How to maintain an effectice research program

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Laboratory animal science is traditionally a service oriented activity with little or no responsibility for research on its own account. However, with the creation of large facilities directed by highly qualified professional staff the opportunity arises for primary research originated by the directors of these facilties. It seems important, therefore, that directors have an understanding of how to maintain an effective research program.

It is easy to believe that there is something unique and different about the management of a research group, and that principles which apply to other 'business' activities (public or private sector) cannot be used in this context. On closer inspection, however, it becomes apparent that research activities have much more in common with other business activities than is usually supposed. There are endless books and course on how to run a successful business. Here it will be shown that the criteria of good business management can, with only a small amount of adjustment and re-definition, be applied to a research group. Furthermore, the application of such criteria are likely to increase the effectiveness and productivity of research.

The main activities within any business are summarised in table 1. All of these activities can be equated with those found in a research program. The buying process is very similar, except that in research 'buying' includes the rather specific feature of obtaining funds to support the other activities. Changing the state of materials and resources into a more valuable product (the research paper) is a simple and equivalent concept, as is the disposal of the enhanced resources (publication of the paper and other promotion of the scientific findings).

Table 1. The essential activation of a business, and also a research program.

1. Buying: acquisition of materials and resources.
2. Making: changing the state of materials and resources (i.e. adding value).
3. Selling: disposal of enhanced resources.

Objectives of a business/research program

The very core of any human activity is to decide the objectives of that activity. In business it is ususally fairly simple to define primary objectives; they are to produce and sell object or service*). But what is the objective or product of a research program? A number of suggestions may be made (table 2). One of the problems of characterising research as a 'business' is the nebulous form of most of these objectives. It is proposed here that discussion is greatly simplified if the main product of research is defined as the scientific paper, and that the objective of a research program is defined as the publication of scientific papers*).

Table 2. Possible objectives of a research program. It is proposed here that, for the purpose of effective management, the publication of papers should be regarded as the prime objective of a research group.

1. To make discoveries.
2. To benefit humanity.
3. To benefit the researcher.
4. To publish papers.

*) Secondary objectives may include such laudable aims as service to the community and equal opportunities; these are rarely, however, the reason why the business is established in the first place.

*) It does not affect the current argument that the paper may be for universal distribution in a journal, or for limited distribution within a single organisation such as a Company.

Selecting a research project

Business is not primarily about innovation or invention, the claims of public relations departments to the contrary. The business school does not teach its students to sit in front of a piece of blank paper and place upon it original thoughts. Typically, genuinely good new ideas will be the product of a single individual. This individual may have adopted one or both of two approaches: either to choose a specific problem and work on it; or to select a rather more general area and then wait for ideas to arrive. The second of these approaches would be anathema to the hardline business manager, but is probably the commonest route by which genuinely new ideas are initiated.

In reality, and whether one is dealing with the industrial or the academic sector, the research manager will spend only a small amount of his time on truly creative thought. Much more time and effort will be devoted to examining a number of already existing concepts and determining which one merits the expenditure of further time and resources. Here, there is more guidance from the business world, because the process can be very similar indeed to the selection of, for example, different manufacturing or marketing topics. The features of a potential new product which managers would examine are listed in table 3, which also shows that these features can be used to characterise a research program. The position of the product determines whether it is in a feasible or appropriate area: a biochemistry group would be unwise to take up basic electronics. Features and quality of research determines whether one should undertake the new work. Does the group usually do well with this type of work? Does the group already have an image in the general field? If so, it will be much easier to get ideas accepted. Poor work from a famous department may be published when similar or even slightly better work from another group may never see the light of day. Are the group's papers (or internal research reports) generally well commended for their presentation? Will there be a strong follow-on to the work or is it likely that, as with much pure academic research, the project will last no longer than a PhD student? The wise research manager would take note of all of the features shown in table 3 when considering a new project. Looking back at projects which have not done well, it is often easy to see in retrospect how they have not met one or more of these criteria.

Table 3. Characteristics of a product which should be examined by a research manager.

1. Position	– Is the topic in our field?
2. Features	– What is good about our research?
3. Quality	– Is our experimental work good?
4. Image	– What is our track record in the topic?
5. Packaging	– Are papers well and clearly prepared?
6. Guarantees	– Will there be further work on this topic?

Leadership

As in all human activities, leadership is essential in research. Indeed, the perfect leader would be almost guaranteed to direct the most highly successful research group, given only a small measure of inspiration and luck.

Teaching the characteristics of effective leadership is an almost universal topic at any business school. Some of these characteristics are listed in table 4. It is assumed that the leader has a high level of competence and knowledge in the relevant topic, but this is not universal. In medical research, for example, it is not uncommon to find a scientific team directed by a clinician with little or no knowledge of the basic technology.

All the characteristics listed in table 4 are highly relevant to the management of a research group. It is obvious that any leader in business or research must firmly believe in

Table 4. The characteristics of effective leadership.

1. Provide a positive sense of purpose.
2. Create a role model.
3. Define clear responsibilities.
4. Be sensitive to the needs of individuals.
5. Recognise what motivates an individual.
6. Anticipate problems.
7. Adapt to change.
8. Think clearly but do not exclude intuition.
9. Act decisively but not impulsively.
10. Determine boundaries in which a team can freely work.

the objectives of the group. In some ways this is easier to achieve in an academic environment where many individuals can expect to be genuinely 'inspired' as opposed to the more synthetic motivation of many business personnel. However, academic leaders can often develop a somewhat idiosyncratic personality and appearance which might be unacceptable in a business context and which can be far from ideal as a role model. The very real success of numerous academic leaders who could be criticised on these lines demonstrates that the role model characteristic is not preemptive.

Effective interaction between the leader and other members of a research team is, by contrast, virtually essential for success. Unless clear guidelines are set down, virtually nothing will happen. In a research environment one may encounter the rare genius who will shine through any eventuality but this cannot be relied upon. Equally, direction must take note of the strengths and weaknesses of the individual member of the team. The most notable error in this respect is to set the high-flyer a pedestrian task, or vice-versa. While it is true that all individuals will eventually reach their appropriate level, much time and effort can be wasted along the way.

The effective leader should always try to anticipate problems, but must avoid taking this to an extreme or communicating a negative attitude to his assistants. A proper awareness of what might go wrong should not become a recipe for inertia. By its very nature science demands a rigidly critical approach. Consequently, it can be very attractive to criticise but do nothing. Adaptation to change is another important facet of this problem. A leader must be able to initiate, but must also know when to stop or change direction. Probably the most important single failure of a leader in a mature research group is failure to adapt to changing circumstances: to remain committed to an outdated technology or a biological or clinical problem which has been solved by other means. This is particularly dangerous in a academic setting where the leader may have achieved political power and tenure which makes him correspondingly difficult to dislodge. In a commercial setting there are usually powerful countervailing forces from other parts of the business.

Recommendations to think clearly and act decisively can easily be regarded as platitudes. Nevertheless, they are truisms of which the leader would be wise to regularly remind himself. As an aphorism, the statement 'never confuse activity with action' has much to commend it. It is always worth reviewing the content of what is apparently a long and tiring day and determine whether it was truly productive. Was the committee meeting necessary? Could the selection of a junior staff member have been safely delegated?

An important aspect of leadership is the actual number of people who can be led by a single individual. It is generally agreed that the maximum number of people who can be directly supervised by one manager is 10. For a business or research group which is below this number, a one level hierarchy is possible (leader and the rest of the team). Above this number some sort of functional subdivision becomes essential, with leaders of each function reporting to the overall leader. An appropriate hierarchy is often easier to achieve in a business setting where structured approaches to management are the rule rather than the exception. In an aca-

demic setting the rule is often broken: for example, with a professor taking on direct responsibility for several PhD students in addition to many other management functions. It is a wise precaution for the leader of a large group to draw and regularly update a management chart, nothing particularly the number of people with whom he has a direct interaction, without the possibility of an intervening manager. None of this is to suggest that the leader should become remote. He should maintain the closest possible contact with all members of staff, an interaction which can sometimes be more productive if direct supervision is not involved. The benefits of short, frequent and informal contracts between the leader and the team has been enshrined in the term 'management by walking around'.

Managing people in a research team

A good case can be made (indeed, it is almost a platitude) that people are the single most important ingredient in any business activity. At its extreme, this view would state that if the people are right, almost nothing else matters. A good businessman (or researcher) will succeed even if he is dealing with a poor product, inadequate resources and an inefficient management. This view may be somewhat over-stated, but few would disagree that people management must come first amongst a number of activities which are essential to the success of any organisation.

The functions of the team manager in respect of people are listed in table 5. The first of these functions is selection. This is, of course, a very large topic. Probably the major difference between the selection process for business and research personnel is that, for the former, the manager is more likely to be assisted by experts. In the academic field there is typically a fairly informal approach, eschewing elaborate psychological and other testing procedures. It is, however, essential for all managers to have some sort of simple checklist against which they can judge what may be quite large numbers of superficially very similar people. This author favours a simple 1–10 score under the three headings of academic qualifications, experience, and 'social' factors. The latter would include, for example, the question of whether the candidate might have to travel long distances to work.

Table 5. The essential features of people management.

1. Selection.
2. Motivation.
3. Delegation.

Once selected, the remaining 'people' functions are motivation and delegation. Assuming that the right person has been chosen, it is vital that they be given total information about the objectives of the team, and that they agree with and can become dedicated to these objectives. Given good selection and motivation, the wise manager will allow staff considerable freedom in how the objectives are achieved, subject only to a monitoring process which is documented as part of these objectives. Lack of ability to delegate is a common fault amongst research managers who may have a charismatic ability to motivate, but then be unable to resist the temptation to supervise every minor detail of on-going work.

Managing and developing the individual research worker

A key responsibility for the research group leader is to manage the individuals within the team. A basic rule is that each individual should not merely be a contributor to the team as a whole but should, while he is part of the team, go through a process of personal development which will eventually enhance his own achievements and rewards.

The key activities in the management of individuals are set out in table 6. This again illustrates the common ground between business and research: the first four would apply just as well to a junior salesman or a junior accountant. The last item – obtaining

Table 6. Managing and developing the individual researcher.

1. Set agreed, written targets.
2. Hold regular meetings.
3. Set writing tasks.
4. Set learning tasks.
5. Aim for a higher degree.

a higher degree – is a unique objective of research, but can perhaps be considered as the equivalent of grooming for promotion. Stimulating the personal ambitions of any member of a team is a highly effective method of getting the best work from that person.

Motivation by money is also a factor, though the importance of money is often exaggerated. Given a certain minimum level of pay, factors such as work-satisfaction and position within a hierarchy are probably of greater significance. An increase in pay can provide a short-term stimulus to an individual but the effect rarely lasts more than three months.

Obtaining resources for business or research

It would be easy to imagine that obtaining resources for a research program, whether public or private sector, differs fundamentally from obtaining resources for a business function. This might possibly apply to the single small business where there is a very direct and immediate relationship between income (sales) and all other activities. However, for a larger and more mature business there is no radical difference between the budgeting process of the research department and that of the marketing department. Both will put forward a profile of what they would like to spend over the ensuing year or years. Both will present arguments as to why these monies should be spent and will endeavour to show senior managers that their particular activities are of more basic importance to the future of the company than those of any other group. All budgeting processes are in effect 'competitions', whether this is between different business functions, or between different research projects in a company or a public institution. It is important to recognise the competitive nature of the process, because it emphasises that a research plan and budget has to be marketed in exactly the same way as any other product. It is rare indeed to find a research project so urgently needed by the client that no effort is required to ensure support.

A significant part of the life of a research manager will be spent in seeking resources for his projects. In the academic sector, the success of a manager is often judged by the size and quality of the grants which he brings to his institution. The total of the funds so acquired ranks pari passu with the other major benchmark of academic success – the bibliography and citation index. In an industrial laboratory the ability to acquire and spend money is less highly esteemed, and the quality of the product is preeminent. Obtaining resources for individual projects is not the only function of the research manager. He must also be responsible for ensuring that there is an adequate infrastructure for the current and future needs of his group. The infrastructure includes long-term staff, equipment and space. Of these three, it is difficult to overemphasise the importance of space which so often may be the ultimate key to long-term success. It is a remarkable but nevertheless true observation that research activities tend to expand into the space available for them. If one department is started with 200 m^2 of space, and another with 400 m^2, then within five years the second group will almost always have a larger total research activity.

Having agreed that space is important, how can the manager seek to acquire it? The short and somewhat pessimistic answer is that it is very rare for the individual manager to create new space. Making new space (i.e. building) is usually a high level corporate decision which may be only distantly related to any of the individual functions which that space will house. For most research managers space is a finite resource;

its distribution is determined by history and politics, where history is yesterday's politics. The only significant piece of advice which can be given to a manager is to negotiate for as much space as possible when he joins the company or institution, and thereafter to grasp any and every opportunity to acquire more space.

Marketing a research program

Many would believe that sales and marketing are uniquely business functions, and that these concepts have no application within the field of research. In reality nothing could be further from the truth. It is vital that the research manager should understand that his main product – the research paper – needs vigorous promotion if it is to be of any value at all.

Table 7. Promotion of a research project.

Communication	–	the paper
Advertising and promotion	–	citations and reprints
Selling	–	lectures and meetings

Promotion of any product involves the three steps shown in table 7. In the case of research the original communication is the paper. One of the most important decisions that the manager must make is on the placing of the paper and the criteria which should be considered are set out in table 8.

All of the decisions shown in table 8 can have a major impact on the effectiveness of the paper. The choice of specialty is superficially simple, but often less so on closer inspection. For example, if a paper contains the clinical findings of a new laboratory technique, should it be in a laboratory journal or a clinical journal? The clinical paper might be more attractive because of its closeness to the end user. However, some of the most widely quoted papers in the biomedical literature are the original descriptions of a technique. Similarly, it is easy for the topic to fall between two clinical areas e.g. obstetrics and neonatal medicine. The choice is then usually determined by the specialty of the originating unit.

Table 8. Placing a research paper.

Customer location	–	what specialty?
Distribution pattern	–	what is the circulation of the journal?
Sales territories	–	US, UK, Europe, (Japan)

Another potentially difficult decision is the pattern of distribution. The natural tendency of all research workers is to seek the widest distribution possible, and in this respect the large weekly journals such as The Lancet and Nature are undoubtedly preeminent. However, such journals have a very high rejection rate, often on the grounds of general interest to their readers rather than the quality of the paper itself. Since such a rejection may follow weeks or months after the submission of the paper, severe delays can result. This author has seen situations in which the undoubted first description of a phenomenon has not been the first publication, merely because the original workers were over-ambitious (or unfortunate) in their placement of the manuscript. The good research manager must try to understand this balance, and sometimes can take advantage of the fact that a 'poor' initial placement can often be corrected by subsequent steps in the promotion process (table 7).

Determining where a paper will be published is relatively straightforward, with some caveats. The obvious target is the national literature of the group's own country. This is an easy decision for the inhabitants of the US, and of the UK and certain other European countries. It is a much less easy decision for the manager in countries which do not have a mature scientific publishing industry: under these circumstances, great efforts may need to be made to ensure publication in a 'foreign' journal with a high reputation and circulation. However, local and less read journals have one compensation which is that they may provide a 'soft

option' for material which does not meet the highest standards of topically or scientific quality. This can be of great importance to those groups (very numerous in the public sector) whose productivity is judged by the quantity as well the merits of their papers.

The formal publication of the paper is the most important single step in promoting a research product but far from concludes the process (table 7). The next step is to ensure that the paper is read and quoted, and the key tool in this process is the reprint. In this context, the 'reprint' is the publisher's off-print of the paper, or the author's own photocopies. The former can be expensive but are often a worthwhile investment. The distribution of reprints can take a number of forms. The least important is the response to the standard 'reprint request', often generated by a secretary or librarian after reading an index of current literature (Current Contents etc). The most important form is despatch of a copy of the paper to all the principal authors who have been quoted in the bibliography, and to others who are considered to be opinion leaders in the topic. This form of unsolicited despatch can play a vital role in ensuring subsequent citation: quotation in papers, invitations to speak at meetings etc.

Monitoring of a research project

Academics, in particular, may be excellent at setting the objectives of a research program, but can be very ineffective in follow-up. In reality, it is incumbent upon all research managers to establish rigorous rules for monitoring the progress of a project (table 9).

Table 9. Monitoring the progress of a research project.

1. Set agreed, written targets.
2. Hold weekly general meetings with team.
3. Hold monthly individual meetings.
4. Set constant writing tasks.
5. Maintain a publications log.

The importance of writing down clear objectives cannot be over-emphasised, yet it is frequently ignored. One reason is that people may see it as a daunting task. However, one side of a sheet of paper is usually perfectly adequate. Another reason is the possibility that objectives may change as a project progresses. In reality this is inevitable, and the clear documentation of such changes is a key part of the whole monitoring process.

The holding of regular meetings, either with groups or individuals, seems obvious. The reason for drawing attention to this rule is the all-too-common complaint, especially from PhD students, that they never see their supervisor. Even quite brief personal contacts can be valuable – another argument for the merits of 'management by walking around'.

The setting of constant small writing tasks is a valuable tool for monitoring and stimulating individual research workers. For example, when they are setting up a new (to them) method, they should be asked to provide a 3–4 page description of the procedure, to include a table of all previous publications on the topic with the main characteristics and variations of each. The supervisor's critique of this summary is a valuable teaching tool, and the information is likely to be essential for future publications. The key to this process is that it should be continuous.

Maintaining a publications log can be a useful tool for the manager of a number of different projects, and lends itself very well to being set up as a simple computer database. All publications on progress are listed, with a description of status (in preparation, in press etc) and an estimate of the likely time of publication. At regular intervals the manager can then analyse how many papers the group will produce in a given time period (e.g. 1 year) and compare this figure with previous experience. If the number (or quality) of publications seems to be significantly reduced, then it is up to the manager to take steps to remedy the situation.

All research groups maintain a list (bibliography) of their publications. However, it is universally recognised that such a list will reflect quantity but not necessarily quality. Because of this the citation index is becoming an increasingly used tool as a surrogate for quality. At this crudest, a citation index will indicate the total number of occasions on which a publication has been cited. This is sometimes refined by detailing the year of citation, by excluding (or separating out) self-quotation, and by providing data in respect of the individual authors of papers. Because many indexes focus only on the first author, it is not uncommon to find that the director's own citation index may decrease with time! Preparation of a regular citation index (for example, by the year) can be an extremely effective method for comparing the productivity of different research groups addressing a similar topic.

Assessing the effectiveness of a research unit

The monitoring procedures described above are all internal processes. In addition, managers will often be involved in assessing the effectiveness of a research group for which they do not have executive responsibility. This is a common function for a general business manager, or for a research manager acting as an adviser to resource providers such as government or research charities.

The standard procedure for external assessment of a business function is the 'SWOT' analysis (table 10) in which each heading is scored on a scale from 1 to 10. Scores above 20 would be regarded as 'satisfactory', and those below 20 as unsatisfactory i.e. calling for closure of the unit, or a major change in direction or management.

Table 10. The 'SWOT' analysis of the effectiveness of a business (or research) function. Each of these features is assessed on a scale from 1–10.

S trengths
W eaknesses
O pportunities
T hreats

Table 11. Signs of weakness in a research group.

1. Diminishing number of publications.
2. Diminishing citations.
3. Diminishing grant income.
4. Diminishing number of students.
5. No recent change in basic technology.
6. Ageing equipment.

There are, of course, specific features of a research group which should be analysed in an external assessment. If an already established unit is under evaluation, the assessor should be particularly concerned to look for the various unsatisfactory signs are listed in table 10. These signs are not infrequently seen in an academic research group which had major successes in the distant past, and whose leader has thereby developed an almost unassailable personal reputation. This is not to denigrate the role of eminent men, but merely to suggest that the direct management role of the senior academic should be regularly reviewed and if appropriate reduced. When handled in a sensitive manner this can usually be achieved without any sense of personal loss by the individual.

The external assessment of a research group should involve detailed review, with the leader and his staff, of the factors listed in table 12. As always, these are entirely generalised to any business activity, but their applicability to research can be readily perceived.

Table 12. Features of a research program which must be regularly reviewed with the manager of a research group.

1. Performance versus budget.
2. Key performance ratios (publications, grants).
3. Follow-up procedures.
4. Opportunities.
5. Competitor activity.

Conclusions

The management of an effective research program is often treated as more of an art than a science. This is remarkable, given the fact that the content of the program should

be almost exclusively scientific, and that 'science' is commonly brought to the management of non-research business activities. But the concept that research management is an art is a fallacy. Here, it has been shown that a standard set of rules which applies to any business activity (production, marketing etc) can equally be applied to a research program, and that the application of these rules may greatly enhance the effectiveness of the research.

Useful further reading

Aluise JJ, Scmitz CC, Bland CJ, McArtor RE (1989): Administrative skills for academic physicians. Medical Teacher *11* (2), 205–212.

Kornberg A (1976): Research, the lifeline of research. N. Eng. J. Med. *294,* 1212–1216.

Summary of discussion

The discussion centered initially on the possibilities for and limitations of performing laboratory animal science research in the central animal units (CAU). Many such units are very small, often with only one or a few scientifically qualified member/s. It was agreed upon the necessity of a minimum "critical mass" of qualified people for the unit to be able to successfully conduct research and develop work within the field of laboratory animal science. It was pointed out, however, that it is necessary also for the small CAUs to get started, at whatever modest scale, to work and produce some publishable results, and thus slowly grow on their own merits. This was backed up by the firm belief that the laboratory animal scientists should be able/allowed to contribute to the advancement of knowledge. Implicit in this is that it is vital for the development of the CAUs to have resources e.g. space, for research of their own.

Next to be discussed was the publication strategies within the CAUs. It was agreed upon that the scientific as well as the technical staff of the CAU could be co-authors on any publication arising as a result of work being done in the CAU. This should, however, be based upon an active scientific contribution from the CAU member, such as being an active part in the planning of the experimental series and/or contributing actively to its conduct. It must be remembered that a CAU, from the point of view of scientists in general, is a service unit, similar to other kinds of service laboratories.

Finally it was emphasised that the director of a CAU has considerable ethical obligations, covering all the work being done on animals in the unit. This could also mean that "negative" results or problems arising in a particular project e.g. the modifying effect of an intercurrent infection on experimental results, might be turned into useful information for the field of laboratory animal science.