborative problem-solving task.

(i) The seventeen groups studied in detail showed a variety of tower designs. This was to be expected as the criteria were chosen to stimulate discussion on design and use of resources, and permit—even encourage—a variety of approaches to achieving a high score. For example, the five highest scoring teams produced towers, built top-down or bottom-up onto rectangular or triangular bases, and with some teams using antenna to gain credit for tower height. The low scoring teams had limited success, showing a lack of direction in design and sometimes seeming to concentrate on less important criteria, *e.g.* saving resources and time. The medium groups again showed variety in tower designs but failed to achieve very high scores sometimes because their towers were not constructed to allow for amendment and improvement when an initial version of the tower had been built.

(ii) The collaborative teams had different patterns of HBDI profiles which showed some associations with tower building performance. Where teams showed a strong homogeneous profile, even though this had some bias (*e.g.* with very high scores in the A-B quadrants), these teams tended to be successful, as did heterogeneous teams with high profiles distributed round the HBDI quadrants. However, where teams had lower values (clustering round central locations in the circular continuum representation, *i.e.* a type of homogeneous-heterogeneous team), they tended to produce lower and, in some cases, much lower tower building scores.

(iii) The above conclusions should take into account team leadership. Where team leadership was strong, *e.g.* in focusing the high homogeneous profiles on the objectives of the task, or

in coordinating the suggestions of the strong heterogeneous teams, then team performances were invariably high. Where the team leader had lower quadrant scores in line with the homogeneous-heterogeneous teams, then progress lacked direction and performances were limited.

(iv) The self-report questionnaires completed by thirteen teams showed that, almost without exception, they considered that they interacted well and performed satisfactorily. This was clearly not the case with the low performing teams, and suggests they rated their performance on group interactions, rather than the quality of the product, perhaps considering they did the best they could in the circumstances.

(v) An interesting trend shown in the questionnaires was that, in general, participants described their contributions in terms which matched their HBDI profiles. There were some exceptions with team members noting their "visionary thinking" (D preference) realising perhaps that this was required in their particular team.

(vi) Although there were few critical comments reported in the questionnaire, a small number noted difficulties in leadership which reflected and gave support to the conclusion noted in *(iii)* above.

CHAPTER 8

A Summary of the Research and Suggestions for Further Work

8.1 A SUMMARY OF THE RESEARCH

Practical aspects of the research took place over three years from 2001 to 2004 with continual feedback to the company, and with participation in some of their policy decisions related to team selection, training and follow-up developments associated with the research. Indeed at the beginning in 2001, several meetings and presentations of the research aims and prospects took place with senior management executives to discuss the approach and its potential value to the company's innovative ambitions. This took some time, but it was necessary to ensure full commitment of the senior management by involving them in adapting to a strategic vision which would be useful in assisting them to compete in the global economy. Further the training scheme decisions and requirements needed their full support as it involved taking staff away from the workplace.

The main objective of the research was to support the development of an innovative culture within the KEMYA business enterprise. This was considered to be an inclusive responsibility of the workforce, and the approach was to be an investment in the cognitive potential of employees that would stimulate and enable them to be more creative within their company responsibilities. These developments were to be assisted through the thinking preferences indicated by HBDI (which covered analytical, organisational, interpersonal, and creative thinking) linked through training courses, with its practical activities and tools, to creativity and collaborative problem-solving in ways that pointed to the corporate innovative vision.

Hence, as noted in Chapter One, the specific research aims were:

- To examine the HBDI profiles of the workforce in various departments of the company and to consider the implications of these data;

- To design a training course in which the HBDI was related to creative and innovative practices and collaborative problem solving; *and*

- To examine the role of HBDI in the process and performance of collaborative problem solving.

The research was set in the Al-Jubail (KEMYA) petrochemical company and, as preparation for the study, previous research was reviewed. This included a review of developments in large scale business enterprises within a global economy noting the increasing importance of cognitive and personality variables in relation to preferred styles of thinking in problem solving and collaboration working. The review considered the validation of the HBDI and the scope of its applications before confirming this choice for the research, and in a review of creativity, in addition to pedagogical issues, the tools ThinkPak and WhackPack were selected and formed part of the training program. Some related applications of HBDI to training, team building, and innovation within companies were noted, and a distinction made between the use of HBDI to solve relatively small ad hoc problems within companies and the approach of this research which was to establish and to integrate HBDI more widely within the working practices of the business enterprise.

Innovation is not easy to define: it is a cognitive process which happens within people, and perhaps is influenced by their different thinking preferences, but it often arises and takes practical forms from reflection on particular working contexts. This is the reason for introducing HBDI into training schemes and collaborative working in ways which ultimately will, hopefully, stimulate the workforce to utilize their thinking preferences in association with others, leading to a confidence that allows innovative suggestions to be placed before managers. Innovation can result in different outcomes with different people and teams, and it is of interest to examine the effects of different team HBDI profiles on their interactions and performances. This might provide managers with useful guidelines in setting up their cross functional teams. After describing the KEMYA petrochemical company in more detail, Chapters Four, Five and Six set out the experimental program and the summary results are presented below.

8.1.1 The HBDI Analysis

From the research literature review, and a careful reading of Herrmann's theories and methods used to design and validate HBDI, it was decided to use this instrument (a self-report questionnaire) to examine the cognitive/thinking preferences of the KEMYA workforce. Four hundred and fifty two selected employees from all departments and levels of management took part and completed the questionnaire.

As noted in Chapters Three and Five, the petrochemical company was an extremely large enterprise clearly organised in its various branches and administrative levels. It employs an international, multicultural workforce, and has introductory courses so that diverse types of employees can become familiar with, and part of, the company vision. KEMYA has a strong scientific and engineering emphasis—reflected in the qualifications and responsibilities of the workforce—but the company also takes responsibility for marketing and financial policy making and these were significant branches/sections of the business enterprise. Further, the company sets up *ad hoc* cross functional groups with particular objectives and terms of reference usually concerned with quality control and evaluation, financial planning, and health, safety and environmental issues. These groups hold a useful place in the company's development and investment programs.

However, it was noted that the results of the HBDI analysis, replicated to a greater or lesser degree throughout all the samples/sections showed strong Analytic (A) and Relational (B) bias in the thinking preferences of participants. Given the scientific and engineering strengths of the company this result was not unexpected, but it should be noted that the empathic/interpersonal (C) and the innovative/creative (D) were not weak. They showed, in general, moderate strength though these thinking preferences were less dominant.

This has implications, we believe (and the research literature review gave some evidence for this) for the company's efforts to be more innovative in its practices and to encourage the workforce to become more creative in their outlook. Further, the cross functional groups have to work in close collaboration, hence empathic/interpersonal skills could be important, as could the need for a mix of thinking preferences to generate different ideas in discussions. These factors relate to the selection practices of the company, and to the training programs which will be most beneficial to achieving these objectives.

In summary, the analysis has noted:

(i) That employees from all sections of the company showed an HBDI bias towards strength in the A (analytical) and B (organizational) thinking preference quadrants, with relatively weaker profiles in the C (interpersonal) and D (imaginative/creative) quadrants.

(ii) This bias, though expected, showed it would be useful to take account of HBDI data (particularly C/D quadrant scores) when selecting cross-functional and *ad hoc* groups (such as Quality Control, and Health, Safety and the Environment) with responsibilities

that required innovative thinking and empathy with sections of the workforce who will be required to assimilate and act on their decisions.

(iii) The relative weakness in the C/D thinking preference quadrants was useful in designing the training program which needed to focus on understanding HBDI profiles and their utilisation, linked to creativity and creativity training, and to collaborative team problem-solving.

8.1.2 The Training Program

The training program was not always easy to arrange since it took employees away from the workplace, and so the organizational arrangements had to be agreed with management and with the workforce. However, as noted in Chapter Six, eighty one training groups, each of four to six members, were organized in a series of twenty training sessions each of which lasted two days. The training had three main phases. First, there was the introduction to the underpinning theories of HBDI, and an explanation of what the thinking preferences entailed. It was pointed out that HBDI was essentially a cognitive metaphor, and participants were cautioned against considering any preference superior to another. Indeed the aim was to show the value of each kind of thinking preference and how it was useful in collaborations to have contributions from all these preferences. Prior to the training course all members had taken the HBDI questionnaire so the meaning of their profiles could be explained and discussed, again noting the value of each quadrant, and of learning to utilize weaker preferences, and particularly to be aware of the different preferences of others.

All the training themes led to practical activities and the Diversity and Walkabout exercise noted in Chapter Six were focused on these awareness skills. The activities were well received and led to much interest and animated discussion.

A second main theme of the training was the development of innovative thinking and creative skills (with associations to the C and D quadrants of HBDI). Again the meanings attaching to creativity and innovation (referencing the ideas of Torrance and de Bono) were explained and discussed. This led to a variety of practical activities using cards (Whack Pack and ThinkPak) which, in group work, encouraged flexibility and originality in thinking before critical evaluation was called into play. This part of the course was well received, and although informal in its management, did not lose its serious purpose. The important link was the link

between theories and the practical activities, with pointers to how a creative orientation could be valuable in the workplace.

The final theme of the course was to bring HBDI and the creative experience into a collaborative problem solving task, namely the design and building of a high tower capable of supporting juice cans. Careful thought was given to this problem. It had to be accomplished within a time frame; it had to accommodate different approaches to tower design; it should use resources economically within a time constraint. These requirements were noted in an instruction sheet which gave a listing of criteria for the awarding of points—which should stimulate and focus discussion. Finally it was decided to partition the hour given for this task into a twenty minute planning period with forty minutes for the building of the tower. After careful consideration it was decided these times were guidelines and it was not necessary for teams to write down a plan before proceeding to the building because initial ideas and proposals could well be changed as the building experience got underway. Hence the planning period was for the team to discuss the criteria, and consider initial ideas without feeling they had to hold to those ideas during the building phase. This activity was popular and showed some interesting performances, and differences, between teams.

So was the training scheme successful? The scheme had to accommodate, and to some extent be compromised, to suit the working practices of the company, but the groups enjoyed the course, and their comments and interactions within the training sessions showed they considered it of value. The company itself has requested the researcher to continue such training. In brief the course—through its materials, activities, and delivery—was sound, and achieved the objectives of improving awareness of the nature and value of the HBDI thinking preferences. It also developed understanding of creativity, encouraging flexibility, fluency and originality in thinking through the brainstorming activities, and a drawing together and applying of this experience in the collaborative problem-solving task. Further, the course, through its structure and interactive activities, could be adapted to suit particular requirements of the business enterprise and workplace situations, and these contexts and issues were suggested by participants—as well as by the researcher—during the course.

However, from this experience, and considering further courses some comments should be made. First, there are different ways of organizing the course. For example should training focus on particular departments in turn, or should it use a mix of people from different departments. This could be a key issue relating to how the company organizes its internal structures. A mixing scheme has the potential advantage of developing relations across

departments, but the disadvantage of participants then going back to their departmental responsibilities with other colleagues not aware of the consequences that could arise from the training. On the other hand, if training focuses on a particular department, that would leave inter-departmental associations to be developed later. Such issues are a stimulus for further work set within different organisational structures of companies.

A second requirement would be to introduce a stronger leadership component within the training scheme, or become appropriately associated with the scheme if such training were to be restricted to certain levels of management. However the collaborative problem solving experience pointed to the need for such a training element to be reinforced.

A third restriction in the course was the limited time given to the collaborative problem solving activity. This meant that only one exercise was given, and there was little opportunity to discuss with teams their performances and interactions in relation to HBDI in the detail that would have been useful. Hence there was no opportunity for teams to carry this experience and reflection into further types of collaborative teamwork. In brief there was limited time to build up a team rapport or for members to become aware of others capabilities. It is of interest to note that in the questionnaire data the types of thinking which individuals reported to be following and reflected their contributions to the problem task closely followed their HBDI preferences. But there were exceptions, usually noting "visionary" thinking where participants evidently recognized this was what was needed to benefit team performance. These are issues that provide a stimulus for further research.

8.1.3 The Analysis of the Problem Task

Eighty-one teams, with a variety of HBDI profiles took part in the collaborative problem solving. It was not possible within the organizational arrangements to systematically set up teams with differing profiles according to a prescription but as the analysis of Chapter Seven shows there was a diversity of types of team profiles which allowed some interesting comparisons to be drawn. Again organizational difficulties limited the amount of time to discuss results with the teams, but some groups were able to fill out questionnaires which asked about their performance as a team, their own thinking preferences they felt they used, and the

contributions they considered they made. Participants were also asked to rate and comment on the contributions of other team members and on the leadership of the group.

In order to deal with the details of performances within the large data set, selections were made of the five highest performing teams, six lowest performing groups and six moderately performing teams. These data were analysed in Chapter Seven together with the questionnaire data they produced.

In the highest performing groups, teams that were effective showed contrastive HBDI profiles and differences in tower designs though all achieved high scores. The first pattern (shown for example by the highest scoring team) had a high/strong HBDI bias in particular quadrants—for the highest team this was the A (analytic) followed by the B (organizational) quadrant. This gave the team a preference for engaging with the problem that was homogeneous within the team and was closely directed to the design objectives set out in the planning phase. The tower was built efficiently to a convention design starting with the top floor (strong enough to hold cans) with the other floors coming underneath.

However other teams (for example, Team 3) in the highest scoring groups had different and more heterogeneous but strong HBDI profiles. Hence the members varied in their thinking preferences but had a wider coverage in the four quadrants. Their tower designs were different, for example using a tripod structure with an antenna to meet the height criterion. Their approach was less planned and more generative *e.g.* the antennae came in at a later stage when the height difficulty was realized, but the team interacted well, as did others with similar heterogeneous profiles that achieved high scores. Both sets of teams, indeed all the highest achieving group had experienced and strong leaders able to keep the team on task with key objectives in view.

In contrast the lowest achieving teams who, typically, produced low towers supporting few cans with poor use of resources, tended to have HBDI profiles that showed no high bias in any quadrant. Their profiles tended to cover three or four quadrants but at a relatively low level so there was little difference between the group members. In this sense they were homogenous but also heterogeneous across quadrants. The leadership (with similar profiles in the examples considered) also seemed unable to generate a progression with the problem, and although the questionnaire data overall reported satisfactory self evaluations, there were comments in these groups which noted a lack of leadership and initiative. The middle teams varied between these extremes but tended to show the same directions when the same biases in team profiles emerged.

These data are partial (only seventeen of the eighty one teams could be considered in detail) and so the conclusion should be treated with due caution, but the data do suggest that successful teams, whether homogeneous or heterogeneous tended to show strong HBDI scores. However there were differences in the tower designs and the range of ideas which were generated. Those teams who were less successful showed lower scores across the HBDI quadrants—this seemed to limit or impede progression and direction. A second, and perhaps obvious trend, was the importance of team leadership. In the high homogenous A/B group it was easier to keep the teams on track, but if problems were more open-ended or diffuse and required a greater profusion of ideas and creativity it is not clear how effective they would be, compared with, for example, a high HBDI profile heterogeneous group. This is a matter for further research but it is worth noting that the leadership in the high heterogeneous groups was effective, pointing to needs, regulating suggestions which drew a good response from members. Clearly research that was able to record the actual interactions between team members (at a greater level of detail than researcher's notes) should yield interesting insights.

This conclusion is supported by the data from the self report questionnaires completed by seven of the teams. These data were sparse and must be treated with due caution, but the results held some interest. The items asked participants to comment on the nature of their contribution (and those of others in the team) to the collaborative problem solving exercise and on their ways of working. The data tended to show that team members generally operated in accordance with their HBDI thinking preferences, and that their varied interactive contributions benefited from leadership. Closer study and interpretation of leadership roles within varying HBDI groups would be useful, especially if a series of collaborative tasks were introduced to reveal the developing dynamics of the groups and the ways their decisions were authenticated.

During the research and training program the company had been kept closely informed of progress and developments, with the researcher being invited to attend meetings and give presentations to several company committees. However on completion of this first phase of the research it was necessary to discuss with management the issues raised, and the ways the resources and experience could be introduced into the company's practices and related to its policy objectives. The research had initiated a creative and innovative culture within the participants and linked to company objectives, but this culture needed to become consolidated and rooted with the policies and practices of KEMYA. This work is ongoing and is outlined in the next section of this chapter.

8.2 ONGOING WORK AND SUGGESTIONS FOR FURTHER RESEARCH

The research has identified many issues of interest for corporate business which are likely to become more important in the future. Giving more emphasis to considering and utilizing employees' thinking preferences and linking this knowledge to selection, innovation and working practices could benefit not only the business enterprise but the working environment and the value of the employees themselves. Hopefully, this research gives some small support to this claim, and the management of the company also approves and supports this viewpoint, and the use of the HBDI data and its incorporation within the training schemes.

The research has progressed in introducing an innovative and creative culture in the workforce linked to HBDI thinking preferences and collaborative working. However, these culture changes have to be consolidated and given practical applications within the policies and practices of KEMYA. It should be noted, the Innovation is now part of the Critical Success Factors (CSF) of the company and highlighted in their Quality Policy documents. Further, it has been stated that these innovative applications will be supported by:

(i) Developing an HBDI database for employees so that such data can be used when setting up cross functional groups and collaborations within the company, especially when these groups have objectives and terms of reference that engage organisational, interpersonal and creative skills.

(ii) Maintaining a focused training program following the themes discussed in Chapter Six; *and*

(iii) Setting up a suggestion system so that innovative ideas can be brought readily and directly to the attention of management.

These issues and developments are discussed in the following sections.

8.2.1 HBDI Survey of thinking preferences: designing a thinking preferences browsing system

The process of mapping the potential thinking of the workforce is crucial. HBDI is a 120-question survey form which results in a profile of the interviewee preferred thinking styles. To

enable company managers and appropriate personnel to have ready access to such data a prototype browsing system is being developed and evaluated. The researcher is an adviser on this project. The main aim of the thinking preferences browsing prototype is to show authorized managers (superintendent level and above) their subordinates' thinking profiles through the intranet of the company. This will be useful information, particularly in the selection and the formation of collaborative cross functional groups. However data protection will be observed and authorized access granted to employees only under supervision.

The suggested system design features include:

- An online HBDI Survey Form-Filling in English and Arabic. Also, there will be a video orientation session and a help line to answer any queries.

- A secure database to ensure accessibility level for different senior employees to access data on employees under their supervision. Also, there will be permissive access to employees to browse their data and the profile of their line managers.

- Provision of Edit capabilities to add or amend data for new employees or for transfers between departments.

- Electronic Literatures, *e.g.* slides and online courses about Whole Brain thinking and its relation to leadership, motivation, communication, collaborative working and other relevant issues.

Figure 8.1 shows the conceptual design of the Home Page of the system put in an organizational chart format. It shows accessible positions in the company (superintendents and above) so that by clicking on one of those position another organization chart will expand until reaching the required employee's profile. These data should aid the matching of work assignments to a team's HBDI profile, or the profile of an individual. Figure 8.2 indicates how the browser links to the thinking preference profiles. Such a system has now been implemented and will be fully tested in the near future. The utilization of the system will be evaluated in terms of usability, and the ways it affects selection and other practices in the company, ultimately trying to relate these innovations to a Return on Investment.

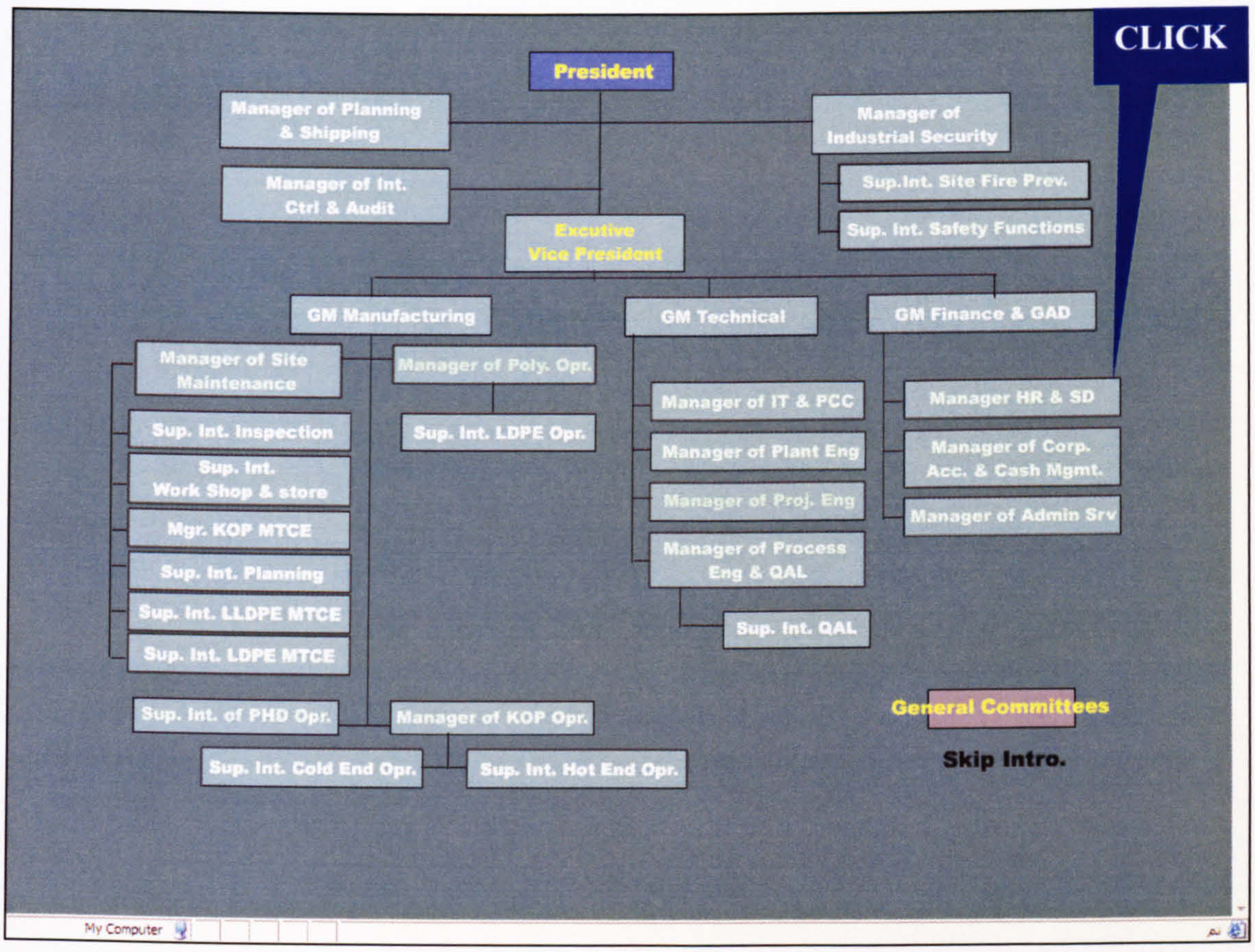


Figure 8.1 The home screen for the Thinking Preferences Browsing

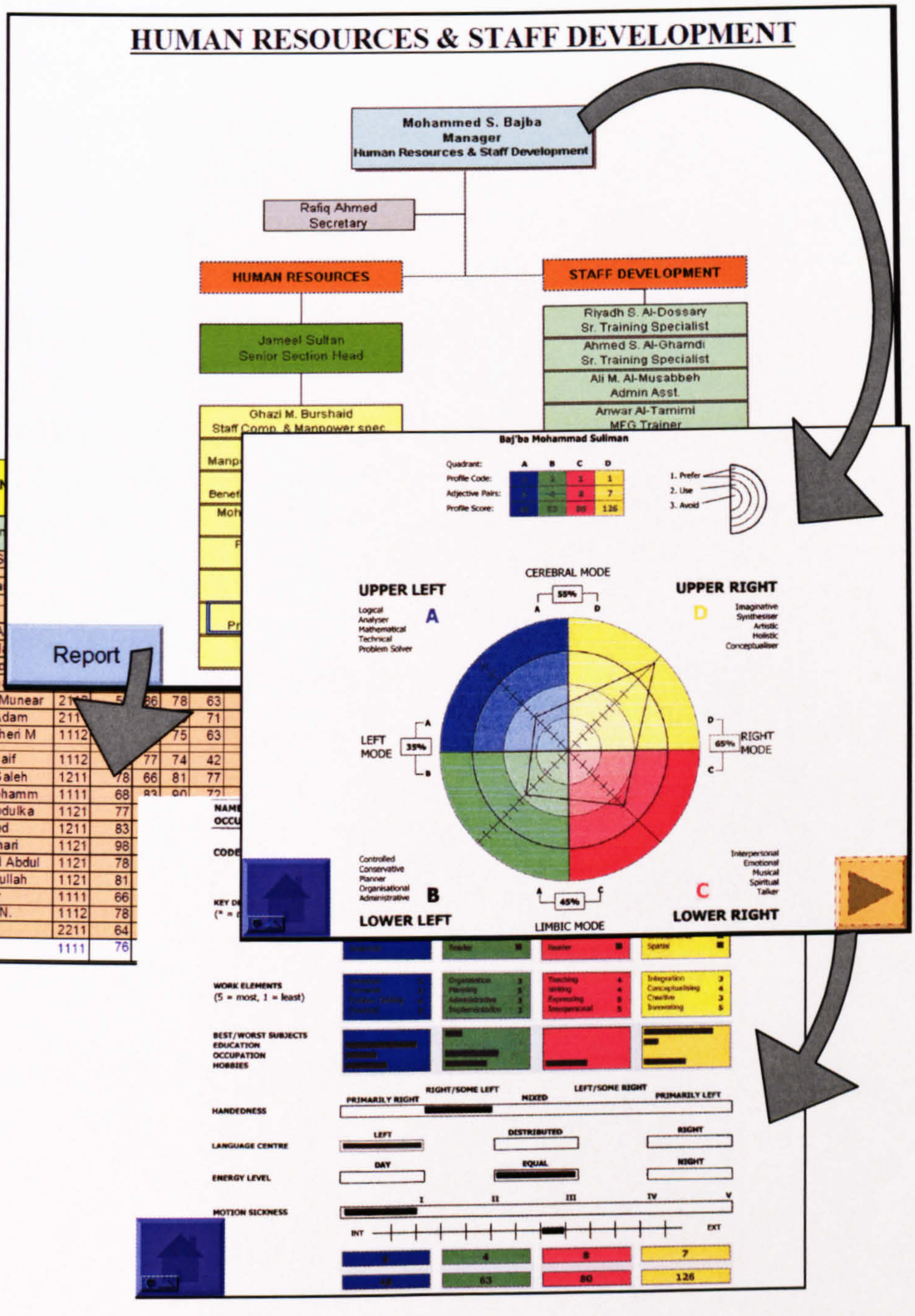


Figure 8.1 Selected screens from the Thinking Preferences Browsing System

8.2.2 Teaching Schemes and Collaborative problem Solving

It was noted earlier that, following the teaching experience recorded in Chapter Six, modifications should be made to the teaching program. Specifically these include *(i)* introducing a component on leadership in relation to collaborative working and the HBDI profiles of participants; *(ii)* greater time being given to the collaborative problem solving component with more opportunities for critical reflection on the experience and its results, and with opportunities for this feedback to be exercised in other different problems which would also contribute to a further building of group cohesion and empathy.

There are two organizational opportunities and modifications which should enrich the research contributions. First, smaller companies with different structures that are less hierarchical are also interested in similar training schemes. This would permit experiments in which training is focused within departments, and can be contrasted where the training brings in participants from different departments. The respective advantages and disadvantages and the resulting effects in the workplace could make interesting case studies. Such studies might also give useful insights in the ways the problems solving teams collaborate and the effects the course organization has on the range of HBDI profiles in the makeup of those teams.

A second opportunity, useful for probing more closely the effects of differing HBDI team profiles and leadership issues on performance, is to collect through video a detailed record of team interactions. This method becomes more tractable with smaller companies. Photographs and some audio records were made in the research reported in this thesis, but the classes were relatively large with several problem solving teams working concurrently so there was no systematic recording of interactions which had to rely of the researcher's observations and the questionnaire data obtained from participants.

With these modifications future research in collaborative problem solving could set up designs to probe interaction patterns linked to HBDI data and leadership. The work could also be extended into several sessions to chart the process of team building and the washback effect on company policies and practices. A longer term and more wide-ranging research study could incorporate the browsing system and the suggestion system (described in the next section) to study the evolutionary process as the innovations come into the company and are tuned to its competitive advantage.

8.2.3 Designing and Evaluating an Advanced Suggestion System

It is not enough to develop and understanding of creativity and innovation. More important is to encourage such practices of constructive thinking in accordance with the different thinking preferences within the workplace. Accordingly an advanced suggestion system is being designed which provides pathways for ideas to be put before managers and other appropriate personnel within the company.

Suggested system design features include:

- Accessibility: Creative ideas might come anytime and posting the idea to the system quickly is very important. So, the computer based system should be capable of easy access, and include perhaps email, document transfer, SMS and telephone voice messages.

- Transparency: all the evaluations of the ideas should be open, credit readily given, but rejections or amendments should be private to the individual or group. This should encourage and motivate all employees to participate as they are assured of the fairness and the integrity of the process.

Again, the evaluation of the system will focus on usability, take-up and satisfaction with the system, and the value of the suggestions which are introduced in terms of a return on investment.

The suggestion system should be accessible from the main screen of KemyaWeb to which employees can submit their ideas and search for participation via keywords. The system should also contain stories of successful ideas that were taken up by the company. Such a system is in embryo form and a screen display is shown in Figure 8.3 below.

It should be noted that the KEMYA company and management supported the innovative program proposed by the research, which has been presented jointly with the Human Resources Manager of KEMYA, at Symposia for Chambers of Commerce in the Eastern Region of Saudi, and to the Saudi Quality Control Council.

Specifically KEMYA has now put in place:

(i) An implemented HBDI database and all new employees at Superintendent level and above will complete the HBDI questionnaire.

(ii) Commissioned continual training following the themes outlined in this thesis (Chapter Six); *and*

(iii) An implemented suggestion system which employees can use to ensure their innovative ideas and contributions can be presented to the KEMYA management. [It should be noted that a tested system is now in full operation in the company and currently over four-hundred suggestions (of various types) have been received.]

Figure 8.2 A screen from the Kemya Suggestion System

In conclusion, it is important that greater attention is given to utilizing the cognitive and innovative resources of employees in an age when globalization and advancing technology are requiring business enterprises to be more innovative and flexible in their organization and

management of the workforce. This research has attempted to show, in a preparatory way, how techniques based on HBDI data, linked to training schemes which introduce creativity and collaborative working can also be articulated or assimilated within existing company structures. Hence its approach is more ambitious than merely using HBDI to overcome small scale or ad hoc problems within a company (useful though this might be) but is less radical than high risk responses to innovation such as downsizing or engaging in takeover bids which require substantial reorganization. Hopefully our approach will encourage other researchers to respond to these challenges, and in this respect it should be noted that several companies have approached the researcher to undertake similar innovative initiatives within their business enterprises.

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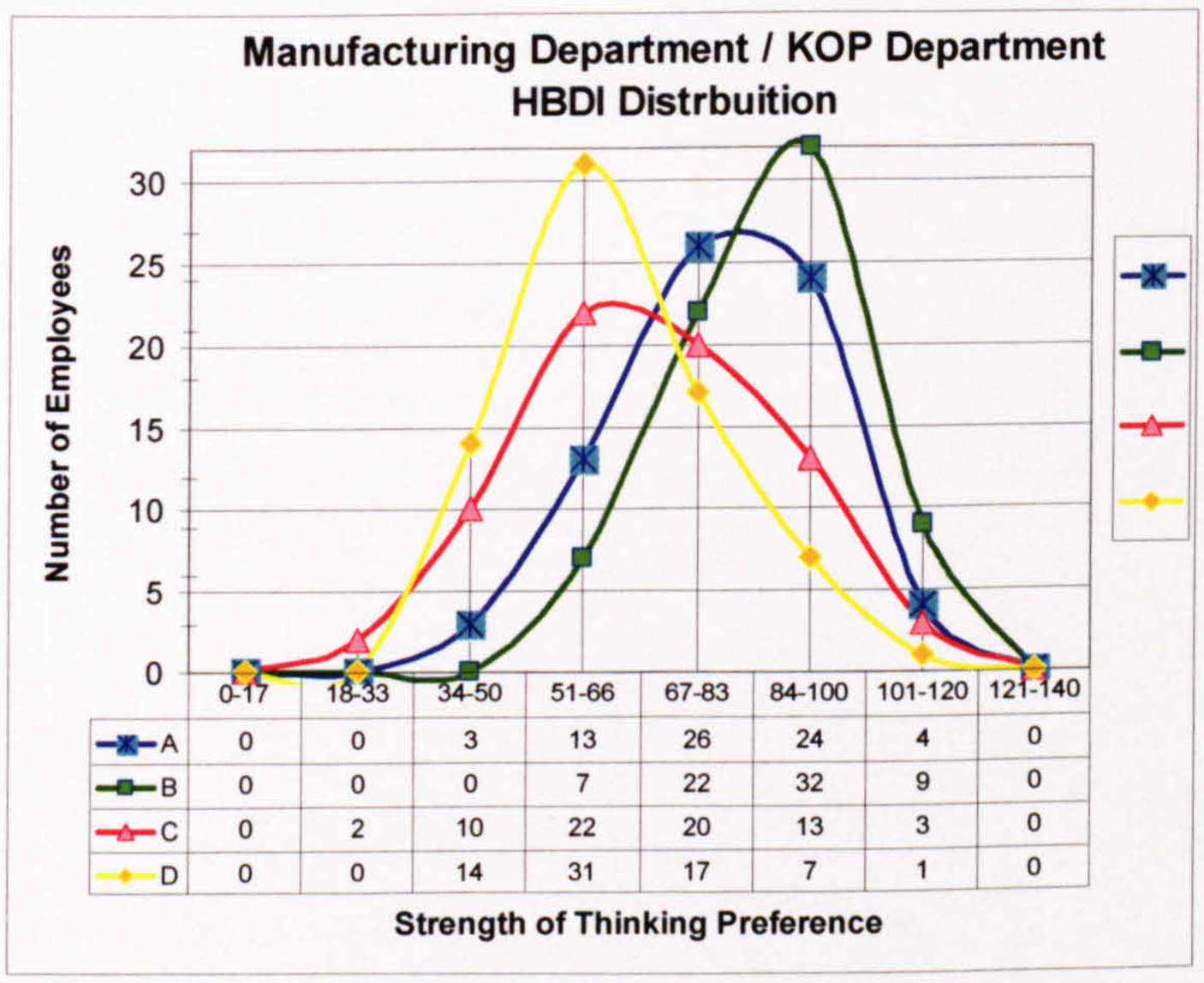
APPENDIX

The HBDI Analyses of the Principal Departments of the Manufacturing Division

1. The Analysis for KOP Department/Manufacturing Division

The HBDI survey was administered to 70 employees in the KOP (Kemya Olefin Project) Department, and the processed data are shown in Figure A1 below.



	0-17	18-33	34-50	51-66	67-83	84-100	101-120	121-140
A	0	0	3	13	26	24	4	0
B	0	0	0	7	22	32	9	0
C	0	2	10	22	20	13	3	0
D	0	0	14	31	17	7	1	0

Figure A1 The HBDI Data Profiles for the KOP Department/ Manufacturing Division

The distributions of the ABCD quadrants scores are relatively free from skew, but the A and B distributions generally show higher scores, and higher mean scores (particularly for the B

distribution) than the C and D distributions. Table A1 shows the Mean, Standard Deviation, and Median scores for these distributions.

	A	B	C	D
Mean	77	86	68	64
Standard Deviation	16	14	19	14
Median	76	89	69	63

Table A1 Summary Statistics of the ABCD Distributions for the KOP Department/Manufacturing Division

In the Very High category (scores >100), the A and B quadrants include 4 and 9 employees respectively, whereas the C and D distributions only contain 3 and 1 employees. In contrast, for the lower classes (below a score of 50) the A and B distributions contain only 3 and 0 employees respectively whereas the C and D scales include 12 and 14 employees. A paired *t*-test shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$). (See Table A2.)

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	77	68	77	64	86	68	86	64
Variance	257	342	257	205	198	342	198	205
Observations	70		70		70		70	
df	69		69		69		69	
t Stat	2.32		4.84		6.40		7.83	

Table A2 Paired Two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

These data confirm that employees are stronger in the left hemisphere thinking preferences in general (with more strength in the B-Quadrant) than the right hemisphere preferences. Perhaps this is to be expected from these employees engaged in the Olefin III Project, started in the last quarter of 2001, since this Department requires technical and procedural skills. The intercorrelations of the HBDI thinking preferences of employees are set out in Table A3.

HBDI Main Scores

	A	B	C	D
A		-0.23	-0.76	-0.16
B			-0.02	-0.42
C				-0.14
D				

Table A3 Thinking Preference Intercorrelations for all KOP Department/Manufacturing Division

As expected, there is a statistically significant ($p<0.01$) negative correlation between A and C, and between B and D scores. Hence those with high analytic thinking preferences tend to be low on interpersonal thinking preferences, and those high on organizational thinking tend to be low on imaginative thinking preferences.

For the KOP employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain *in stress* situations. (See Table A4.)

Adjective Pairs Scores

HBDI Scores	A	B	C	D
A	0.61			
B		0.53		
C			0.68	
D				0.59

Table A4 Intercorrelations between HBDI and Adjective Pairs scores for the KOP Department/Manufacturing Division

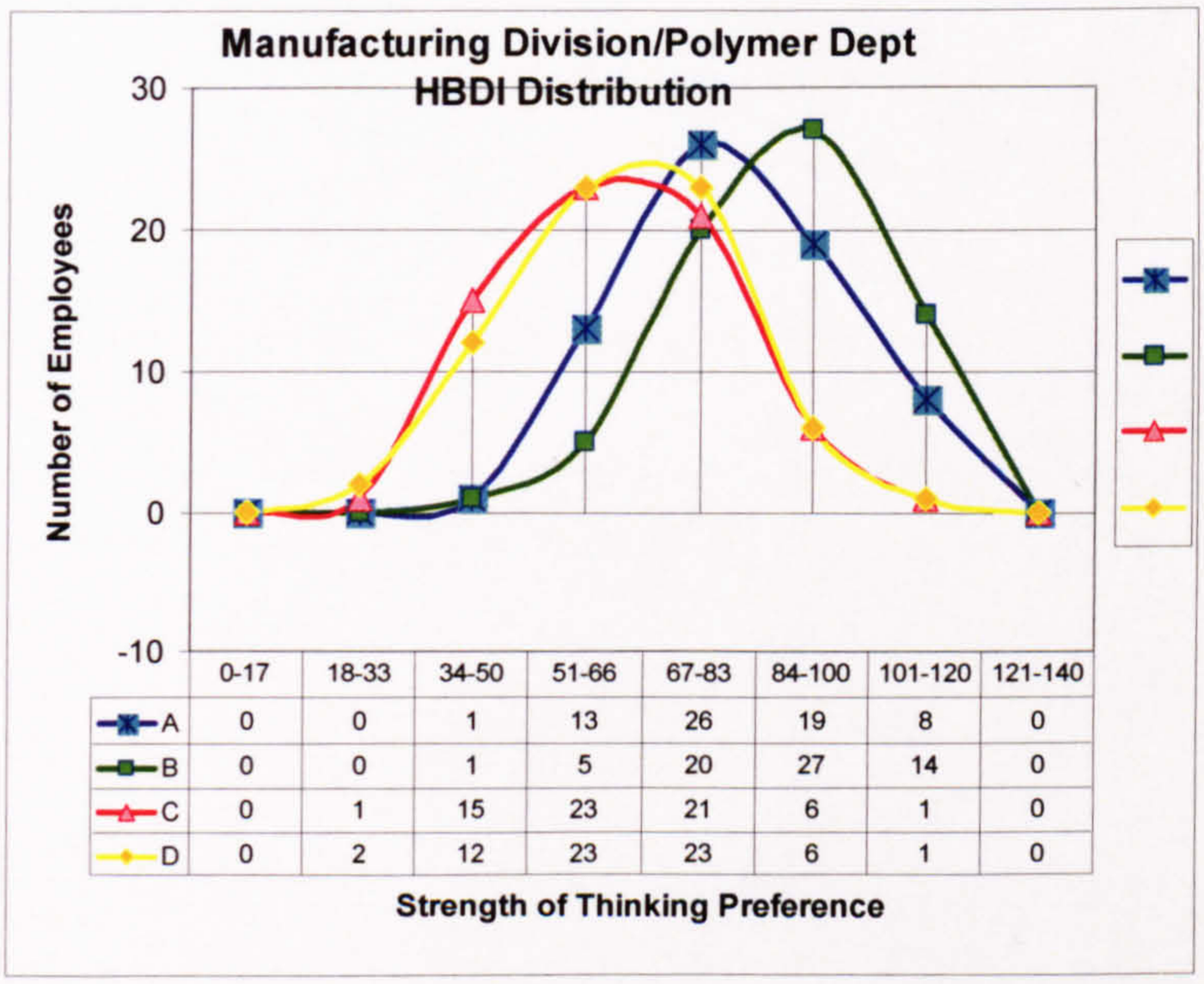
However, although the same intercorrelation pattern between the Adjective Pairs scores remains, there are differences compared with the HBDI intercorrelation (see Tables A3 and A5). The high negative A-C value is reduced slightly, though still statistically significant ($p<0.01$), and the negative B-D value is increased. However, the big change is in the B *v* C value which is now negative and statistically significant indicating these high on organizational thinking seem to become lower on empathic preferences under stress. The other negative correlation values do not achieve statistical significance. (See Table A5.)

	Adj. Pairs Scores			
	A	B	C	D
A		0.16	-0.64	-0.22
B			-0.46	-0.56
C				-0.22
D				

Table A5 Intercorrelations of Adjective Pairs Scores for the KOP Department/Manufacturing Division

2. The Analysis for the Polymer Department/Manufacturing Division

The HBDI survey was administered to 67 employees in the Polymer Department of the Manufacturing Division, and the processed data are shown in Figure A2 below.



	0-17	18-33	34-50	51-66	67-83	84-100	101-120	121-140
A	0	0	1	13	26	19	8	0
B	0	0	1	5	20	27	14	0
C	0	1	15	23	21	6	1	0
D	0	2	12	23	23	6	1	0

Figure A2 The HBDI Data Profiles for Polymers Department/Manufacturing Division

The distributions of the ABCD quadrants scores are relatively free from skew, but again the A and B distributions generally show higher scores, and higher mean scores than the C and D distributions. Table A6 shows the Mean, Standard Deviation, and Median scores for these distributions.

	A	B	C	D
Mean	81	87	64	65
Standard Deviation	15	15	16	16
Median	81	86	63	66

Table A6 Summary Statistics of the ABCD Distributions for Polymers Department/Manufacturing Division

In the Very High score category (>100), the A and B quadrants include 8 and 14 employees respectively, whereas the C and D distributions only contain 1 and 1 employees. In contrast, for the lower classes (below a score of 50) the A and B distributions contain only 1 and 1 employees respectively, whereas the C and D scales contain 16 and 14 employees. A paired *t*-test (see Table A7) shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$).

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	81	64	81	65	87	64	87	65
Variance	237	257	237	268	226	257	226	268
Observations	67		67		67		67	
df	66		66		66		66	
t Stat	4.90		4.90		8.11		6.77	

Table A7 Paired Two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

These data confirm that employees are stronger in the left hemisphere thinking preferences, *i.e.* the analytical, technical, organizational, and procedural styles, than the right hemisphere preferences of interpersonal and empathic, imaginative, and intuitive thinking preferences. Perhaps this is to be expected (particularly the high B quadrant scores) from scientists and engineers engaged in the development and management of the manufacturing processes.

It is of interest to consider the intercorrelations of the HBDI thinking preferences of employees, and the Pearson product moment correlations are set out in Table A8.

HBDI Main Scores

	A	B	C	D
A		-0.21	-0.60	-0.31
B			-0.14	-0.40
C				-0.05
D				

Table A8 Thinking Preference Intercorrelations for the Polymers Department/Manufacturing Division

Again a consistent pattern merges. There is a statistically significant ($p<0.01$) negative correlation between A and C, and between B and D. Hence those with high analytic thinking preferences tend to be low on emotional and empathic preferences in their thinking, and those high on organizational thinking preferences tend to be low on the imaginative thinking preferences. For these employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain under stress. (See Table A9.)

Adjective Pairs Scores

HBDI Scores	A	B	C	D
A	0.39			
B		0.42		
C			0.55	
D				0.56

Table A9 Intercorrelations between HBDI and Adjective Pairs scores for the Polymers Department/Manufacturing Division

However, although the same intercorrelation pattern between the Adjective Pairs scores remains as for the HBDI intercorrelations, the A *v* C, and B *v* D values are somewhat reduced, and the B *v* C and C *v* D negative correlations are now statistically significant (see Table A10). Perhaps this indicates that under stress, although the same associations remain, the preferred thinking characteristics tend to be more prominent with greater negative correlations to the other types of thinking preference.

Adj. Pairs Scores	A	B	C	D
A		-0.09	-0.56	-0.06
B			-0.44	-0.30
C				-0.45
D				

Table A10 Intercorrelations of Adjective Pairs Scores for Polymers Department/Manufacturing Division

NOTE: *These HBDI analyses show similar characteristics between the principal departments making up the Manufacturing Division.*

3. The Analysis for the Finishing and Packing Department/Manufacturing Division

The HBDI survey was administered to 57 employees in the Finishing and Packing Department, and the processed data are shown in Figure A3.

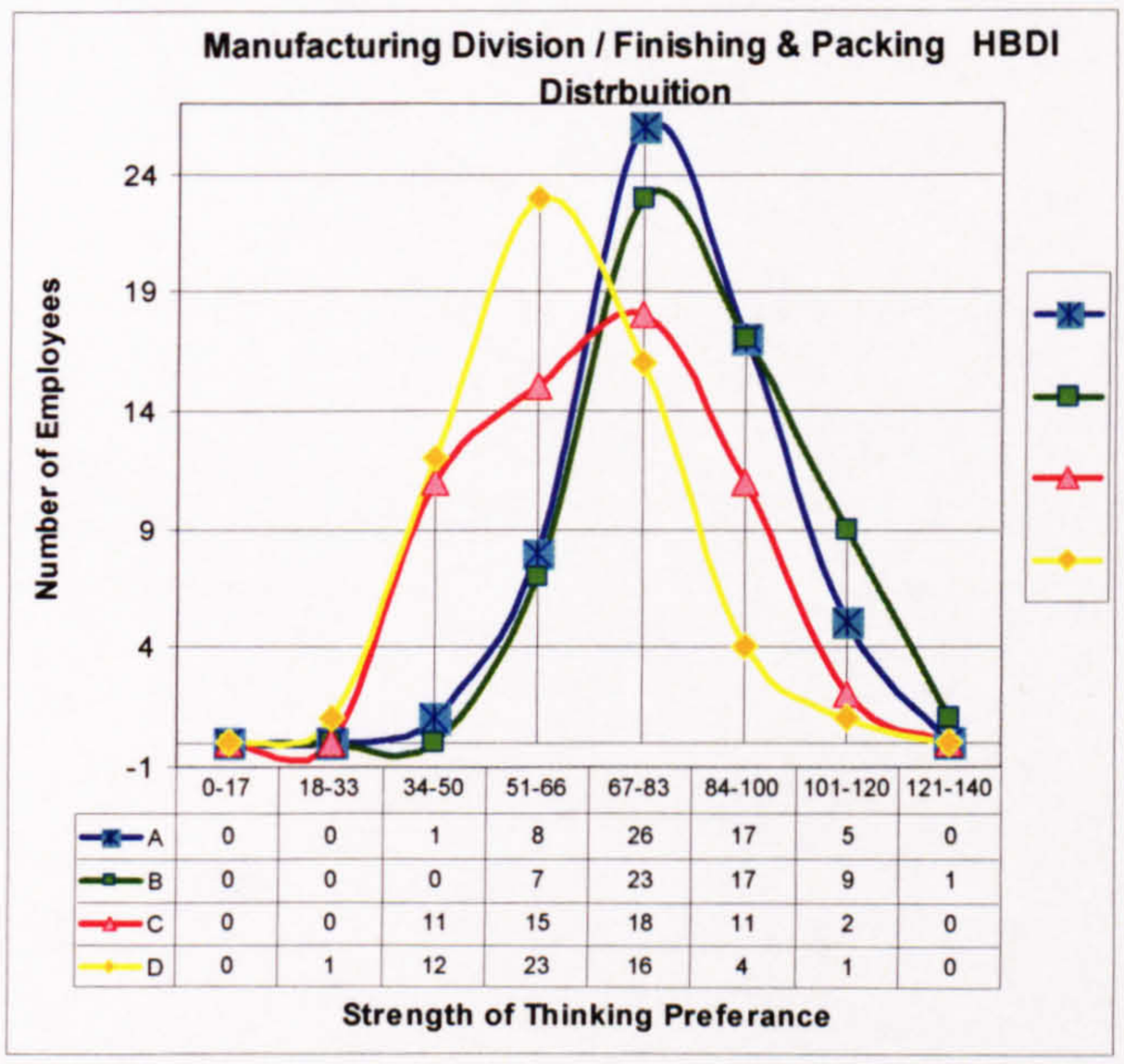


Figure A3 The HBDI Data Profiles for the Finishing and Packing Department/Manufacturing Division

The distributions of the ABCD quadrants scores are relatively free from skew, but the A and B distributions generally show higher scores, and higher mean scores than the C and D distributions. Table A11 shows the Mean, Standard Deviation, and Median scores for these distributions.

	A	B	C	D
Mean	80	85	69	62
Standard Deviation	15	17	17	15
Median	78	83	71	60

Table A11 Summary Statistics of the ABCD Distributions for the Finishing and Packing Department/Manufacturing Division

Scores above 100 are rated as Very High, and in this category the A and B quadrants include 5 and 10 employees respectively, whereas the C and D distributions only contain 2 and 1 employees. In contrast, in the lower classes (below a score of 50) the A and B distributions contain only 1 and 0 employees respectively, whereas the C and D scales contain 11 and 13 employees. A paired *t*-test (see Table A12) shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$).

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	80	69	80	62	85	69	85	62
Variance	229	292	229	233	289	292	289	233
Observations	57		57		57		57	
df	56		56		56		56	
t Stat	2.92		6.82		4.78		6.35	

Table A12 Paired Two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

These data confirm that employees are stronger in the analytic and organizational thinking preferences than the preferences of interpersonal and intuitive thinking. Perhaps this is to be expected in a Finishing and packing department where critical judgements and organizational skills are required.

The intercorrelations of the HBDI thinking preferences of employees and the Pearson product moment correlations are set out in Table A13.

HBDI Main Scores

	A	B	C	D
A		-0.17	-0.76	0.07
B			-0.14	-0.47
C				-0.22
D				

Table A13 Thinking Preference Intercorrelations for the Finishing and Packing Department/Manufacturing Division

Again there are statistically significant ($p<0.01$) negative correlations between A and C, and between B and D scores, indicating those with high analytic thinking and organizational thinking preferences tending to be low on empathic and intuitive thinking preferences. For these employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain under stress (see Table A14).

Adjective Pairs Scores

HBDI Scores	A	B	C	D
A	0.46			
B		0.49		
C			0.60	
D				0.56

Table A14 Intercorrelations between HBDI and Adjective Pairs scores for the Finishing and Packing Department/Manufacturing Division

However, although the same intercorrelation pattern between the Adjective Pairs scores remains, as for the HBDI intercorrelations their negative values are reduced for the A *v* C, and B *v* D values but again the negative values on all the other measures (with the exception of A *v* B) are increased, perhaps again indicating an increased compartmentalization of thinking preferences under stress. (See Table A15.)

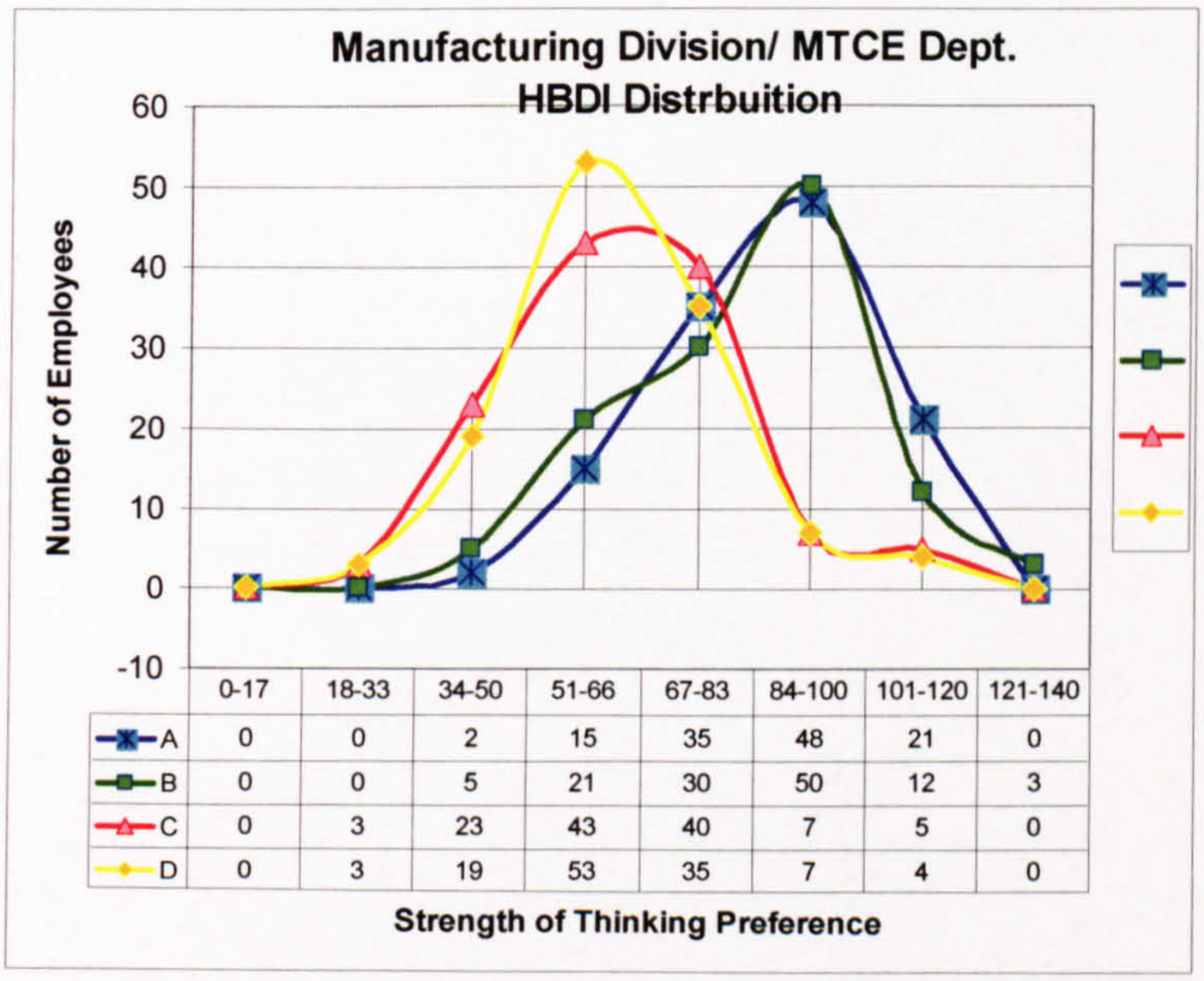
Adj. Pairs Scores

	A	B	C	D
A		0.03	-0.42	-0.46
B			-0.50	-0.30
C				-0.32
D				

Table A15 Intercorrelations of Adjective Pairs Scores for the Finishing and Packing Department/Manufacturing Division

4. The analysis for the Maintenance Department/Manufacturing Division

The HBDI survey was administered to 121 employees in the Maintenance Department and the processed data are shown in Figure A4 below.



	0-17	18-33	34-50	51-66	67-83	84-100	101-120	121-140
A	0	0	2	15	35	48	21	0
B	0	0	5	21	30	50	12	3
C	0	3	23	43	40	7	5	0
D	0	3	19	53	35	7	4	0

Figure A4 The HBDI Data Profiles for the Maintenance Department/Manufacturing Division

The distributions of the ABCD quadrants scores are relatively free from skew, but the A and B distributions generally show higher scores, and higher mean scores than the C and D

distributions. Table A16 shows the Mean, Standard Deviation, and Median scores for these distributions.

	A	B	C	D
Mean	85	83	64	63
Standard Deviation	16	17	16	16
Median	86	84	63	62

Table A16 Summary Statistics of the ABCD Distributions for the Maintenance Department/Manufacturing Division

Scores in the Very High category (>100) show the A and B quadrants include 21 and 15 employees respectively, whereas the C and D distributions only contain 5 and 4 employees respectively. In contrast, in the lower classes (below a score of 50) the A and B distributions contain only 2 and 5 employees respectively whereas the C and D scales contain 26 and 22 employees respectively. A paired *t*-test (see Table A17) shows the differences in the mean scores between A-C, A-D, and B-C, and B-D to be statistically significant ($p<0.01$).

	A	*C*	*A*	*D*	*B*	*C*	*B*	*D*
Mean	85	64	85	63	83	64	83	63
Variance	259	267	259	248	300	267	300	248
Observations	121		121		121		121	
df	120		120		120		120.00	
t Stat	7.77		10.18		8.68		7.51	

Table A17 Paired Two Sample t-Test for means scores between A-C, A-D, and B-C, and B-D

These data in Table A17 confirm that employees are stronger in the analytic and organizational thinking preferences than in preferences for interpersonal and intuitive thinking. Table A.18 shows the intercorrelations (*i.e.* Pearson product moment coefficients) of the HBDI thinking preferences of employees.

HBDI Main Scores

	A	B	C	D
A		-0.29	-0.62	-0.07
B			0.00	-0.53
C				-0.23
D				

Table A18 Thinking Preference Intercorrelations for the Maintenance Department/Manufacturing Division

Again, there are statistically significant ($p<0.01$) negative correlations between A and C, and between B and D. Hence those with high analytic thinking preferences tend to be low on emotional and empathic thinking preferences, and those high on organizational thinking tend to be low on imaginative and intuitive thinking preferences. For these employees, the intercorrelations between the HBDI scores and equivalent Adjective Pairs scores are positive ($p<0.01$) indicating that the same thinking preferences are likely to remain under stress. (See Table A19.)

Adjective Pairs Scores

HBDI Scores	A	B	C	D
A	0.50			
B		0.57		
C			0.59	
D				0.58

Table A19 Intercorrelations between HBDI and Adjective Pairs scores for the Maintenance Department/Manufacturing Division

However, although the same intercorrelation patterns between the Adjective Pairs scores remain, as for the HBDI intercorrelations, their values are reduced (see Table A20), and the negative correlations of B *v* C, and C *v* D achieve significance ($p<0.05$). Similar trends have been noted with the other groups of employees in the Manufacturing and other Divisions of the company.

Adj. Pairs Scores

	A	B	C	D
A		-0.13	-0.49	-0.19
B			-0.28	-0.40
C				-0.47
D				

Table A20 Intercorrelations of Adjective Pairs Scores for the Maintenance Department/Manufacturing Division