MANAGEMENT AND LEADERSHIP OF

RESEARCH SCIENTISTS AND ENGINEERS:

WHY ARE WE MISMANAGING A STRATEGIC HUMAN RESOURCE?

PRESENTATION TO THE

PRODUCT DEVELOPMENT EXCELLENCE WEEK 2007

CONFERENCE

June 13, 2007

Renaissance Hotel

Pudong, Shanghai

Thomas E. Clarke, M.Sc., M.B.A.

Stargate Consultants Limited
(Now Clarke-Reavley Consultants)

Nanaimo, British Columbia

http://www.tomeclarke.ca

MANAGEMENT AND LEADERSHIP OF

RESEARCH SCIENTISTS AND ENGINEERS:

WHY ARE WE MISMANAGING A STRATEGIC HUMAN RESOURCE?

> "Not only is good management of research the critical difference between a thriving research organization and an average one, but research is the most difficult to manage of all functional activities" – Senator Maurice Lamontagne, 1972

The fact is that we have known how to effectively manage innovation, and lead and motivate research scientists and engineers for over forty years. When I first took an interest in this area back in the mid-1960's, there were already two major journals dealing with the topic; the IEEE Transactions on Engineering Management (1953) and Research Management (1957) [now called Research-Technology Management]. Now there are at least 15 dedicated R&D management journals.

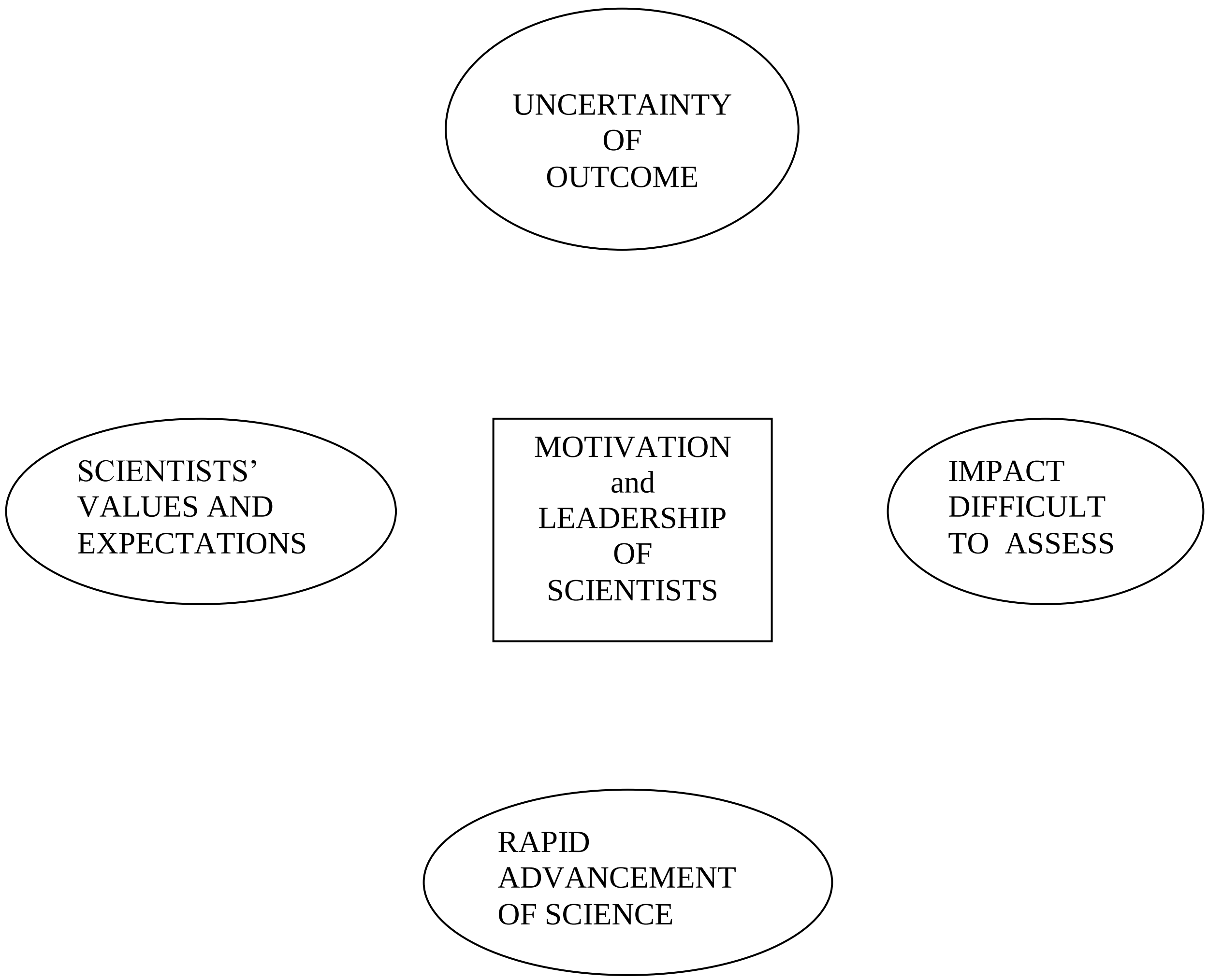
Another fact is that the application of that knowledge into the everyday management of scientists and engineers is not consistent from company to company, or from one laboratory to another. Rosabeth Kanter, former editor of the Harvard Business Review, in her recent article entitled, "Innovation: The Classic Traps" (HBR, Nov. 2006) notes that companies repeatedly make the same mistakes in promoting innovation that their predecessors did years before; they are not learning from the mistakes of the past.

My presentation this evening is intended to summarize what we know about the motivation and leadership of scientific staff in order to promote both creativity and productivity in the R&D laboratory.

The four themes I am going to cover are:

- what is unique about being a managing a scientific organization;
- what gives research scientists and engineers the greatest job satisfaction (e.g., prime motivators of research staff);
- what are the characteristics and actions of an effective leader of scientific staff; and
- why do we continue to have difficulty in this area of management?

THE R&D WORK ENVIRONMENT



Before addressing motivation and leadership of scientists, I would like to put the environment in which you must motivate and lead scientists in context.

There are several unique features to the R&D environment that must be taken into account in the management process. For a full listing of the features please read "Unique Features of an R&D Environment and Managing Scientists and Engineers" on the Clarke-Reavley website http:www.tomeclarke.ca.

Uncertainty Associated with Scientific Activities

> "R&D, by its very nature, is an activity that is aimed at generating new knowledge, testing hypotheses about how matters in the physical or social world act and react, and in general, providing know-how which can be used to create or improve activities or systems in that part of our life to which they pertain. (Salasin and Hattery, 1977, p.5)

A distinguishing feature of R&D that differentiates it from other functions in an organization is the level of uncertainty associated with it. R&D is characterized not only by uncertainty in terms of how long a research project might take or how much it will cost, but also by the nature of the results. This is especially so at the research end of the R&D spectrum, which is usually regarded as the stage from basic scientific research through to experimental development

A fully competent scientist may tackle a research project, and conduct it in a totally acceptable manner, and still not obtain the output required to answer the scientific question or solve the problem being addressed. In most organizations this would be considered a failure, and reflect badly on the worker. However in a well managed R&D organization, the results would be viewed as valuable in that a line of research has been shown to be unproductive, and another approach must be made. The researcher would not be blamed for this "failure".

In another situation, totally unexpected results might be obtained which may lead to even greater benefits. Is it a failure that the original objectives were not met? Technically yes, but only a bureaucratic mind or "bean counter" would insist on calling it a failure. 3M's glue that would not permanently stick to anything was clearly a technical failure at one level, but a huge success at another given the widespread use of it in "Post-It" notes in all their many manifestations.

Uncertainty associated with scientific activities can also take the form of "by-products" of the research process that the observant scientists must recognize. As we now know, the important drug penicillin was not a planned discovery, but the result of Alexander Fleming noting something unusual in a petri dish.

Most other professionals, such as medical doctors and lawyers, usually deal with an existing knowledge base (e.g., well-understood diseases or prior case law), or known technology. This is not the case for scientists. They are either developing a new understanding of a natural phenomenon, developing new analytical techniques, or solving a problem for which there is no known solution. In some cases, they must throw out what they think they know, and work in totally unknown territory. No other professional occupation faces the situation of pushing back the frontiers of science or engineering**.** To quote from the old TV series, Star Trek, **"*To go where no one has gone before*"**.

Difficulty of Assessing the Contribution or Impact of the Research Results

The output of research is knowledge and it is difficult to predict in advance, with any accuracy, the quality, quantity or usefulness of the knowledge that will be generated from any given research project. Yet accountants, finance officers (bean counters), bureaucrats and politicians like to be able to show quantitative evidence that the resources invested in research have tangible results or impacts, usually within the time frame of their budget or evaluation period, or their term of office.

Many management researchers have noted that, even when the results of a research project can be measured, in that the research has achieved its objectives or produced some tangible results, the delay between obtaining the results and the eventual application of those results in a product or methodology can be so great that it is difficult to use the results of the research in planning for the future. Technological forecasting is more art, than science.

In many cases, the results of one line of research must await developments in other areas of science or technology before their impact or application can be seen.

The impact or applications of laser technology, for example, languished for years before practical applications were developed. No one could have predicted such widespread uses from laser beams substituting for record player needles to substituting for surgical scalpels in optical surgery.

Assessing the contribution of a scientist's output to a field, or the eventual impact that contribution will have in the future, can be especially challenging. In some cases, a scientist's manager may be ill-equipped to evaluate the scientist's performance because of a lack of an in-depth knowledge of the scientific field of the scientist being evaluated. On more than one occasion, Nobel Prizes in science have been awarded years after the initial scientific discovery, because at the time the value or importance of the discovery to the field or to a completely different field of science was underestimated. A prime example of this is the awarding of the Nobel Prize in Physiology in 1983 to Barbara McClintock for her work in plant physiology more than 30 years earlier.

These uncertainties make it difficult for science managers, during annual performance appraisals, to determine what rewards and recognition are warranted, and to what degree.

Rapid Advancement of Scientific or Technical Knowledge

In no other area of human endeavor is change more dominant than in science and technology. In almost no other profession is the pace of change as rapid. Medical procedures change relatively slowly, changes in management practices and theory can be measured in years, changes in law can take decades. In contrast, it has been estimated that the half-life of initial engineering education is less than five years.

Technological obsolescence is a constant fear of scientists and engineers because it is very easy to fall behind. An assignment that takes a scientist away from his or her work for six months, may, depending on the field, force the scientist to have to study the field anew for a year just to catch up with colleagues. This does not occur in most other professional occupations.

Technological obsolescence also applies to equipment and analytical procedures. Out-of-date equipment or techniques limit the ability of the scientists to be involved in "cutting edge" R&D, and also limit the services a laboratory can offer to its clients.

Failure to avoid technological obsolescence in either people or equipment will result in inadequate, or overly expensive solutions to problems, problems avoided and not solved, and a general reduction in the organization's ability to fulfill its mandate or to survive. Thus avoiding technological obsolescence in the face of rapidly evolving science and technology is another of the unique characteristics of the R&D work environment.

DIFFERENCES IN EXPECTATIONS, VALUES, ATTITUDES AND MOTIVATION OF RESEARCH SCIENTISTS AND ENGINEERS

Research scientists and engineers, while sharing many attributes with highly trained people in other professions, have some characteristics that are more associated with them, than with other professionals.

Orientation Towards Things Not People

In general, people who go in for science or engineering are oriented more towards things or natural phenomena than people. Many are characterized as having a poor grasp of social skills, and do not make friends easily. They are more comfortable working with things that they can objectively measure and control (Badawy, 1983). In addition, many scientists, more than engineers, are introverts, preferring the company of a few friends or acquaintances rather than being surrounded by strangers at a party.

One result of this orientation is the reluctance among many research scientists and engineers to take on managerial responsibilities. Unlike many other professionals, most scientists and engineers do not seek out promotion to the ranks of management as this would force them to interact with people to a greater degree and detract from their focus on their scientific profession. They simply would not get any satisfaction out of a management position. In a survey of scientists and engineers in the Canadian federal government conducted several years ago, to determine their views on becoming a supervisor, one respondent when asked whether he would like to be an R&D supervisor said, "hell no, I would rather drive a cab". This author has also noted the difficulties some Canadian government laboratories have in encouraging competent scientific staff to move into managerial positions.

Orientation Towards Profession Not Employer

Research scientists and to a lesser extent research engineers care more about how their colleagues around the world think about their work than what their immediate supervisor thinks. Scientists or engineers with what is called a "cosmopolitan" orientation:

- are low on loyalty to their employing organization;
- are high on commitment to advancing knowledge in their professional field; and
- look for rewards/recognition from their peers in their professional community.

Badawy (1971) in a study of role orientations of scientists concluded that the goal orientation of scientists who have a more cosmopolitan perspective was towards:

- advancement of knowledge for its own sake;
- establishing a reputation through publishing;
- having research achievements that will bring professional recognition; and
- advancing and moving ahead as specialists in their field.

This orientation may be the result of the socialization process which research scientists and engineers are subject to while attending university and obtaining advance degrees.

Other professionals, including some scientists and engineers, are more likely to have a more "local" orientation to their work that is described as:

- being very loyal to their employing organization;
- having a greater commitment to the application of knowledge rather than to advancing knowledge in their professional field; and
- looking for rewards/recognition from their employer.

This difference in orientation between cosmopolitan and local is something a manager must keep in mind when thinking about how to motivate an employee.

Expectations and Values

> "Because professionals invest more time and energy in educational preparation for their work than do most other employees, they bring unique, higher and more specific expectations to work" (Miller, 1988).

Scientific researcher expect to be treated as highly valued independent professionals, and not just another employee that has to blindly follow orders from senior management.

Miller (1988) outlines some generalized organizational and work-values usually held by professionals (with a cosmopolitan outlook):

- professionals feel that they have a moral and ethical right not to follow the direction of management when it goes against their principles and values;
- being critical of management is a professional responsibility - and often fun;
- individualism is desirable, perhaps even one of the rights of the professional;
- the goal of good science for the scientist - or of a powerful effective program for the programmer - is often more important than and transcends organizational goals in the eyes of the professional; and
- when professionals apply personal knowledge and expertise in a creative way, this usually builds a strong emotional bond (ownership) with the work output. This can be good because it supports a drive for excellence, and/or bad because it often means the professional resents the organization's need for a project end and the passing of the output to another phase.

There is also a strong expectation among scientists and engineers "at the bench" that their immediate R&D managers will, themselves, have a scientific or engineering background. The myth of "a manager is a manager is a manager" falls apart very quickly in an R&D environment. The manager is expected to be able to provide substantive advice, and act as a sounding board for technical ideas or proposals. This cannot be done by someone who does not have scientific or technical training in the field under study.

Many studies have noted that an R&D manager's initial credibility comes from his/her credibility as a contributing scientist or engineer, and then later, hopefully, as an effective manager.

PRIME MOTIVATORS OF SCIENTIFIC STAFF

> "Motivation is the art of getting people to do what you want them to do because they want to do it" - Dwight D. Eisenhower, Former President of the U.S.A.

When we talk about motivation, what do we mean in practical terms?

What we generally mean is how to encourage employees to work to the best of their ability on projects of value to the organization, and be proud of what they do.

Some of the prime motivators or factors in the organization's culture that give the scientists and research engineers the greatest job satisfaction are:

North American

- solving challenging problems/achieving project success;
- having interesting work to do;
- working with good people;
- being able to work independently;
- making a positive impact;
- having the opportunity for personal growth, and/or promotion;
- giving and receiving positive feedback;
- getting international exposure for your work;
- working in a culture where ideas flow freely, and you can speak up;
- receiving rewards, or recognition, especially from outside the organization, and
- being asked for your advice.

Chinese

- having a new product you worked on be a success in the marketplace;
- being rewarded for working hard;
- having your ideas accepted by subordinates;
- receiving recognition and respect;
- having your skills/capability enhanced;
- receiving promotions and salary increases;
- making friends at work, having good relations with co-workers;
- being asked to do the work you like to do; and
- being given the authority to make decisions.

The key factors in the work environment which cause the greatest dissatisfaction or de-motivation among researchers are:

North American

- too much bureaucracy;
- inadequate recognition for achievements;
- no advancement opportunities;
- not enough feedback from management;
- inadequate facilities or equipment;
- being assigned too many administrative duties;
- lack of resources to do a good job;
- having low morale in the workplace;
- having unbalanced distribution of work load; and
- not being respected by senior management.

Chinese

- not being recognized, rewarded or promoted, lack of job security;
- being unfairly criticized by your boss;
- overloaded with work, resulting in a lot of overtime;
- success belongs to the boss, failure to the employee;
- boss telling you how to do the job;
- too many rules, regulations, and poor policies;
- having your reasonable suggestions rejected by your boss, without explanation;
- having unclear job responsibilities;
- having a lack of decision-making authority; and
- not being able to meet the unreasonable performance expectations of management.

Summary of Motivation Theories

Scientific staff are highly motivated when they are allowed to satisfy their psychological needs for:

- achievement,
- recognition,
- self-fulfillment, and
- professional growth or advancement

through working on projects of a challenging, important and/or interesting nature.

Even in times of economic and job uncertainty, the opportunity to do challenging, interesting work and to gain recognition are the most powerful motivators of scientists (Bucher and Reece, 1972).

What all this boils down to is that scientific staff are enthusiastic about their work and are most productive and creative when they experience job satisfaction; when they can take pride in what they do and accomplish.

First, some warnings. Don't assume that what gives you great satisfaction, on the job, is the same thing that excites your employees. **Motivation is personal**. You may get great satisfaction doing a particular activity but your staff or even another manager may get no satisfaction from doing it.

Second, if the work assigned does not lend itself to satisfying the psychological needs of the employees and provide job satisfaction, and you cannot change the job in any significant way, then there is only a few things you can do to make the situation more acceptable; increase your interpersonal support for the employee; make sure that the factors which can make people very dissatisfied such as bureaucratic company rules or poor quality of the managers, are corrected and minimized; and allow the researchers to spend some of their time and company resources on "pet" projects of interest to them. These pet projects may payoff big for the company.

LEADERSHIP STYLE OF AN EFFECTIVE R&D LEADER/SUPERVISOR

> "When the best leaders work is done, the people will say 'we did it ourselves' " - Lao Tzu, Philosopher

The many studies of leadership/management in the scientific setting overwhelmingly emphasize the need for the manager to be able to manage in a participative/consultative style. A participative style manager understands that his/her job is to create a work environment that promotes productivity and creativity through the sharing of decision-making and power with employees.

This does not mean that situations will not arise where the effective manager must be more directive in dealing with employees, but his/her normal style should be consultative.

Another important skill the manager must have is the ability to listen very carefully. The use of "active listening" skills is important if the manager is to really understand what he/she is being told.

A major personal characteristic of the effective R&D leader is that he/she is honest, and approachable, and has the interpersonal skills to deal with interpersonal conflict.

The following are the results of several short surveys of scientists who have attended our R&D management workshops to determine the characteristics or actions of the best R&D manager they ever had who brought out the best in them. They reported that their "best manager":

North American

- had trust and confidence in their ability;
- provided positive feedback;
- was a good planner and used a consensus approach;
- allowed them autonomy in determining their research approach;
- would accept criticism without reprisal;
- was tough, demanding and fair;
- slow to anger, but when angry remained controlled and focused;
- acknowledged and rewarded accomplishments;
- facilitated networking;
- encouraged risk-taking and creativity;
- was honest and approachable (e.g., "walked the talk");
- had a positive attitude toward their own career and their organization;
- was a good mentor, setting high standards;
- could make decisive decisions when necessary;
- supported the team to senior management;
- reinforced the importance of their work; and
- was a good two-way communicator.

Chinese

- took care of the career paths of subordinates;
- was a good role model;
- was a source of technical information;
- was fair, and open in his dealings with subordinates;
- had good interpersonal skills, was friendly and approachable;
- fought for subordinate's benefits and compensation;
- understood the nature of R&D work;
- got involved in the work;
- appreciated good work; and
- rewarded and motivated them.

In contrast, the scientists described the worst R&D manager they had experienced in the following terms:

North American

- dismisses input from subordinates as irrelevant;
- inflexible, doesn’t listen to others and has a “my way or the highway” attitude;
- micro-manages minutia;
- shows disrespect and talks down to others;
- lets you think things are all right, when they are not;
- poor communicator; does not keep group up-to-date on decisions;
- no “backbone”; did not support them to senior management;
- has zero tolerance for mistakes, quick to fire people;
- is unethical/dishonest and puts themselves first;
- indecisive, and lacks interpersonal skills;
- side steps dealing directly with problems by establishing a committee to study them;
- never finishes anything before moving on to the “next new thing”;
- bluffs when he/she doesn’t know the answer to a question, and then makes the questioner feel stupid by saying that the questioner should know the answer; and
- puts his/her own projects on a higher priority for resources.

Chinese

- made unilateral decisions, and provided no explanations for his decisions;
- wanted very detailed project reports, did not trust subordinates;
- did not consult with employees;
- did not take his share of responsibility when a project failed;
- did not reward or praise good work, or provided rewards unfairly;
- only paid attention to results, knew nothing about the process by which the results were obtained;
- had an inadequate technical background, easy to fool;
- did not shield researchers from administrative demands; and
- was unable to say "no" to his boss when boss asked for the impossible.

ACTIONS TO PROMOTE PRODUCTIVITY AND CREATIVITY

Identify the Motivational Needs of Your Researchers

How can you find out what motivates your employees. Psychological tests not withstanding, the simplest way is to observe them, and ask them.

Be observant, take note of what type of work appears to make them happy, when they successfully complete a project. This should give you some idea as to what psychological needs they are trying to satisfy, and the type of work they would prefer to do.

Since employee job satisfaction is what the manager should be aiming at, and how he or she can promote it, answers to the following questions in one-on-one meetings with an employee should provide some insight into what "makes a particular employee tick".

1. What gives you the most satisfaction in doing your work?

2. What gives you the most dissatisfaction in doing your work?

3. Is there something you feel you could do to help the company, that you are not being asked to do?

4. What can I, as your manager, do to allow you to be more effective in your work?

5. Is there something that I am presently doing that is impeding your ability to work to the best of your ability, and/or getting job satisfaction?

Obtaining honest and accurate answers to these questions depends critically on the relationship that you, as the manager have built up with your employees. If you have a reputation of being overly critical, autocratic and/or incompetent, then asking the questions will result in answers the employees think the "you the boss" wants to hear.

Allow Scientific Staff the Freedom and Autonomy to Make Decisions About Their Work

This factor stands out above all others as being critical to the creative process with scientists and research engineers. It also fulfills the need for achievement by scientific staff being held responsible for project outcome.

The main form of freedom or autonomy mentioned in the literature is freedom to determine how a project or problem will be tackled (operational autonomy). This form of freedom to act is in line with general management best practices that state that authority and responsibility should be delegated as far down the managerial ladder as possible. Operational autonomy allows employees to feel they are in charge of their project; to feel in control. Other forms of freedom described in the literature are: freedom to follow up on ideas, freedom to change research direction when necessary, freedom to work on areas of greatest interest, freedom to follow projects from the idea stage to the "finished" product, and freedom to pursue, without penalty, ideas that do not have official approval (Kaplan, 1960; Steiner, 1965; Gerstenfeld, 1970; Osbaldeston et al, 1978; Shapero, 1985; EIRMA Workshop, 1994; Amabile, 1998).

Some organizations go as far as allowing researchers strategic autonomy to select some of the projects they work on (e.g., 3M's 15% of time/resources spent on personal projects).

Total freedom, however, is not conducive to useful creativity. Thus most authors recommend that freedom/autonomy be generally confined to the determination of approaches to solve a problem, rather than strategic autonomy which involves setting the R&D agenda (Amabile and Gryskiewicz, 1987; Pelz and Andrews, 1976).

Provide Challenging, Interesting Project Assignments

The assignment of research/technical projects is a critical managerial tool for motivating staff to be both creative and productive.

Challenging, interesting assignments are noted by many management authors as being a key factor in supporting creativity and productivity in an R&D environment Vincent and Mirakhor, 1972; Osbaldeston et al, 1978; IRI Study Group, 1969; Gerstenfeld, 1970; Wolff, 1979; Ranftl, 1986; Bean, 1995). For this reason, creative personnel would like the freedom to select their own projects.

Challenging, interesting assignments, when successfully completed, allow researchers to gain respect and recognition from their peers, and provide for their needs to experience achievement and self-fulfillment on the job. Uninteresting, unchallenging assignments do not allow for need satisfaction and can be a major source of demotivation and frustration.

Challenging work assignments can also play a major role in preventing technological obsolescence among researchers. Challenging projects that demand that researchers must learn new techniques or acquire new knowledge provide opportunities for growth and self-development.

Many authors also point out that having clear goals or objectives on work assignments is important to creativity and productivity (IRI Study Group, 1969; Gerstenfeld, 1970; Zachary and Krone, 1984; Westwood and Sekine, 1988; EIRMA Workshop, 1994).

In reality, it is not always possible to provide an unending stream of either challenging or interesting projects. Importance to the employer is not always synonymous with challenge or interest to the scientist. From a practical point of view, the best a manager might be able to do is to make sure that a stream of uninteresting or unchallenging work is interspersed, from time-to-time, with projects that are either interesting or challenging, from the perspective of the employee, or allow the researcher some time and resources to work on a "pet" project.

Reinforce the Importance of the Work

Never assume that the scientists understand the importance of a particular assignment to the organization or the “client”. Ensure they know.

The importance of the research project either to the organization, or to the advancement of science or engineering is a major factor in ensuring the involvement of scientific personnel (Kaplan, 1960). This, in turn, has been noted as a factor in productive R&D organizations (Bean, 1995). The assignment of a low-importance project to a creative person will result in neither creativity nor productivity.

One way of educating the researcher to the importance of a project is for the employee to meet the “client” for the work. Better yet, for the employee to be part of the team that is requesting the work. They will then understand more clearly why the work is necessary, and how it is to be used by the client group. It is easier to let down someone you don’t know and have never met, than it is someone you do know.

Being a member of the client team might allow the analytical laboratory input into the best way for the client to collect samples for testing. The client group can be an important source of feedback to the employee on how well he/she are doing their supporting task.

Provide Adequate Resources (Time and Money) to Support Creativity and Innovation

To encourage creativity and productivity, the scientists must be provided with adequate resources in terms of personnel, equipment, facilities and time (Clarke, 1971).

It is extremely frustrating to scientific staff to be given a challenging, interesting assignment, but not the necessary resources (including time) to complete it in an effective and efficient manner. If inadequate resources force scientists to do what they consider to be a substandard job, then they will not get any satisfaction on completion of the project. For those scientists who look for recognition from their peers, using equipment that is several generations behind that used by their colleagues will not likely lead to results that would be acceptable for publication or presentation at a conference.

Stable financial support is a major factor in sustaining the scientist's commitment and enthusiasm for a project and in encouraging creativity (Sharwell, 1981; Westwood and Sekine, 1988). Resources should also be available to follow up on unplanned ideas as they evolve during a project (Shapero, 1985; Lewis and DeLaney, 1991).

Creative workers must be provided with sufficient time for reading, discussion and thought and creative reflection (Osbaldeston et al, 1978; EIRMA, 1994).

While pressure in the form of deadlines is thought to encourage creativity, the deadline should be set in consultation with the staff, otherwise it is counterproductive (Osbaldeston et al, 1978; Amabile and Gryskiewicz, 1987; Wolff, 1979). Hence it is important to have a manager that does consult with staff when setting both objectives and time lines (i.e., participative style of management is their normal style).

More time can be made available for creative people to conduct their research by reducing their administrative burdens (Lewis and Delaney, 1991). It is unfortunately not uncommon to hear first level science managers to say that science is what they do on weekends or after dinner. The downloading of administrative tasks through unwise cutbacks is turning many science managers into part-time clerks.

"Pots" of money should be set aside for unexpected ideas or opportunities identified by people in the organization. Access to this money should be relatively easy. IBM, for example, has established a $100 million dollar innovation fund to support the best ideas brought forward by staff, independent of their normal planning and budgeting process, to allow for bottom-up ideas to flourish.

Reduce the Fear of "Failure" in Your Organization

A major duty of an effective science manager is to reduce the "terror quotient" in their organization for trying new, potentially risky activities.

Risks will be taken only if it is safe to take them. If an organization severely penalizes employees for taking on challenging assignments and failing, then no risks will be taken. If trying something new which results in a success is not rewarded then employees will play it safe and stick with the status quo, no matter how ineffective present practice is. This is the situation in many government organizations were taking a risk and being successful is more or less ignored, but failing is pounced upon with the full weight of penalties.

Encouragement to take risks and try something new, and to be open to new ideas is also an important factor in encouraging creativity (Steiner, 1965; IRI Study Group, 1969; Gerstenfeld, 1970; Shapero, 1985; EIRMA, 1994; Amabile and Gryskiewicz, 1987; Ranftl, 1978; Lewis and Delaney, 1991; Johnson, 1996, Amabile, 1998).

Ensure a Responsive and Equitable Reward and Recognition System

> "Whether managers use a people oriented approach or a monetary one , the intensity of application of a reward system is tied to its effectiveness" – L. W. Ellis and S. Honig-Haftel, 1992

Although creative scientific staff are generally self-motivated (e.g., operating at the upper levels of the Maslow Hierarchy, and have a high need for achievement), it is important that an organization has in place a system of rewards and recognition that reinforces the creative/productive behavior of its scientific staff.

Feelings of achievement and recognition can be influenced by the reward and recognition process in place in the workplace.

Forms of reward and recognition can be classified into several broad, non-exclusive categories:

Intrinsic-Extrinsic Rewards/Recognition

Intrinsic Rewards or Recognition are those experienced by an individual as a result of good job performance (e.g., feelings of achievement, pride, and competence).

Extrinsic Rewards or Recognition are those that are provided by the employer for a job well-done (e.g., promotion, salary increase, bonuses, public recognition at company function)

Monetary-Non-monetary Rewards/Recognition

Monetary Rewards or Recognition are those that have significant cash value such as a pay raise, large salary bonus, or stock options.

Non-monetary Rewards or Recognition, while still involving a small cash outlay by the organization, are more symbolic in nature in that they tend to satisfy the psychological needs of, for example recognition (e.g., small gifts, dinner vouchers, tickets to cultural or sporting events, etc.) Authority to make such awards is usually delegated to immediate managers.

Individual-Team Rewards/Recognition

Individual Rewards or Recognition are those provided to an individual for exceptional or outstanding performance above that of their colleagues. These can be monetary or non-monetary.

Team Rewards or Recognition are those that are provided to the whole team as a result of outstanding performance by the team in meeting group objectives. These rewards can be intrinsic, or extrinsic (monetary or non-monetary).

Intrinsic (internal) rewards (psychological need satisfaction) are seen to be associated more with creativity than extrinsic rewards such as salary or promotion. Thus management should ensure that its actions provide for intrinsic rewards or forms of recognition.

Among the intrinsic rewards sought by R&D staff are:

- the feeling of self-fulfillment that comes from completing a difficult task;
- recognition for hard work and good performance from supervisors, peers and colleagues;
- experiencing significant achievement for a job well-done;
- senior management showing a genuine interest in their work;
- having the opportunity to grow and develop as a professional;
- having the authority to make decisions about their work (e.g., operational freedom);
- appreciation of their creative contributions and ideas; and
- receiving constructive feedback on their progress.

Extrinsic rewards, which are sought out by scientific staff who look to their employer for recognition and reward, must be provided in a fair and equitable manner, otherwise de-motivation and conflict can occur. Extrinsic rewards include:

- salary increases,
- bonuses, stock options, profit sharing,
- larger office,
- overseas experience,
- headquarters assignments,
- promotion, and
- royalty payments from intellectual property licenses.

In order to properly ensure that the form of reward or recognition reinforces the employee's motivation to be productive or creative, a manager must know whether the employee has a more cosmopolitan orientation to their work, or a more local orientation.

In the area of recognition, for example, a cosmopolitan oriented scientist would not be highly motivated by praise from senior managers, but would be from praise from his/her peers and colleagues inside, and especially outside, the organization. Hence sending the cosmopolitan-oriented scientist to present a paper at a conference would be very rewarding. Someone with a local orientation would be very pleased with a personal meeting with the CEO where the CEO praises his/her work in front of senior managers and fellow workers.

The use of a dual career ladder to recognize and reward professional employees for their work and dedication has been successfully used by many organizations. Lack of a dual promotion ladder for researchers has been associated with low creativity (Wolff, 1992). The dual ladder has its greatest impact on scientists with a cosmopolitan orientation to their work.

The use of a simple and timely "pat on the back" and a "thank you" for a job well done is also a powerful motivator. Fear that such recognition will raise expectations of higher monetary rewards should not be an excuse for not thanking people for a job well done.

Above all, make sure that your reward and recognition system is not inadvertently supporting poor performance or disruptive behaviour.

Encourage Interaction with Colleagues and Clients

Praise and recognition from peers is a powerful motivator for some scientists and research engineers. The work environment and, if possible, the physical layout of the work place should encourage communication among the scientific staff and others in the organization, as well as among the scientific staff elsewhere.

Conference attendance cannot and should not be considered a luxury. In addition to its being a vital conduit for new information about the latest scientific or technical advances or potential new business opportunities to enter the organization, it also provides a major mechanism for scientists to have their psychological needs for personal growth fulfilled (i.e., learning about new techniques, etc.).

Interaction with the outside world can also be facilitated by the use of temporary exchange programs with similar laboratories, or by encouraging adjunct professorships at local universities or colleges. Exposure to new ideas and methods of operation is also a good way of staving off technological obsolescence.

Interaction with existing and future clients increases the probability that the ideas and solutions to problems proposed by researchers will be more relevant to the needs of the clients. However, marketing departments should not insist that the researchers blindly follow the advice and opinions of current clients, as this could result in missing opportunities for future clients, and future new market areas. As Clayton Christensen notes in his book, "The Innovators Dilemma", a great danger to really creative innovation is slavishly listening to current customers. It "can inhibit breakthrough innovation".

MANAGERIAL ACTIONS THAT MAY DE-MOTIVATE RESEARCH STAFF

Science managers can, from time-to-time, make a decision, or take some action that inadvertently results in an employee being denied satisfaction of a psychological need. Lack of consultation with staff can contribute to this situation.

In those hopefully few situations where prior consultation with staff is not possible or permitted, good managers stop and ask themselves, “how will this decision or action affect the ability of my employees to satisfy their psychological needs or to gain job satisfaction?” before proceeding to implement their decision or action. They put themselves in the shoes of the employee so that they can anticipate the reaction of the employee and be prepared for it. If the reaction will negatively impact productivity or creativity, then the manager has an opportunity to rethink the action/decision or introduce it in such a way as to reduce the negative consequences.

While the lack of initiating the above mentioned managerial actions will result in a poorly motivated workforce, the following actions can have a direct impact on lowering an employee’s motivation and job satisfaction:

- Arbitrary or overly restrictive rules about talking on the job
- Change in work schedule that breaks up work groups or car pool schedules
    - reduces ability to satisfy social or belonging needs
- Criticizing an employee’s performance in public
    - reduces ability to satisfy need for self-esteem or the respect of others
- Insisting that all decisions must cleared through supervisor
    - reduces any feeling of achievement or responsibility even if the project is a success
- Arbitrarily setting project completion times instead of in consultation with employee
    - reduces any feeling of respect for the employee’s input into decisions; impacts self-esteem

- Tendency to take over a technical problem instead of assisting the employee to solve it

  - reduces ability to satisfy the need for achievement, responsibility and for professional growth

- Changing reporting relationships

  - if employee is asked to report to a person which at a lower level in the management hierarchy, they will feel a loss of status and self-esteem.

WHY ARE WE NOT MOTIVATING AND LEADING OUR SCIENTIFIC STAFF MORE EFFECTIVELY?

I mentioned at the beginning of my presentation that knowledge about how to effectively motivate and lead scientific staff has been known for many years. Why then has this proven to be so difficult?

I believe there are four fundamental reasons for this problem.

Selection of Prospective Leaders is Flawed

First, selection of potential science managers has been based too much on a person's scientific or technical skills alone, to the detriment of selection based on their scientific or technical skills **and** their ability to learn and apply management skills. I call this the "myth of the single criterion". Rosabeth Kanter believes that this is a common mistake made by senior management. The result is that unfit, or autocratic people get appointed to supervisory positions and cause great stress among their subordinates.

These new supervisors may lack the interpersonal skills needed to promote good communication and team building, to promote good cooperation between their teams and others in the organization, and be unable to resolve interpersonal conflicts which inevitably break out in any organization.

In addition, these people may have the arrogant attitude that they do not need to learn anything about managing people. This is ignorance fuelled by arrogance. I have heard of situations where science managers had to be threatened with dismissal to get them to take a management course. My favorite example was a senior science manager who when told he needed to attend a management course said, "Management course, why do I need to attend a management course, I have a Ph.D. in physics". These managers believe there is nothing they need to learn about managing people.

Studies have shown that autocratic managers are unable to share decision making and authority with employees and would want to micro-manage to the point where individual initiative and creativity are stifled (Pelz and Andrew, 1976). Other studies confirm that poor managers are a major source of dissatisfaction among professionals.

Inadequate Recognition for the Need for R&D Management Training

Secondly, even if a potentially good science manager is selected, some organizations still have a bad habit of moving bench level scientific or technical staff into a supervisory position without one minute's training as a scientific or technical manager. These newly appointed R&D managers have had no exposure to the vast pool of knowledge and information that has been accumulated over the past fifty years on R&D management. As a result many scientists and engineers fail to make the grade as managers, and cause considerable harm to the organization in the form of lower morale, reduced productivity, and loss of key personnel through resignation. Without training, the new supervisors are doomed to repeat the mistakes that have been well documented in the R&D management literature.

Universities could alleviate this problem somewhat by incorporating in their graduate science and engineering programs at least one compulsory course on R&D and/or innovation management. As an intrinsic part of the overall training of research scientists/engineers, the course would familiarize the students with the basics of R&D/innovation management, and bring to their attention the body of knowledge that exists that they could draw upon later in their careers.

I am no longer surprised when science managers who have been in managerial positions for several years sign up for my R&D management workshops and admit that this is the first time they have had any management training.

The first level of R&D management is a critical management level in the hierarchy of an R&D-based organization. The actions of a first level science manager can have immediate effects on the morale, creativity and productivity of a laboratory.

It is therefore important that the proper selection of potential science managers complimented by exposure to R&D management principles and theories, and not just general management training, before they are assigned to a management position.

This training will reinforce that their role in the organization is going change from being only a technical contributor, to facilitating the technical contributions of others, and that there is a body of knowledge on R&D management that it is important to learn and apply. It will help them avoid the trap of trying to manage scientific staff relying only on their technical skills and personal experiences.

Such training will also reinforce their understanding that their actions shape the work environment and determine whether their organization will survive.

Blind Adoption of Management Fads

> "A fad is simply a folly committed by enough intelligent people to confer upon I eminent status", - Mel Perel, Battelle, 2002

A third negative factor is the blind adoption of the latest management fads by senior management who have little or no understanding of the unique challenges of managing creative and productive researchers. Management approaches that may be applicable to the non-R&D setting, are forced upon R&D personnel, usually with disasterous results, such as lowered morale or reduction in creativity (e.g., Six Sigma, TQM).

Too Few R&D Management Journals Publishing Practical (Useful) Articles

Fourthly, I believe another contributing factor to the lack of application of what we know about effective R&D management has been the steady decline in the number of articles written by practicing R&D managers in R&D management journals. For example, articles by R&D managers concerned with how they deal with difficult-to-manage scientists are a rarity. With the exception of a few R&D management journals, many of the articles being published are written by academics to impress other academics. The information contained in the articles are of little practical use to R&D managers. It has been disheartening to watch some previously useful journals become so esoteric and theoretical that a Ph.D. in management is required to decipher their articles. So while more R&D management journals are being published today, the overall body of information that can be put into immediate practice by R&D managers is not expanding. Journal editors should make more space available for articles written by R&D managers that provide practical advice and information for their fellow managers.

CONCLUSION

I have covered a lot of material in this presentation, and so I would like to close by emphasizing the following points:

- better selection and training of first line science managers is critical to the overall improvement in the motivation and leadership of scientific staff;
- universities should be part of the solution by incorporating at least one compulsory R&D management course in their graduate curriculum;
- the effective science manager “motivates” staff by creating opportunities in the work environment for them to satisfy their psychological needs; to gain satisfaction from their work, to reinforce their self-esteem and allow them to gain the recognition of both colleagues inside and outside the organization;

- be aware of management fads, and whether they will, in fact, support creativity or productivity, or just keep the "bean-counters" happy;

- task assignment is key in both keeping scientific staff highly motivated, and in avoiding technological obsolescence; and

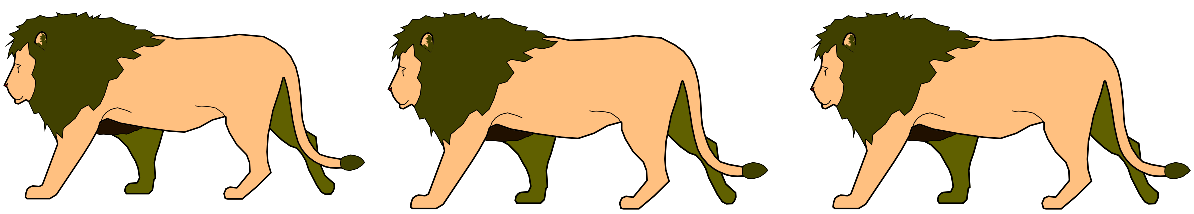
- effective management and leadership of scientists is a major challenge; it is not easy; it takes well trained dedicated people, applying both scientific **and** managerial skills and knowledge, to accomplish it successfully.

The difficulty in effectively managing scientists is captured by quote by Joseph Martino, Associate Editor of Technological Forecasting and Social Change:

"It has been said that managing scientists is like herding cats.

I've raised cats and I've managed scientists.

I am not sure but what I would prefer to herd cats"



BIBLIOGRAPHY

Amabile, Teresa M., "How to Kill Creativity", Harvard Business Review, Vol. 76, No. 5, September-October, 1998, pp. 77-

Amabile, Teresa M. and Gryskiewicz, Stanley S., “Creativity in the R&D Laboratory”, Technical Report No. 30, Center for Creative Leadership, P.O. Box 26300, Greensboro, NC, 2748-6300, May, 1987

Andrews, F.M., “Social and Psychological Factors which Influence the Creative Process” in Perspectives in Creativity, edited by I.A. Taylor and J.W. Getzels, Chicago, IL: Aldine, 1975

Badawy, M.K., "Managing Career Transitions", Research Management, Vol. 26, No. 4, July-August, 1983, pp. 28-31

Badawy, M.K., "Understanding the Role Orientations of Scientists and Engineers", Personnel Journal, Vol. 50, No. 6, June, 1971, pp. 449-454, 485

Bailyn, L., “Autonomy in the Industrial R&D Lab”, Working Paper #1592-84, Albert P. Sloan School of Manaement, M.I.T., 1984

Baldwin, Carliss Y., "How Capital Budgeting Deters Innovation - And What to Do About It", Research-Technology Management, November-December, 1991, Vol. 34, No. 6, pp. 39-45

Bean, Alden S., “Why Some R&D Organizations Are More Productive than Others”, Research-Technology Management, Vol. 38, No. 1, January-February, 1995, pp. 25-29

Bucher, G.C. and Reece, J.E., "What Motivates Researchers in Times of Economic Uncertainty", Research Management, Vol. 15, No. 1, January, 1972, pp. 19-32

Chen, Chao C., Ford, Cameron M. and Farris, George F., “Do Rewards Benefit the Organization? The Effects of Reward Types and the Perceptions of Diverse R&D Professionals”, IEEE Transactions on Engineering Management, Vol. 46, No. 1, February, 1999, pp. 47-55

Christensen, Clayton M., "The Innovators' Dilemma: When New Technologies Cause Great Firms to Fail", Boston, MA: Harvard Business School Press, 1997

Clarke, Thomas E., "Letter from Shanghai: Teaching Chinese R&D Managers", Research-Technology Management, Vol. 50, No. 1, January-February, 2007, pp. 4-5

Clarke, Thomas E., "Why Do We Still Not Apply What We Know About Managing R&D Personnel?", Research-Technology Management, Vol. 45, No. 2, March-April, 2002, pp. 9-11

Clarke, Thomas E., "Unique Features of an R&D Work Environment and Managing Research Scientists and Engineers", Clarke-Reavley Consultants, http://www.tomeclarke.ca, November, 1996; also published in Knowledge, Technology & Policy, Vol. 15, No. 3, Fall, 2002, pp. 58-69

Clarke, Thomas E., "Danger - Management Fad Ahead", Research-Technology Management, Vol. 40, No. 1, January-February, 1997

Clarke, Thomas E., "Review of Literature on Rewards and Recognition for R&D Personnel", Nanaimo, B.C.: Stargate Consultants Limited, February, 1996

Clarke, Thomas E., "Research Scientists: Prima Donnas or Dedicated Workers", Canadian Research and Development, Vol. 4, July/August, 1971, pp. 38 &21

Clarke, Thomas E. and Reavley, Jean, "Science and Technology Management Bibliography - 1954-2010", Nanaimo, B.C.: Clarke-Reavley Consultants, 2010; available free at http://www.tomeclarke.ca

Depres, Charles and Hiltrop, Jean-Marie, "Compensation for Technical Professionals in the Knowledge Age", Research-Technology Management, Vol. 39, No. 5, September-October, 1996, pp. 48-56

EIRMA, "Stimulating Creativity and Innovation", Research-Technology Management, Vol. 37, No. 2, March-April, 1994, p. 13

Ekvall, G., "Climate, Structure, and Innovativeness of Organizations", (Report 1), Stockholm, Sweden: The Swedish Council for Management and Organizational Behavior, 1983

Foster, R.M., "Innovation: The Attacker's Advantage", New York: Summit, 1986, p. 242

Gerstenfeld, Arthur, "Organizational Climate for Creativity", in Effective Management of Research and Development, (Ch. 5), Reading, MA: Addison-Wesley, 1970, pp. 55-67

Gupta, Ashok K. and Singhal, Arvind, "Managing Human Resources for Innovation and Creativity", Research-Technology Management, Vol. 36, No. 3, May-June, 1993, pp. 41-

Hayes, Robert H. and Abernathy, William J., "Managing Our Way to Economic Decline", Harvard Business Review, July-August, 1980, pp. 67-77

Heininger, S. Allen, "R&D and Competitiveness - What Leaders Must Do", Research-Technology Management, November-December, 1988, Vol.31, No 6, pp. 6-7

Herzberg, Frederick, Mausner, Bernard and Synderman, Barbara, "The Motivation to Work", New York: Wiley and Sons, 1959

Hurley, Robert F., "Group Culture and Its Effect on Innovative Productivity", Journal of Engineering and Technology Management, Vol. 12, Nos. 1/2, July, 1995, pp. 57-75

IRI Study Group, "Motivation, Incentives, and Rewards for R&D Personnel", Research Management, Vol. 12, No. 3, May, 1969, pp. 169-171

Isenson, R.S., "Allowed Degrees and Type of Intellectual Freedom in Research and Development", IEEE Transactions on Engineering Management, Vol. EM-12, No. 3, September, 1965, pp. 113-115

Johnson, Marvin M., "Finding Creativity in a Technical Organization", Research-Technology Management, Vol. 39, No. 5, September-October, 1996, pp. 9-11

Kanter, Rosabeth Moss, "Innovation: The Classic Traps", Harvard Business Review, Vol. 84, No. 11, November, 2006, pp. 73-83

Kaplan, Norman, "Some Organizational Factors Affecting Creativity", IRE Transactions on Engineering Management, Vol. EM-7, No. 1, March, 1960, pp. 24-30

Koning Jr., John W., "Three Other R's: Recognition, Reward and Resentment", Research-Technology Management, Vol. 36, No. 4, July-August, 1993, pp. 19-29

Lamontagne, Maurice, "A Science Policy for Canada", Ottawa, Ontario, 1972

Leet, Richard H. "How Top Management Sees R&D", Research-Technology Management, January-February 1991, Vol. 34, No. 1, pp. 15-17

Lewis, Robert and DeLaney, William F., "Promoting Innovation and Creativity", Research-Technology Management, Vol. 34, No. 3, May-June, 1991, pp. 21-25

Maccoby, Michael, "Is There A Best Way to Lead Scientists and Engineers?", Research-Technology Management, Vol. 49, No. 1, January-February, 2006, pp. 60-61

Martell, Kathryn D. and Carroll, Jr., Stephen J. "The Role of HRM in Innovation Strategies", R&D Management, January, 1995, Vol. 25, No. 1, pp. 91-104

Maslow, A.H., "Motivation and Personality", New York: Harper and Row, 1954

McClelland, D.C., "The Achieving Society", Princeton, NJ: Van Nostrand, 1961

McPherson, J.H., “A Proposal for Establishing Ultimate Criteria for Measuring Creative Output”, in Scientific Creativity: Its Recognition and Development, C. Taylor and F. Barron, eds., New York: Wiley, 1963, pp. 2-29

Miller, Donald B., "Challenges in Leading Professionals", Research-Technology Management, January-February, 1988, Vol. 31, No. 1, pp. 42-46

National Science Board Committee on Industrial Support for R&D, "Why U.S. Technology Leadership is Eroding", Research-Technology Management, March-April, 1991, Vol. 34, No. 2, pp. 36-48

Osbaldeston, M.D., Cox, J.S.G. and Loveday, D.E.E., “Creativity and Organization in Pharmaceuticals R&D”, R&D Management, Vol. 8, No. 3, 1978, pp. 165-175

Pelz, D.C. and Andrews, F.M., “Freedom” in Scientists in Organizations, Ch. 2, New York: Wiley, 1976, pp. 8-34

Perry, Tekla S., “Managed Chaos Allows More Creativity”, Research-Technology Management, Vol. 38, No. 5, September-October, 1995, pp. 14-17

Peters, E.B., “Overcoming Organizational Constraints to Creativity and Innovation”, Research Management, Vol. 17, No. 3, May, 1974, pp. 29-33

Ranftl, Robert M., “R&D Productivity”, Study Report, Second edition, Culver City, CA: Hughes Aircraft Company, 1978

Ranftl, Robert M., “Seven Keys to High Productivity”, Research Management, Vol. 29, No. 5, September-October, 1986, pp. 11-18

Salasin, John and Hattery, Lowell, in "The Management of Federal Research and Development: An Analysis of Major Issues and Processes", Mclean, VA, The Mitre Corporation, 1977, pp. 3-16

Sapienza, Alice M., "From the Inside: Scientists' Own Experience of Good (and Bad) Management", R&D Management, Vol. 35, No. 5, November, 2005, pp. 473-482

Shapero, Albert, “Managing Creative Professionals”, Research Management, Vol. 28, No. 2, March-April, 1985, pp. 23-28

Sharwell, W.G., “A Prescription for Innovation”, Research Management, Vol. 29, No. 1, January, 1981, pp. 6-7

Smeltz, Wayne and Cross, Barrington, “Toward a Profile of the Creative R&D Professional”, IEEE Transactions on Engineering Management, Vol. EM-31, No. 1, February, 1984, pp. 22-25

Steele, Lowell, W., "Selecting R&D Programs and Objectives", Research-Technology Management, March-April, 1988, Vol. 31, No. 2, pp. 17-36

Steiner, G.A., "The Creative Organization", Chicago, IL: University of Chicago Press, 1965

Vincent, H.F. and Mirakhor, A., "Relationship Between Productivity, Satisfaction, Ability, Age, and Salary in a Military R&D Organization", IEEE Transactions on Engineering Management, Vol. EM-19, No. 2, May, 1972, pp. 45-53

Vroom, V.H., "Work and Motivation", New York: Wiley and Sons, 1967

Westwood, Albert R.C. and Sekine, Yukiko, "Fostering Creativity and Innovation in an Industrial R&D Laboratory", Research-Technology Management, Vol. 31, No. 4, July-August, 1988, pp. 16-20

White, Daniel, "Stimulating Innovative Thinking", Research-Technology Management, Vol. 39, No. 5, September-October, 1996, pp. 31-35

Wolff, Michael, "R&D Productivity Revisited", Research-Technology Management, Vol. 35, No. 3, May-June, 1992, pp. 12-14

Wolff, Michael, "What Does the CEO Want?", Research-Technology Management, July-August, 1991, Vol. 34, No. 4, pp. 10-12

Wolff, Michael, "How to Find -- And Keep -- Creative People", Research Management, Vol. , No. 9, September, 1979, pp. 43-45

Zachary, William B. and Krone, Robert M., "Managing Creative Individuals in High-Technology Research Projects", IEEE Transactions on Engineering Management, Vol. EM-31, No. 1, February, 1984, pp. 37-40

Thomas E. Clarke, M.Sc., M.B.A.
President
Stargate Consultants Limited
1687 Centennary Drive
Nanaimo, B.C. V9X 1A3

http://www.tomeclarke.ca

Prepared June 2, 2007