REVIEW OF THE R&D MANAGEMENT LITERATURE CONCERNED WITH CAREER MANAGEMENT OF SCIENTIFIC PERSONNEL

Prepared for the

WORKFORCE AND MOBILITY WORKING GROUP

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BACKGROUND

To assist the members of Mobility and Work Force Working Group in carrying out their responsibilities, Stargate Consultants Limited was commissioned to produce this brief review of the literature on R&D management with special emphasis on strategic workforce planning and career management for scientific personnel.

This review of the R&D management literature that is concerned with career management of scientific personnel is prompted by problems identified in the 1994 audit of the Auditor General of Canada of "The Management of Scientific Personnel in Federal Research Establishments" (Ch. 11).

The chapter deals with the renewal and maintenance of the scientific expertise in government laboratories, the need for an adequate career management program for scientific staff, and the need for an adequate infrastructure for the selection, training and development of R&D managers. In particular, the audit identified:

- inadequate career management programs in place specifiically designed for scientific personnel;
- insufficient numbers of young scientists being hired to ensure the creativity of the laboratories;
- inadequate provision of scientific and technical training (including conference attendance) to maintain the scientific/technical skills of the existing staff in present and future areas of research/development; and
- the lack of any consistent and well thought out program for the selection, training and development of a cadre of effective R&D managers who must operate in a changing laboratory environment.

In addition, the audit identified the various barriers that exist to hiring and releasing professional employees in a timely manner that matched the scientific needs of the departments.

The audit used the terms "scientists" or "scientific" to include engineers and technical personnel. This review will also use this broad definition.

As a result of the 1994 audit, and the many reports that preceded it calling for action to be taken to improve the quality of management of scientific personnel in federal government departments, the Human Resources Branch of the Treasury Board of Canada established five workgroups to develop a framework that will support leadership and effective management of a productive, qualified and sustainable scientific workforce in the context of the changing role of government laboratories towards closer links with the private sector.

Each of the five working groups are focussed on a particular concern identified in the Auditor General's report and concerns raised in subsequent discussions with senior departmental officials. The five groups are targeted as follows:

Group One - Development of an infrastructure that supports the training and development of R&D managers, and development of policies and procedures to ensure the maintenance of the skill/knowledge base of present scientific personnel to meet existing and future needs.

Group Two - To examine the present classification system as it applies to scientific and engineering personnel and develop a system more appropriate to a scientific work force.

Group Three - Examine the present systems of rewards and recognition for innovative activity and develop a system that is more conducive to encouraging creativity, productivity and utilization/ commercialization of R&D output among the scientific staff.

Group Four - To develop organizational models appropriate to a new role for government laboratories, and identify the need for new employment relationships and authorities. To develop mechanisms that will result in more effective career/employment planning for the scientific staff (with special attention being paid to the careers and employment of women), and for increased movement of scientific staff both into and out of government laboratories in line with laboratory mission requirements. To examine the impact of the new change in role of government laboratories on the technical group.

Group Five - To review and recommend ways in which younger scientists can be recruited into the federal government laboratories as either term, contract, or indeterminate employees to support a more client oriented research culture.

REVIEW OF THE R&D MANAGEMENT LITERATURE

There are not many articles concerned with career planning or management for scientific personnel. It has not been a popular topic for R&D management researchers for several years. Thus many of the articles reviewed are from the 1970s and early 1980s.

This does not, however, reduce their usefulness in developing a career planning/management program for scientific staff in federal government departments and agencies. It does, however, limit the literature in providing examples of present practice in scientific organizations. This information will have to be obtained directly from scientific organizations via survey or telephone/personal interviews.

The following is a brief review of the R&D management literature that deals with the areas of career planning, technological obsolescence, and multiple career ladders. More articles on these and other R&D management topics can be found in the Science and Technology Management Bibliography - 1995.

Scientific Workforce Planning

A common theme in the R&D management literature is the need to match human resources requirements to the R&D strategy of the organization and not the other way round. In other words, "R&D [human] resources are matched to needs rather than matching work to [present] resources" (Ransley and Rogers, 1994). The authors quote from an Arthur D. Little study which calls for a recruiting, training and career development program that is integrated into an organization's R&D strategy, with a five- to ten-year horizon.

Workforce planning enables management to have the needed mix of skills or knowledge at its disposal when and where it is required. It enables organizations to make use, as much as possible, of the talent it presently employs, and avoids shortfalls in skill/knowledge it might require in the future.

Workforce plans can include, for example, details of the present workforce, the profile of the workforce expected to be needed in the future in terms of skill/knowledge requirements, number and type of staff in particular scientific areas, number of scientists predicted to retire in the next 5-10 years, number of scientific staff under 35, ratio of professional staff to supporting technical staff (i.e. technicians/technologists), and the needed actions to ensure the continuity of expertise in core scientific areas. In effect, management needs to know what it has in the way of human resources now, what it will need in the future, and how the new resources will be acquired (i.e. through internal development or external hiring).

Career Planning

> *The lack of movement of scientists out of the laboratory into other career paths in the department to allow for the hiring of new and younger scientists for research work is a serious shortcoming in federal government laboratories. (Lortie Report, 1990, Section 4.1.4, pp. 56-57)*

Career planning is an important tool in determining whether an organization will have the skills and knowledge in place when it needs them. An effective career management program will assist employees in using and developing skills and knowledge which will be of benefit to the organization and to the growth and self-esteem of the employees. Career/employment management is a vital tool in avoiding technological obsolescence in the lab.

It should be noted that what is being called for here is not the traditional style of career planning, with its inherent paternalistic nature, but a more dynamic form of career planning with the employee playing a major role. In his review of career orientations of R&D professionals, Aryee (1992) argues that a technical professional must be proactive in the management of their careers and managers must view career development of technical professionals as a joint responsibility. Schirmer (1994) states that career management is a proactive process enabling professionals to make choices, adapt to circumstances, to grow, and ultimately to control their own destiny. One of those choices may be to remain or leave an employer dependent upon whether the work offered is challenging and results in personal growth.

Even in the case of "temporary" employees, career/employment management must take place in order to assure prospective employees that they will obtain new skills or experience that will make them more marketable for their next assignment. If this is not done, the laboratories will only attract second or third-rate talent.

Effective career planning in scientific organizations ensures an adequate level of turnover of scientific staff (also referred to as "Throughput Management") so that a steady stream of younger scientists can be employed. A career management program would provide for the assessment of the career opportunities for the employee based on an analysis of the department's requirements, the strength and weaknesses of the employee, and the employee's needs and aspirations. Career planning would provide valuable information in guiding an employee into a career path (e.g., scientific, managerial, project, commercial) that most suits their abilities and the needs of the organization. Some of this guidance is provided, in some organizations, by a professional career counselor, and in others by the individual's direct supervisor.

One recent review article on best R&D management practices does mention, however, the need to have defined career paths and alternatives for all levels of R&D personnel and that these options should be communicated effectively, and that career development programs be in place that encourage cross-functional development (Ransley and Rogers, 1994).

As noted by many R&D management researchers, managing R&D personnel effectively poses some unique challenges not covered in general management literature because of the conflicting expectations of scientists and engineers and their managers regarding such matters as freedom, loyalty and control.

Staff Turnover as a Career Planning Tool

It is absolutely necessary that a laboratory have a broad age distribution, including a substantial number of people under the age of thirty. This is not a situation noted in federal government laboratories today. A career management program can assist in making room for new hires by moving the lower contributing people into other areas of the organization where their work will be of value.

Even in times of financial restraint, some provision must be made to move mature R&D people into other useful and satisfying activities so that the hiring of young researchers can continue. This can be done through the hiring of permanent employees, or temporary employees such as post-docs, or contract/terms (Branscomb, 1973).

Decker and Van Atta (1973) found during a study to determine how the Lawrence Livermore Laboratory could maintain its vitality in the face of a hiring freeze, that R&D managers felt that seven percent was the desired minimum turnover of professionals of which no less than three percent should be new hires. A local Ottawa firm targets eight percent of its technical professionals for movement out of its laboratory, with four percent leaving the organization altogether, and the remaining four percent moving elsewhere in the organization.

Decker and Van Atta recommend that organizations experiencing no-growth situations ensure adequate turnover by evaluating employee performance to cull out poor performers, and to identify other employers who need remedial attention or retraining.

Mid-Career Development Counseling

There is a critical need for a sound and meaningful mid-career development plan for each scientists or engineer. Unfortunately, many R&D managers hide behind the concept that individuals must work out their future for themselves.

Branscomb (1973) suggests that every five years or so, each professional should, together with his or her employer and a disinterested third party technical professional, take time to made a serious reappraisal of where he or she is going.

At this time the professional employee may decide he or she wants to remain in the R&D area, and if the employer concurs, their manager should prepare a plan for avoiding technological obsolescence through training and project assignment. If however, the employee indicates they wish to move to a new area, or the employer wishes to move them, and there is agreement, then a program of training and development suitable to moving into the new area can be developed.

Womens' Careers in R&D Laboratories

Many studies have identified the challenges that women face in pursuing a career in science or engineering. Gabor (1994) in her study of why there are so few women scientists or engineers in industry identified paternalism, salary discrepancies, and sexual harassment as difficulties women must overcome. She recommends the use of mentoring and job tracking programs to assist women in their career progression. She notes that Proctor and Gamble uses a career pathing and mentoring program to keep women on an advancing career path.

Northrup (1988) notes the under representation of women in R&D management roles. Women may be screened out for management positions because the people making the decisions tend to be conservative, older men.

Toohey and Whittaker (1993) in their review of women in engineering noted a reluctance by some employers to send women into the field, especially on out-of-town assignments. They suggest that this type of discrimination hinders the professional development of the female engineer.

This author in conversations with federal government female attendees of his R&D management courses has been told of sexual harassment behaviour of male colleagues. In one example, when mentoring by a senior male supervisor took place, as recommended by Gabor, the manager was accused by male subordinates of playing favourites, or worse.

Dual Career Couples

Numerous studies show that dual career couples are becoming much more common in our society.

In her review of dual career couples in R&D laboratories, Bradbury (1994) found that dual career couples are more prevalent in R&D laboratories than in the professional labour force in general.

She found that dual career couples assess recruitment overatures from companies to one of them in terms of the ability of the other to obtain employment in the same area. Bartels (1991) found that, in the decision-making process of dual career couples considering a job opportunity in a distant location, both men and women gave significantly more weight to the possibility for job opportunities for their spouse than to any other factor.

This gives firms which locate their laboratories in large urban areas a distinct advantage over firms that locate their laboratories in smaller urban, or rural areas because of the greater probability of career employment for the spouse. Thus Bradbury found that dual career couples

have a tendency to locate in large urban areas which offer a greater number and variety of job opportunities.

Bradbury states that, "the greatest impact of the dual career couple on corporations is with respect to transfers and relocations". Transfers which involve physical relocation are more likely to be refused by dual career couples, especially if the new location does not offer the spouse the opportunity to continue their career.

She argues that because of this situation, organizations should modify their career development policies if transfers to locations in which the spouse cannot continue their career is envisaged.

Thus a scientist or engineer that is in a dual career situation faces a considerable barrier to mobility to which the employing organization must be sensitive. Attempting to force a relocation could cost an organization a valuable employee.

Multiple Career Paths

One area in which R&D management differs from general management is in the provision, by many science-based organizations, of multiple career path options for their scientists and engineers. In traditional non-scientific organizations, employees are expected to strive to move from being specialists in their field up a single promotion ladder to the ranks of senior management.

As will be described below, there appears to be at least four career orientations and thus possible career paths that should be made available to scientific and engineering staff.

Early R&D management researchers noted that many scientists and research engineers had little or no interest in becoming a manager, but many made the move in order to obtain greater salary and organizational rewards. This usually resulted in a poor manager.

In the 1950s, some firms experimented with the concept of a "dual promotion ladder". This allowed scientific staff to move up in the organization either on the traditional management ladder or on a newly created "technical or scientific" ladder. People moved up the technical ladder based on their scientific or technical contribution, not on the need to take on managerial responsibilities. It was an attempt to get around the dilemma described by H.A. Shepard as:

> *"When a good scientist is made a manager, a good scientist is lost. Yet, promotion to management is the reward for competence in scientific work. Hence the laboratory becomes a school for making non-scientists of its scientists". (Shepard, 1959)*

Later on, some firms split their single technical ladder into two ladders: the scientific ladder and the engineering ladder, so that criteria used to determine promotion up each ladder could more closely be aligned with the expectations and contributions of each employee group. Some technology-based firms have gone a step farther by splitting their technical ladder into three streams; one for technicians, one for non-Ph.D scientists, and one for Ph.D. scientists.

In the past few years, a third career orientation has been identified which has been called a **Project Orientation** (Allan and Katz, 1986, McKinnon, 1987). To date this orientation has only been detected among older engineers. Allen and Katz describe project oriented engineers as being not as concerned about external technical reputation as their technical ladder oriented colleagues but seem much more influenced by the intrinsic nature of the task. They are not particularly motivated by the prospect of promotion up either a technical or managerial ladder. They are, however, motivated by the prospect of a continuing flow of interesting, challenging projects. McKinnon argues that, "interesting and challenging assignments should no longer be considered only as a means of moving towards organizational advancement, but should be regarded as rewards in and of themselves".

With the changing role of government laboratories towards greater involvement and interaction with the private sector, Turpin and Deville (1995) suggest that there is even more career paths that must be considered for scientists and engineers in publicly funded R&D institutions. They argue that the increased emphasis on government laboratories operating in a more "business-like" manner with greater efforts being made to commercialize government developed technologies has resulted in the need to "develop a whole new set of skills and behaviours that were previously quite foreign to many scientists". As a result of their examination of the changes that have been taking place at Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO), they believe that three career or occupational streams can be identified within government funded research organizations:

Science Stream built on the core value of scientific excellence (i.e. scientific or technical ladder)

Science Management Stream built on the core value of industrial relevance (i.e. R&D manage ment ladder)

Commercial Stream built on the core value of generating financial returns to the organization (i.e. Scientific entrepreneur or marketeer)

Another stream that could be added to these three is a "**policy or strategy**" stream (i.e., a person moves from the laboratory into a science/technology policy or strategy development position in their organization). Based on this short review, it is clear that at least five career paths or role expectations exists for scientists and engineers today.

Thus to be effective, scientific organizations must provide the option of multiple career paths if they are to provide their scientific and technical employees with rewards and motivation to ensure high productivity, creativity and timely exploitation of R&D output.

Overcoming Negative Aspects of Career Plateauing

In times of downsizing and cutbacks, today's organizations do not have the ability to promote as they did in the 1980s when organizations were expanding.

The question then arises, how to keep technical professionals motivated to perform at their best if there are no career paths for them to be promoted up.

In line with the above comments about Project Orientation, Hall and Louis (1988) found that if technical personnel were assigned to interesting, challenging projects that demanded that the personnel learn and apply new skills, the employees retained their enthusiasm and motivation to perform well. They suggest that work, where possible, be packaged into discrete meaningful and purposeful projects that are closely linked to the needs and purposes of the organization. They argue that by being engaged and involved in work that is stretching, exciting and developmental, the employee's career focus becomes the work, and not the organizational hierarchy.

This approach would clearly be needed in the case of temporary or contract employees whose career aspirations would not be oriented towards the employing organization but towards learning new skills and gaining experience that could be marketed to other prospective employers.

Attitude Towards Training and Development

Having a proactive training and development program that support recommendations that result from performance evaluation activities is vital if career planning is to have any meaning. A proactive training and development program differs from the present situation in that it is the organization, through the managers that suggest training and development in line with organizational needs.

Unfortunately, a major weakness in any training and development program is an attitude among R&D managers that training and development is the sole responsibility of the scientists,

and hence they do not encourage training and development (Dubin, 1972). This attitude was noted in an October 1991 study conducted by Health Canada of the scientific and professional staff. Their study reported that, "Employees, including scientists and professionals, have to struggle to obtain the information (on long-term training, exchange programs and courses) and persuade their managers to allow them to participate in these programs. Managers are not committed to approve or provide the training needs identified through the appraisal process".

In another government department, a 1992 study of training and development activities found that little attention was paid to training recommendations on appraisal forms if it required the spending of significant amounts of money or time. Several respondents to the study noted that requests to work in outside laboratoriess for 6-12 months were occasionally met, at senior management levels, with the question that if the department can afford to let someone go for that period of time, perhaps the department doesn't need that person in the first place. That attitude poisoned the idea of developmental leave.

In this same department, there was overwhelming agreement that the major weakness in their training and development activity for scientists was the lack of recognition by senior management that conference attendance is a vital part of the continuing education of scientists. Another weakness identified was the tendency to just get by with the skill levels people presently have.

McBride (1984) in his study of government scientists in Canada noted a negative attitude towards continuing education and classes.

SUGGESTED FOCUS FOR THE WORK FORCE AND MOBILITY GROUP

Flexibility/Freedom to Assign/Release Human Resources

In order to respond in a timely manner to changing needs in human resources, departments must have the freedom or flexibility to hire and release employees quickly. This is especially important in the case of contract projects where producing results quickly for a client is important.

The Work Group should develop guidelines for increased athority to hire and release scientific/technical personnel on an as-needed basis. The period of employment should fit the length of time needed to complete the project. i.e. no arbitrary five year limit.

The Work Group needs to determine the form that the employment contract for temporary employees should take; are the present contract or term employment conditions realistic given the present circumstances facing government laboratories.

Improved Evaluation of Personnel Skills and Knowledge

At the heart of any career management program is an effective analysis of the present skills, knowledge, interests and aptitude to acquire new skills of the present work force. This analysis must be done in line with the organization's strategic R&D/business plan.

This is more than just performance appraisal as it must have a strong forward looking element, which is missing in most government performance appraisals done today. It should identify the career objectives of the employee, match those with the needs of the organization, and then determine what training and development is necessary for the person to achieve his or her career goals. This assumes that money and time is available for training and development, otherwise this will rapidly become a cynical exercise.

Information should be gathered on best practice in this area. ie. Do organizations train supervisors to do this, or do they have specially trained career counselors, what tools do they use.

Where the career interests of the employee and the needs of the employer do not match, then mechanisms should be in place to assist the employee in finding employment elsewhere. This should be more than just a token effort, but a real outplacing service.

Throughput Management

The Working Group should consider two aspects associated with the movement of personnel into and out of the laboratory: temporary assignments, and permanent moves out of the laboratory.

Some firms have a policy of moving a fixed percentage of personnel out of their laboratories each year. Generally this occurs with new hires who are evaluated against the needs of the organization. Some are released from the organization altogether, others are moved out of the laboratory into other parts of the organization where their skills/knowledge can more effectively contribute to the organization's mandate. This opens up positions for new hires into the lab.

This movement of people out of the laboratory can also apply to longer term employees who have either become less needed by the laboratory (quality of their work has declined or their knowledge/skills no longer required) or have acquired new career interests. Annual career counseling sessions would identify such a change in work interests.

The Work Group needs to acquire information on best practice associated with movement of "permanent" employees within an organization. i.e. what percentage do the best managed R&D organizations use in deciding how many people to move out of the laboratory.

Information needs to be obtained on best practice in situations where the employees skills/knowledge or interests no longer meet the needs of the employer. i.e. what is the best outplacement approach when dealing with highly trained scientific professionals.

The Work Group also needs to tackle the difficulties mentioned by many government departments in encouraging scientific staff to work in other labs located some distance away from home and family. How do other organizations overcome the reluctance of scientific staff to these relocations, especially in the case of dual career couples.

Another difficulty associated with having government staff temporarily assigned to private sector laboratories is the reluctance of some private sector laboratories to have strangers in their labs; proprietary information concerns. The willingness of the private sector to have government personnel in their laboratories should be determined.

The Work Group also needs to determine what are the realistic opportunities for exchanges of personnel with other government laboratories, foreign and domestic. What has been the experience of foreign governments in setting up personnel exchanges?

Women in Scientific Careers

There has not been any comprehensive study of the careers of women in federal government laboratories to determine whether they face any additional hurdles to having a successful career.

The Work Group should examine whether there are any systemic barriers to career development, either along technical or managerial lines for female scientists and engineers.

Multiple Career Paths

In cooperation with the other appropriate working groups, the Working Group should address the issue of formalizing a multiple career path for scientific and technical personnel. It should take into account the findings in the R&D management literature.

Best practice information should be obtained from firms or other government organizations that employ multiple ladder systems.

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