

Teams in the Test Tube

Building Team Performance in R and D Organizations

ABSTRACT

Teams are increasingly important in the management of R and D Organizations. However, effective management of teams is a major challenge because of the strongly individualistic and competitive cultures which are typical of many scientific disciplines. The factors which are critical for success in R and D teams, particularly multi-disciplinary teams, are defined, the factors which are most important in distinguishing between highly successful and less successful teams are identified and the application of these findings in the improvement of team performance is described. Sustained performance improvement is demonstrated as a result of carefully targeted, team development interventions.

TEAMS IN THE TEST TUBE

BUILDING TEAM PERFORMANCE IN R & D ORGANIZATIONS

The Importance of Teams in Research and Development

Teams are an increasingly important feature in the structures of Research and Development (R and D) organizations. Although the popular view of scientific research strongly features individual genius and dramatic breakthroughs, the reality is that the process of scientific discovery and knowledge creation is typically characterised by incremental advances contributed by many individuals working cooperatively, sharing information and building on the creative ideas of one another.

Increased use of multi-disciplinary approaches to research requires even greater attention to team processes. Multi-disciplinary teams are becoming more popular because many research problems now require a level of knowledge and expertise or a combination of disciplines that few individuals can provide on their own. A second reason is that many discoveries and innovations are taking place at the intersections of different disciplines. This requires a cooperative approach to sharing information between disciplines and, as Sapienza (1995) points out, a greater understanding between the methodologies, language, culture and paradigms of different disciplines. Thirdly, greater pressure is being exerted on R and D organizations to deliver tangible returns on the investment of both private and public funds. Effective, multi-disciplinary or cross functional teams can reduce R and D cycle times, leading to earlier application or commercialization. Finally, many university, public and private sector research organizations are recognising that their greatest strength and main source of competitive advantage is the diversity of disciplinary skills and knowledge that they can bring together in a single team to address national or industry problems.

The interest in teams in R & D parallels the interest in many other types of organizations. Mohrman, Cohen and Mohrman (1995), based on literature reviews and their own research, identify some generic reasons for increasing use of teams as units of work, particularly in knowledge organizations. The almost universal requirements are for organizations to be more aware of the external environment and market needs or opportunities, to decide quickly on the most appropriate strategy, to implement it rapidly, to learn or acquire new, individual and organizational competencies and to change easily. Flatter organizational structures are seen by many theorists as being more likely to meet these requirements than traditional hierarchies. They also argue that flexible, team-

based structures will be more capable of meeting the combined effects of pressure and complexity than the formal communication channels, rules and prescribed authority that characterize hierarchical structures.

Despite the parallels in other organizations, managing R and D team performance poses a number of special challenges. There are strong elements of competition and individual achievement in the cultures of many scientific disciplines. Interpersonal communication and people management skills are often neglected and sometimes ignored in the training and development of scientists. Finally, there is an overwhelming belief amongst scientists that sheer intellectual horsepower will overcome any possible deficiencies in communication or team processes.

Research on R and D Team Effectiveness

Many social researchers have developed generic lists of factors which are important in work teams. In one of the relatively few studies which has looked specifically at the effectiveness of R and D teams, Taylor, Snyder, Dahnke and Kuether (1995) found that clear and important goals, clean communications and supportive management are key factors. Other researchers have looked at team processes in relation to innovation. Katz (1993), for example, identified the importance of a team culture, political astuteness and strategic linkages between the research team and the business strategy in the development of the Alpha chip at Digital Equipment. However, there is little published research on multi-disciplinary research team effectiveness and the relationship between the “hard” factors such as scientific expertise and the “soft” factors associated with team dynamics.

Purpose of the Current Research

The current research was specifically designed to identify the factors which are critical to the success of multi-disciplinary, scientific research teams and to compare the importance of knowledge and resource based factors with interpersonal and team process factors. The research has two components: a quantitative component which was used to identify and quantify the factors; and a qualitative component which was used to identify and describe the behaviours and team processes used by successful teams in their day to day interactions. This paper provides a brief summary of the quantitative research and provides an example of its application in diagnosing and improving team performance.

Identification of Factors Relevant to R and D Team Performance

An extensive search of the literature on team performance and R and D management was conducted to identify a comprehensive list of factors which were mentioned in relation to the performance of research teams. The list was supplemented by interviews with research leaders and managers of funding agencies in government and private sector organizations. The initial list of more

than 100 items was reduced to 21 factors by combining similar concepts and eliminating the factors which were considered to be less significant by research leaders. A pilot study with a small sample of project leaders resulted in a further reduction to the following 17 factors which have been grouped into four categories. Behavioural definitions of the factors are shown in Appendix 1.

Team Leadership	Team Resources	Team Dynamics	Team Processes
Inspirational leadership	Scientific and technical expertise	Trust	Goodwill and cooperation
Project management	Equipment and facilities	Respect for individuals	Climate for creativity
Clarity of purpose	Information sharing	Conflict management	Team learning
Autonomy in operation	Market/client awareness	Alignment of individual and team values	Group brainstorming
		Appropriate pressure	

The Research Team Effectiveness Questionnaire

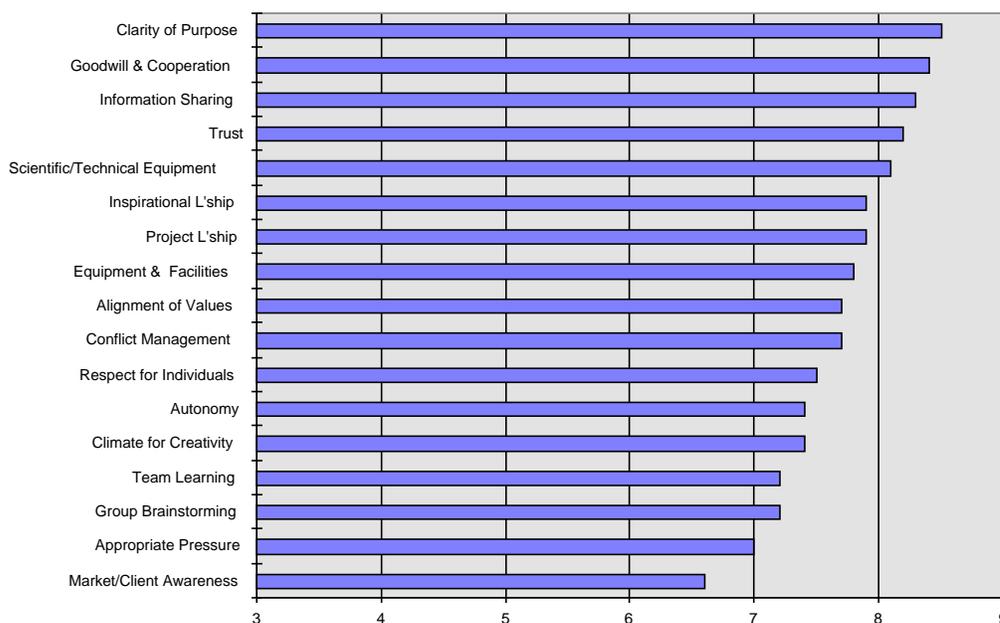
A questionnaire was developed to obtain information about the importance of these factors in research teams. The Research Team Effectiveness Questionnaire (RTEQ) consists of 51, behaviour-based items, with three items addressing each of the 17 factors. The questionnaire uses a seven point, Likert scale to record responses.

The questionnaire was administered to a sample of 250 research scientists working in government agencies and universities. Each respondent completed the questionnaire twice, separated by a period of three to four days. The first time, respondents completed the questionnaire in relation to their most effective, current or recent teams and the second time in relation to their least effective, current or recent teams. "Effectiveness" was defined as "the capacity of the team to achieve its research objectives". (The results are being validated by testing teams which have been rated as highly successful or unsuccessful by independent indicators such as awards, significant patents or premature termination by clients or funding agencies.)ⁱ

Results

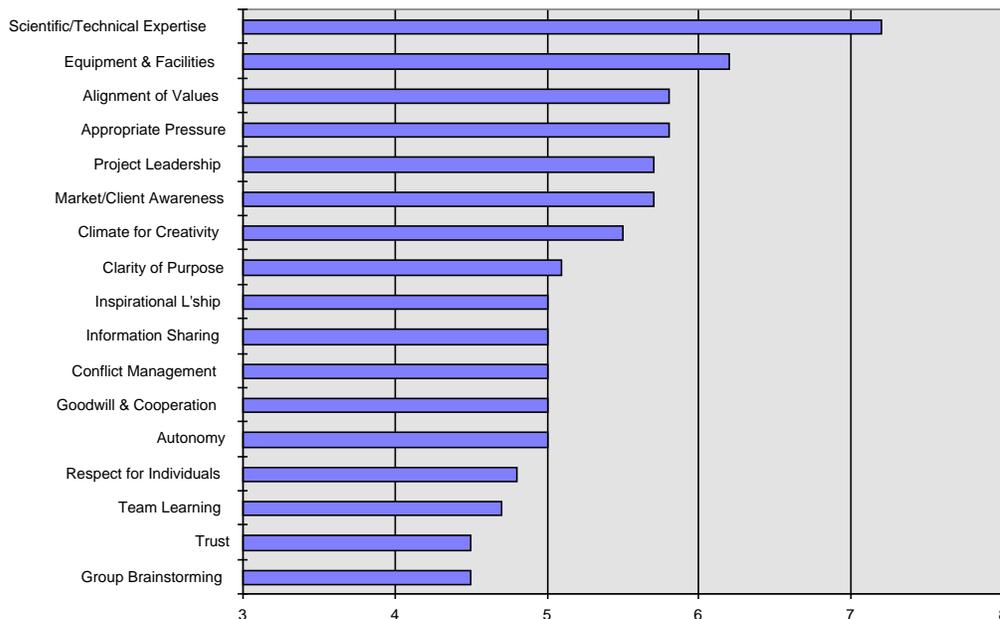
The results for the Most and Least Effective RTEQs are shown in the following graphs. Figure 1 shows the mean scores for responses on the most effective teams. Figure 2 shows responses for the least effective teams. The scores have been normed to 10 for ease of comparison. Figure 3 shows the differences between the normed means for factors in the two populations of teams. A difference of 0.5 or more between factors is likely to be significant.

Figure 1. Most Effective Team Results - Rank Order of Factors



The most effective teams scored highly on all of the factors. The range of mean scores for the most effective teams was 6.7 to 8.5. The highest scores were for **Clarity of Purpose**, **Information Sharing**, **Goodwill and Cooperation** and **Trust**. The lowest score was for **Market/Client Awareness**. The relatively high scores for all of the factors was expected given that each emerged from an intensive screening of factors relevant to team effectiveness. The three categories of factors were distributed fairly evenly throughout the rank order, although all of the leadership factors were in the top third. The difference between the highest scored factor, **Clarity of Purpose**, and the lowest scored factor, **Market/Client Awareness**, was only 18%, confirming that all of the factors are well managed or evident in effective teams.

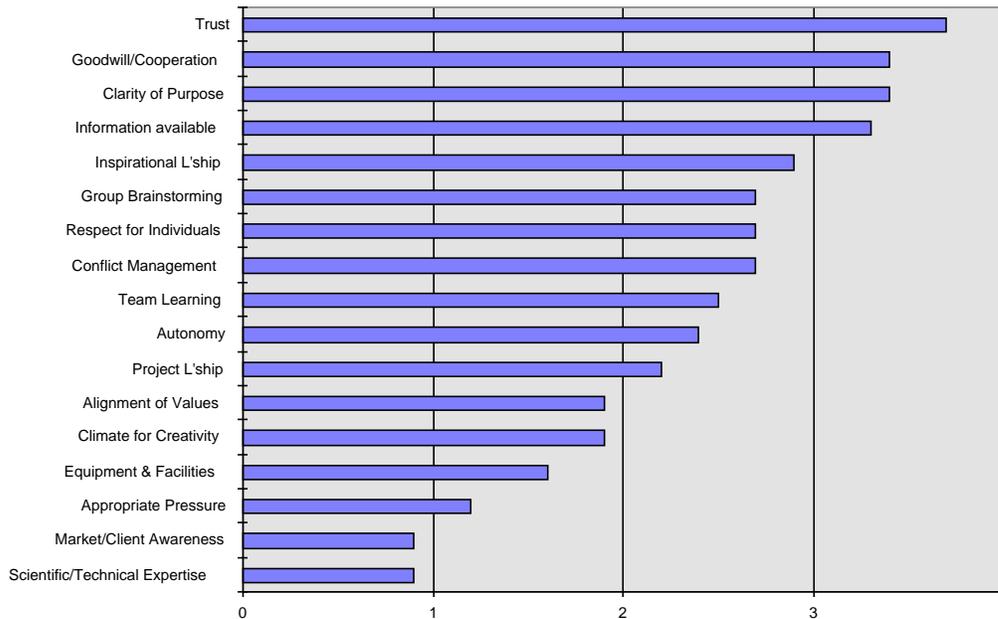
Figure 2. Least Effective Team Results - Rank Order of Factors



Scores for the least effective teams were significantly lower for most factors. There was a greater range between factor scores, with a maximum difference of 28%. There was also a significant difference in the pattern of rankings. The highest scores were for the “hard-edged” or resource factors, **Scientific and Technical Expertise**, and **Equipment and Facilities**. The ranking of these important, “hard-edged” factors at the top indicates that they were well covered, even in the least effective teams. The team dynamic and process factors were concentrated in the lower half of the distribution of rankings.

The most revealing information emerges from Figure 3. It confirms that the factors showing the greatest difference between the most effective and least effective teams are the “soft”, team dynamics and process factors.

Figure 3. Ranking of Differences Between Most and Least Effective Teams



The results indicate that while the resource factors such as *Scientific and Technical Expertise* and *Equipment and Facilities* are necessary, they are not sufficient conditions for research team effectiveness. There is little difference in the level of expertise and quality of equipment between the most and least effective teams. The factors which show the greatest difference between the most and least effective teams are the “soft” factors such as *Trust* and *Goodwill and Cooperation*. Leadership factors are also significant discriminators. The results imply that the greatest scope for increasing the effectiveness of most R and D teams is to focus on team dynamics, team process and leadership issues.

While these findings may seem obvious to Human Resource and Organization Development specialists, they often surprise research scientists who place greatest emphasis on the intellectual quotient rather than the emotional or social quotient of research teams. The presentation of relatively objective data to demonstrate the importance of team dynamics has been helpful in convincing team leaders and members to reflect on their team processes.

Applications

A version of the RTEQ has been developed as a diagnostic tool to assist in designing interventions to improve the effectiveness of research teams. Approximately 50 teams have used the questionnaire to obtain data on perceptions of team performance and to initiate discussions on team development strategies. Many encouraging outcomes have been reported and the impact of some of the interventions has been documented. The following

case study is presented as one example of the use of the questionnaire and methodology to assess initial perceptions of team effectiveness, to design a team development intervention and to monitor the impact immediately after the intervention and again after eight months.

The DWE Team Case Study

The following case study relates to a team in the Division of Wildlife and Ecology (DWE) of the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The team was based in the tropical city of Darwin in the Northern Territory of Australia. The DWE team was established to study the ecology of Australia's tropical savannas and to recommend appropriate land use and wildlife management strategies to government agencies. The team consisted of 17 members: six scientists, seven technicians, a communication/liasion person and three support staff. The team had been operating for a number of years but had undergone a significant change in function about one year before the intervention.

The team development intervention was requested from a scientist who had been appointed from within the team to be its new leader. The questionnaire was administered to each of the members of the team to obtain their initial perceptions of team effectiveness and to assist in the design of the intervention. The response sheets were returned anonymously. The same questionnaire was administered to participants four days after the workshop and again eight months later.

The initial results were used to design the intervention by the team leader and the authors (who were contracted as facilitators). The results showed low scores for *Inspirational Leadership, Clarity of Purpose, Information Sharing, Project Management, Respect for Individuals, Conflict Management and Team Brainstorming*. The design team considered that the first five of these factors could be specifically addressed in a three-day, team development workshop and strategies or skills for the final two could be introduced for later practice and implementation by the team. The design team also considered that team dynamics factors such as *Team Learning, Trust and Goodwill and Cooperation* would develop as a result of enhancement of the leadership and process factors.

The design of the workshop enabled the recently appointed leader to share his vision for the team in its new role, to gain input and commitment from team members and to work cooperatively on implementation strategies. Team members completed the Team Management Indexⁱⁱ and shared their team role preferences with others as a way of generating greater understanding and respect for their individual differences. The team documented their history over the previous 20 years on the walls of the workroom. The "wall of wonder" included organizational changes, research achievements and disappointments,

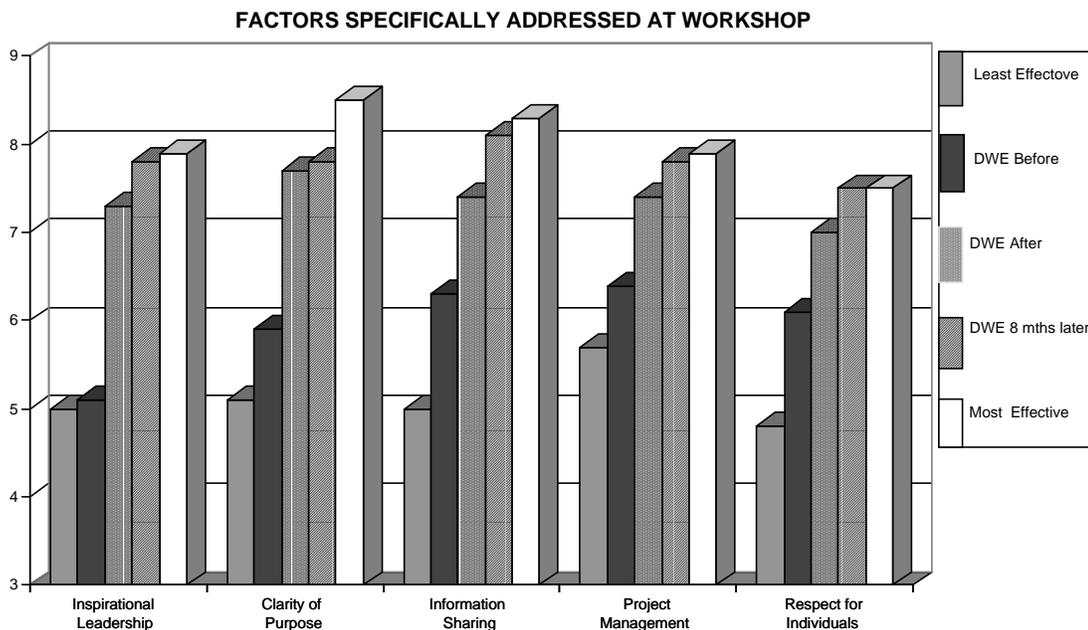
staff changes and social events. All members contributed to sharing the team's history; the more recent members added significant world events, movies and pop songs which related to the timing of team events. After dinner on the second evening, sitting around the outdoor pool, they told stories about their heroes and villains and related their myths and legends. On the final day, they were introduced to techniques for conflict management and team brainstorming for later practice and they commenced work on a strategic plan to achieve their research and management goals.

Evaluation of Results

The normed scores on each of the 17 factors before the workshop, immediately after and eight months later are shown in relation to the normed scores from the data base for most and least effective teams. The scores are grouped into factors specifically addressed during the workshop (Figure 4), factors indirectly addressed (Figure 5) and factors not addressed during the workshop (Figure 6).

The results show a significant increase in the factors which were specifically addressed during the workshop between the "before" scores and the immediately "after" scores.

Figure 4 Factors Specifically Addressed at the Workshop.

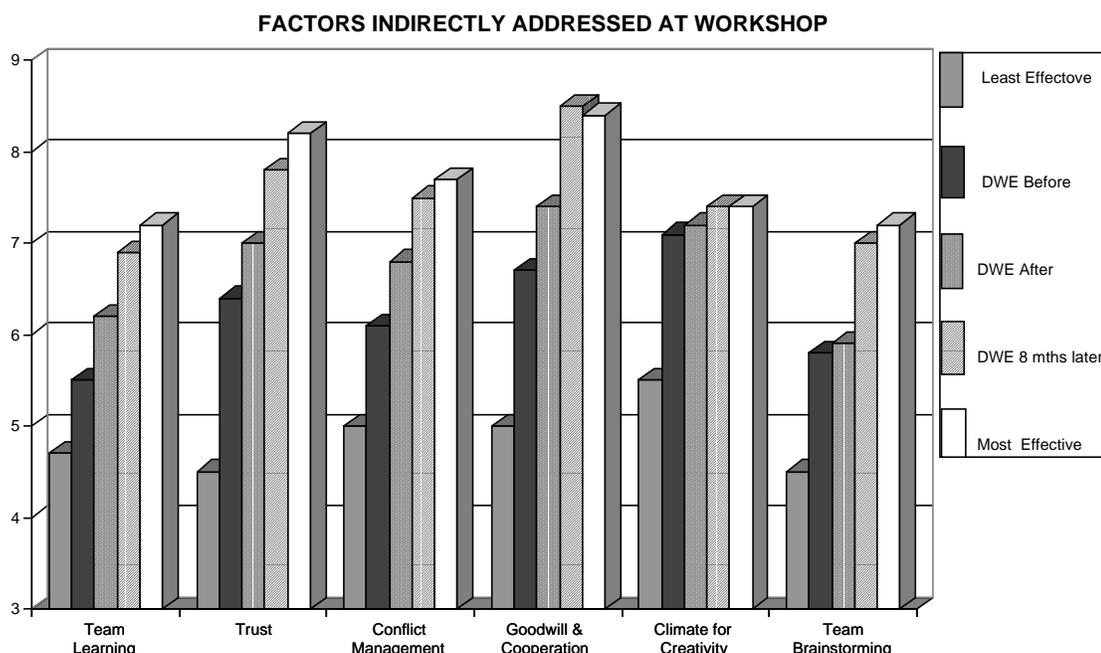


These results are consistent with the expectation that factors specifically covered in the presentations and team development activities undertaken during the workshop would show the greatest increase. The scores for these factors were

maintained or continued to increase slightly between the immediately “after” and the “8 months later” surveys.

Factors indirectly addressed at the workshop (Figure 5) generally showed a smaller increase between the “before” and immediately “after” scores and a larger increase between the immediately “after” and “8 months later” scores. Again, this is consistent with the expectation that perceptions changed at the workshop would influence behaviours and interactions back at the work place but the impact would take time to register.

Figure 5 Factors Indirectly Addressed at the Workshop.



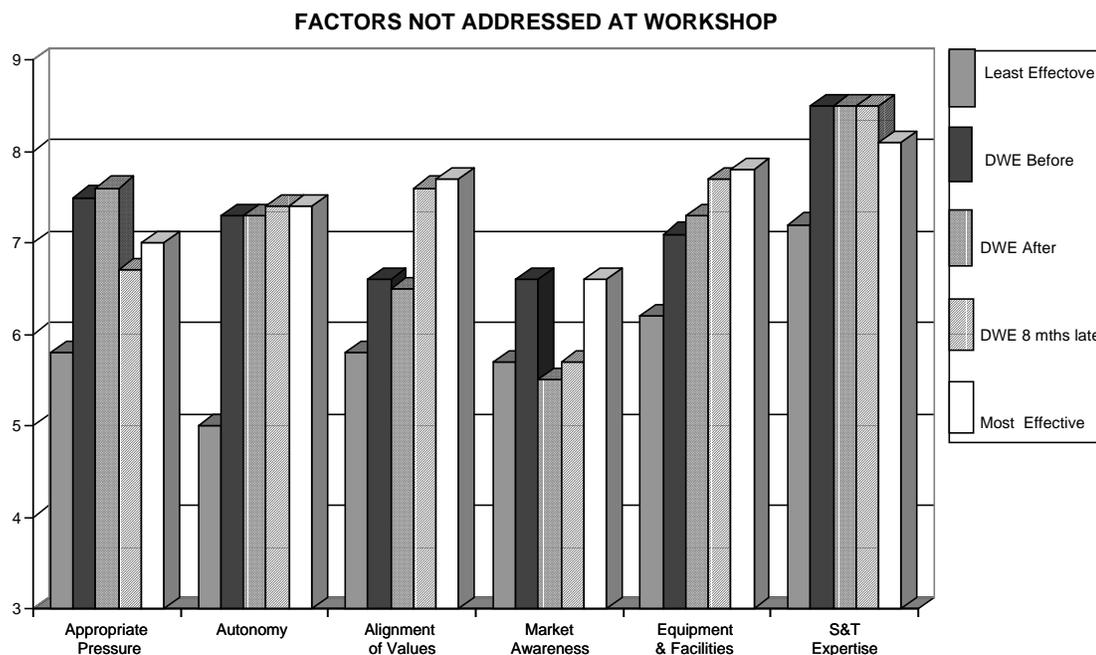
The factors in this grouping such as *Trust* and *Goodwill and Cooperation* take practice or experience to develop in a team.

The main exception to the pattern in this grouping is *Climate for Creativity*. However, the score for this factor was very high before the workshop (close to the norm for the most effective teams) and showed an insignificant increase from its high base in the following surveys.

There is some variability in the pattern of factors not addressed at the workshop (Figure 6). The team resource factors, *Scientific and Technical Expertise* and *Equipment and Facilities* showed no significant change which is consistent with the stability of staffing and physical resources. The ratings for *Autonomy* also remained constant at a high level. *Alignment of Values* increased between immediately “after” and “8 months later” while *Appropriate Pressure* declined

between the last two surveys. The reasons for the changes in these two factors are not immediately apparent.

Figure 6 Factors Not Addressed at the Workshop



The factor that is inconsistent with the general pattern is *Market/Client Awareness* which declined significantly after the workshop and remained low at the eight month assessment. A possible explanation is the team had recently become part of a new research grouping, resulting in a significant change in their research directions and priorities. In talking through the implications and discussing their new directions, it is likely that team members discovered that they knew less about the requirements and expectations of their new clients than they had previously thought.

Implications

The results of the surveys strongly suggest that an appropriately designed team building workshop can have a significant impact on the perceptions of team effectiveness by members and that these changes can be sustained over time. A follow up study is planned to determine the extent to which the changed perceptions translated into enhanced team performance as indicated by independent, outcome measures of performance.

The results also suggest that the methodology has value in diagnosing team performance issues, in guiding the design and implementation of team

development activities and in providing a relatively objective assessment of changes in perception of team effectiveness. Its greatest value may be in generating a set of data which can be used as a discussion starter in addressing team dynamics and process issues in a supportive and constructive manner.

ⁱ Preliminary results of the validation study are confirming the patterns reported in this paper but with greater differences between the most and least effective teams for the team dynamics and process factors.

ⁱⁱ The Team Management Index is a questionnaire which produces a profile of an individual's team role preferences. It is marketed by Team Management Systems and described by Margerison (1990).

Appendix 1

RESEARCH TEAM EFFECTIVENESS QUESTIONNAIRE

FACTOR DEFINITIONS

1	Inspirational Leadership	the capacity of the leaders to develop a shared vision, stimulate creative thinking and gain the commitment of members
2	Trust	the extent to which members feel they can be open, honest and direct and can rely on each other for support
3	Scientific and Technical Expertise	the quality and diversity of scientific knowledge and expertise relevant to the team's work
4	Clarity of Purpose	the extent to which the goals and objectives of the team are clear to all members and each understands his/her role.
5	Autonomy in Operation	the degree of control and flexibility within the team to plan and conduct its work
6	Appropriate Pressure	the sense of pressure generated by clients or stakeholders or by the intrinsic nature of the work

7	Team Brainstorming	the level of synergy from sharing new thoughts and sparking ideas of one another
8	Information Sharing	the access to information required to do the job and understanding of the capabilities and responsibilities of others in the team
9	Conflict Management	the extent to which conflicting views are valued and managed constructively as part of the team's creative processes
10	Respect for Individuals	the extent to which the different capabilities and personal styles of individuals are valued and respected
11	Team Learning	the ability of the team to evaluate its performance, build on its successes and learn from its mistakes
12	Values Alignment	the extent to which individual values and beliefs are aligned with team goals and priorities
13	Goodwill and Cooperation	the capacity of team members to cooperate and achieve results through informal and intuitive understandings
14	Climate for Creativity	the extent to which divergent or lateral thinking is encouraged through team meetings and other communication processes
15	Market/Client Awareness	the level of understanding of all members of the team of the needs and expectations of clients or funding agencies
16	Equipment and Facilities	the access to equipment, facilities or specialist techniques required to undertake the work
17	Project Leadership	the capacity of the leaders to gain resources, set performance standards and deliver results within time and budgets

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