LEVEL II

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# Managerial and Organizational Determinants of Efficiency in Research Teams



by

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This report concerned: (1) Listing and defining organizational variables between the leader and the quality of research and (2) the evaluation of the work (pharmaceutical research) in terms of individual traits, relationship of traits to each other, situational variables, self and management ratings, and relationships between performance, job satisfaction and prestige of the laboratory. It describes basic research and will be of primary interest to research scientists in organizational management fields.

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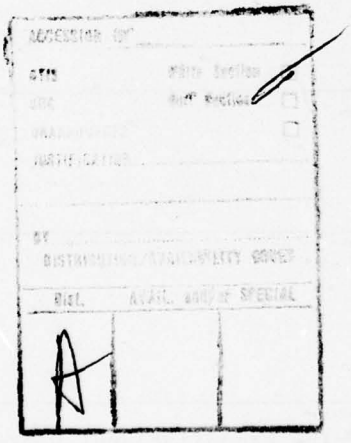
Results indicated that quality of research among the samples of French Pharmacy teams was a function of organization characteristics, leadership behavior, job satisfaction, worker attitude and social climate. Organizational determinants of research success seem to involve favorable personality traits and good adaptation to the research environment.



CONTENTS

# MANAGERIAL AND ORGANIZATIONAL DETERMINANTS OF EFFICIENCY IN RESEARCH TEAMS [1]

C. LEVY-LEBOYER, B. VOISIN-VEDRENNE

## I. Definiton of the problem and previous studies.

The "trait" versus "situation" controversy in research on leadership effectiveness has left place to the idea of contingency; effective leadership represents some interaction between the characteristics of the leader and the characteristics of the situation. This model is well represented by Fiedler's work: he has identified one measurable leader characteristic which seems to be related with effective leadership, but in a different way (positive or negative) depending on the situation (Fiedler, 1971a, 1971b, 1974). Other series of significant research were aimed at understanding the behavioral styles which are characteristic of leadership activity. Unfortunately, recent reviews (Korman, 1966; Kerr and Schriesheim, 1974) fail to reveal any substantial consistent effects associated with a given behavior, since relationships between efficiency and leadership style are always moderated by the organizational settings. The same conclusion was reached by Fleishman (1974): reviewing twenty years of research on consideration and initiating structure, he stressed the fact that attention must be given to situational variables because they should have an impact on the relationship between consideration, initiating structure and criteria of organizational effectiveness. Yukl (1971) came to a similar conclusion.

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Moreover, most of the research following the contingency hypothesis has been done on leader personality (specially Fiedler's LPC) and not on leader behavior, nor on his intellectual qualities, still less on his social relationship with other members of the organization. Validation of Fiedler's model seems to give more support to the contingency idea itself than to the hypothesis of an immutable leadership style. Research in this particular field has only recently applied the interaction principle to the intellectual qualities of the leader (Fiedler and Leisler, 1977) or to his behavior in various conflict-type situations, which suggests that "it may be important to train managers... to select the most appropriate style of leadership for each individual subordinate".

The idea of contingency is obviously essential to the organizational approach. It is not any more possible to argue that the psychological profile of a leader is determinant of his subordinates' behavior independently of the situation and of the organizational characteristics. However tempting it may be, the idea of interaction today raises more questions than it actually solves. In particular, it presupposes the ability of measuring the different facets of performance as well as the existence of an exhaustive list of the relevant organizational characteristics.

In fact, one feature, common to nearly all the research on leadership is that they limit themselves to rather crude evaluations of efficiency while applying sophisticated analysis to leader behavior. Obviously, a leader's behavior may be very efficient from one point of view and not from another point of view. This is what has been shown in

a research that we have recently completed in a hospital setting (C. Lévy-Leboyer and al., 1976). The general conclusion can be summarized as follows: leader's behavior associated with efficiency when managing subordinates coming from the French West Indies, was not always efficient when managing French metropolitan nurses belonging to the same department. And this relationship had different features according to the size of the department, as well as to the percentage of West Indian nurses on the staff.

What tools do we have for analyzing organizational characteristics? Classifications inspired by J. Woodward (1965) or by Pugh (1969) which are mainly directed to production firms but not adjusted to service organizations. Furthermore, these classifications neglect the possible existence, within the organization, of sub-systems representing particular features. In fact, only the anatomical characteristics of the organizations or the departments (size, shape, dispersion of units, span of control...) can be actualized whatever the nature of the organization.

This double lack is particularly significant when one tries to apply a contingency model to the field of research. Classical surveys have indeed related the productivity of the research workers and their creativity with the characteristics of their personality. Roe (1951) has shown that the research workers in Physics and Biology are characterized by: strong drive, sustained effort, and clear-cut interest. The most creative chemists and psychologists show more dominance, initiative and motivation for intellectual success (Chambers, 1964). Scientific and

technical personnel who are productive describe themselves as more original, imaginative, curious, enthusiastic and self confident (Van Zelst and Kerr, 1954). The creative scientist in NASA Research Centers is very confident that he could perform at a high level, very independent and hard working (Taylor and Smith, 1967). Buel (1965) gave a precise definition of the biographical indicators of creativity for 132 research workers in Pharmacy: wide interests, positive self-image, need for independence, over-involvment in job-related activities, interest in unstructured work situations.

However, only a few studies have attempted to relate leadership and criteria of scientific productivity, even though everybody agrees that leadership behavior is of considerable weight in achieving success for research teams. Existing data follow a very traditional pattern, i.e., they are relations between supervising behaviors and scientists' efficiency. They agree more or less on one point - the benefits of participative management in research: scientists seem to be more effective when they are able to influence decisions, when they have some autonomy and receive a moderate level of coordination from their supervisors (Pelz and Andrews, 1966; Cotgrove and Box, 1970). In an extensive study relating many facets of leader behavior with productivity, Andrews and Farris (1967) have found only one factor related to the rated innovativeness of scientists: leader technical skill,- but one should point out that it is a built-in skill and not a behavioral feature. Characteristics of job such as job challenge and direct responsibility in the relations with customers determine also job involvment and performance (Hall and Lawler, 1970).

One research shows that satisfaction is greater in private research than in public organizations (Cotgrove and Box, 1970). But no research has been dedicated to the study of variables which moderate the effects of leadership on research outcomes,- with one recent exception (Barnowe, 1975) as it shows that isolation from the scientific community and scientist's length of service moderate the relationship between a measure of the assistance provided by supervisors to research workers, closeness of supervision, and scientists' contribution to knowledge and applied practices.

The various surveys use fairly criteria of performance. Barnowe (1975) takes in account the number of published works over the past five years, self-estimation of the scientific contribution of the research worker and the team, as well as the eventual practical applications of the research. Van Zelst (1954) uses not only the number of published reports but also the number of patents. For Pelz and Andrews (1966),the criteria are: evaluation of the scientists' work by peers and supervisors on their contribution to general, technical or scientific knowledge in the field and on their over-all usefulness in helping the organization to carry out its responsibilities; and the number of scientific products over the past five years (patents, technical papers accepted by professional journals, technical books accepted for publication, unpublished manuscripts or reports). Moreover, these performance measures were adjusted to remove the effect of certain factors such as the obligation to publish in government laboratories.

However, none of these surveys has investigated the relationship between the different criteria used, nor has applied to the gathered data statistical techniques such as factorial analysis,- although it certainly would help to determine the independent axis which reflect the success of the research workers and, eventually, to establish a typology of their efficiency. Only Buel (1960) attempted to group descriptions of behavior on a serial scale which can be applied to different types of research workers,- each item on the scale grouping different behavioral features.

The present research has two parts. This report concerns the first stage in which we had two goals:

1) to give an accurate and exhaustive definition of the organizational characteristics which are liable to modulate the relationship between the behavior of the leader and the quality of research.
2) to analyze the evaluations, both objective and subjective, of the research work so as to answer the following questions:
   - can we find characteristics of performance and behavior which are, in general, simultaneously present in one individual?
   - are these characteristics non-related or moderately related to each other?
   - can they be explained by the situation of the research worker in the laboratory (years of service, function, competence) ?
   - is the structure of the estimates taken from the evaluation forms filled-in by the management similar to those taken from the self-evaluation forms of the research workers themselves?
   - what are the relationships between the different aspects of performance, satisfaction of the individuals and other aspects

of the work relation,- especially prestige of the laboratory and its financial facilities?

## II. The Framework of the Research

### A- French Research in Pharmacy

Research in Pharmacy is aimed at creating new remedies. According to the definition given by the National Economic Development Office (1972), it essentially consists of:

- the use of chemistry or biology in the discovery of new active molecules,
- the use of bio-chemistry in defining the mode of activity of these molecules,
- the use of pharmacology in the precision of their biological effects,
- and the use of toxicology in discovering their secondary effects.

Furthermore, two phases are more closely linked to innovation in Pharmacy:

- transformation of an active molecule into a pharmaceutical product (galenic pharmacy)
- research of production methodology.

Research in this field is extremely active because there is a renewal of drugs: according to a recent inquiry (J.P.Dupuy and S.Karsenty,

1974) the average life span of a drug is 14 years, and 70% of the commercialized drugs last less than 10 years. This rapid rotation probably explains the evolution which presently marks the heuristical process of research in Pharmacy. After J.C. Doré (1975), four types can be described:

1) the research is dependant on chance; therapeutics are ruled by empiricism and one heals "little or not known illnesses with poorly defined or non-defined products".
2) the research relies upon fortuitous observations: activity of a vegetal product (opium, papaverin); activity of a synthetized product (ether, aspirin).
3) the research is based on systematical screening: on the basis of the fortuitous observation described under (2), one seeks to improve the therapeutical action by modifying the initial molecule and also to optimize the effects of the drug by means of galenic Pharmacy.
4) the research is based on the knowledge of the bio-chemical mechanisms which explain, in a rational and thoroughly studied way, the interaction between "exogenous chemical molecules perfectly defined and endogenous molecules of the organ or of the parasite of the sick person".

It is obvious that the first two types have disappeared. However, research in Pharmacy has only just started the shift from type 3 to 4 and both of them still coexist within a given sector, or even within one organization.

B- The Laboratories selected for this survey.

Initially, we planned to contact laboratories both in the "public" and "private" sectors (University and private firms). It is indeed to be assumed that the replies to questions under Chapter one would vary with the nature of the laboratory in point. For instance, one of the environmental conditions to be considered is the University imperative rule to publish findings, whereas publication may be prohibited in the private sector for reasons of competition. Furthermore, in private firms, personnel is much more flexible than in State agencies. In the former, the management may decide to increase or reduce a team, whereas in the latter, research workers are on the Government payroll and follow a slow and rigidly regulated career.

Actually, the situation is even more complex than we thought. First of all, laboratories are highly specialized, and this has organizational consequences. In private firms, several laboratories are closely interconnected since it is necessary for research to pass through all stages from the shaping of a molecule up to the production of a drug. In the State sector, laboratories work independently from each other since they can carry out fundamental research without necessarly creating a drug. In the second place, it is somewhat too simple to oppose the State and the private sectors. Private firms will have research teams with different organizational patterns, according to their size. A small firm will use several specialists within a single team whereas the research department of a large firm will include specialized laboratories

with complementary capabilities. Furthermore, in the State sector, we have to do with Schools of Pharmacy, the laboratories of which are headed by University professors and include different types of research workers: "enseignants-chercheurs" (both research worker and teacher), students of the "troisième cycle" (working for a Ph D), those holding a research scholarship or working on a post financed by another State agency (such as the C.N.R.S., INSERM)...Other laboratories are independent from Universities but wholly financed by Government funds and are related to such agencies as INSERM, CNRS, Institut Pasteur.[1]

Without purporting the work out a strictly representative sample, we deemed it therefore necessary that this diversity be duly represented and the several types of laboratories equitably distributed. As regards the sector, we have considered four possibilities:

- a Paris University (School of Pharmacy of Paris V),
- a Paris suburb University (School of Pharmacy of Paris-Sud),
- Public agencies,
- Private firms,

As regards the specialty, we followed the distinction between research and development given by the National Economic Development Office (Focus on Pharmaceuticals, London, 1972). Pharmaceutical research is classified in four subjects:

a) Application of chemistry and biology to new molecules discovery.

b) Application of bio-chemistry to assess drugs and remedies activity.

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(1) CNRS = National Center for Scientific Research.

INSERM= National Institute for Health and medical Research.

c) Application of pharmacology to discover and assess biological effects of new molecules.

d) Application of toxicology to show secondary effects of new molecules having a pharmacological activity.

Finally, of the three private firms which enabled us to set up our sample of six laboratories, one was small, one average and one large. The resulting sample is shown in table 1.

| Table of research in Pharmacy | A | B | C | D | Total |
|---|---|---|---|---|---|
| University of Paris V | 2 | 1 | 2 | 1 | 6 |
| University of Paris-Sud | 1 | 1 | 1 | | 3 |
| State agencies | 1 | | 1 | | 2 |
| Private firms (1 small,1 average,1 large) | 1 | 2 | 1 | 2 | 6 |

Table 1 - Laboratory sample.

## III. Methods

The literature as well as our contacts with representatives

of pharmacy research enabled us to work out the two tools we needed for the first stage of our research. Actually, we wished:

1) to list the organizational data that could act as a modulating factor between staff behavior and research workers' behavior.
2) to collect information on research workers' behavior so as, after statistical processing, to establish a scoring sheet of independent elements of success.

The Interview Guide for contacts with the laboratory staff was based on four main themes:

- the research personnel (training, career , promotion rules)
- the research team (size, specializations, levels, work plan)
- management process (decision making, relationship with outside agencies on which laboratories depend and relationship with research workers).
- the relationship with the environment (between fundamental and applied research laboratories; functional relations between different specializations; institutional relationship of the State and Private sector).

Two questionnaires were prepared; one for laboratory staff in a position to evaluate research workers and bearing on:

. a global evaluation(on a 5 points scale)
. satisfaction of the research workers(on a 4 points scale)
. a list of 21 qualities (with a 5 points scale for each)
. an evaluation of the progress to be expected from the research workers (5 points scale);

The second questionnaire is for the research workers themselves. In addition to the items in the first questionnaire, it includes:

- questions on the identity of the subject (sex, age, status, training, years of service) and job description.
- a global evaluation of satisfaction with the job and specific evaluations of 12 job elements (on a 5 points scale)
- information on published works and participation in scientific meetings
- two open questions on the research worker's assets and difficulties
- an evaluation of the laboratory scientific standing.

So as to keep subjects' anonimity while being able to match the scoring sheet with self-evaluation questionnaire, the following procedure was applied: all research workers were invited to choose a pseudonym which they writed on their questionnaire and communicated themselves to the laboratory manager. Questionnaires were directly sent by research workers to the psychology-team in special envelopes.

All told, 126 research workers replied to the survey. We have the scoring sheet for 98 of them. This difference is caused by the concern felt by research workers in some laboratories about their questionnaire being made known to the management; then, they did not mention pseudonym. This kind of reaction can be better understood once it is known that research, both private and State-sponsored, feels today the effects of the economic crisis: not only is recruitement very low, but careers are slowed down and security of employment is not guaranteed.

## IV- Results

### A. Organizational characteristics.

Classification concerning production organizations are numerous. The best known of them is certainly by Joan Woodward, but other authors have also made similar suggestions (Thompson, 1967; Perrow, 1967; Harvey, 1968; Hickson, 1969). Theoreticians of organizations have also given a definition of structural characteristics which can be applied to any type of organization such as the charismatic-bureaucratic dimension (Weber), open system-closed system (Barnes), or the routinized-uncertain dimension (Crozier) - None of these classifications concern research agencies and no available typology can be of use in establishing a contingency pattern for research management.

Throughout the interviews with laboratory managers, we have therefore gathered data and established a catalogue of organizational characteristics in order to classify research laboratories. The following list requires two comments. On the one hand, the analysis of organizational characteristics was made from a systemic point of view. In other words, we have taken into account the relationship between each laboratory and its environment.

On the other hand, it is to be assumed that there characteristics are interdependent, either because they have causal relations between themselves, or because two or more of them have one general cause.

A clear-cut typology will not be established before the end of the second part of our research, when we have gathered information from a sufficient number of laboratories.

However, we may already, as an hypothesis, give a definition (as did Woodward for the different types of production) of the different types of research which should impose a special style of organization on the laboratories.

Actually, we distinguish between:

1- A fundamental research which, regarding pharmacy, may be oriented towards Physics and Chemistry or Biology.

   1a. Research on physical or chemical properties of molecules.

   1b. Research on the action mechanisms of molecules at the cell level.

2- A clinical research which, regarding pharmacy, may be oriented towards conditioning or investigation of the clinical effects of the molecules worked on.

   2a. Galenic Pharmacy

   2b. Study of clinical effects of molecules

3- An empirical research which, regarding pharmacy, may be oriented towards the creation of molecule series or investigation of their manufacturing processes.

   3a. Creation of new molecules

   3b. Research of industrial manufacturing processes for the molecules selected on the basis of their therapeutic qualities.

This classification will be tested when the following informations are gathered from a series of laboratories (in the next stage of our research). Four group of characteristics have been distinguished: they concern anatomical dimensions, laboratory facilities , communication and decision-making process.

1. Anatomical dimensions.

Size

Our sample is composed of laboratories very different in size. Some of them employ less than ten persons, others up to 30 research workers.

This great disparity seems to correspond to the various types of pharmaceutical research and to the sectors concerned. Therefore, a large number of employees is the result of organizational structures which enable a great number of research workers to work simultaneously, successively or in parallel on the same research.

Structure

In the field of pharmaceutical research, two types of structure are frequently found: a structure based on scientific departments ("vertical structure"), a structure based on projects ("horizontal structure")- A majority of laboratories in our sample have adopted the former structure.

According to some of the managers interviewed, the vertical structure is considered easier to apply as it implies a pyramidal organization of skills within one scientific discipline. However, the vertical structure seems to have several disadvantages.Having little flexibility, this structure paralyzes communication between research workers belonging to different departments. Research workers are isolated within their own specializations and may stagnate because of the lack of dialogue with colleagues working in other disciplines.

The second type of structure, "horizontal structure", seems to be less frequent in France. However, two"leaders"in our sample try to apply this system which appears to be more satisfactory in their case. In working out the same project, several research workers belonging to complementary fields are put together. However, this structure seems to create two difficulties: it requires that the leader of the project have inter disciplinary skills, and,in general, that each specialist have a very high level of competence.

In between these two extreme types of structure, others do exist,but they are more difficult to describe because they concern specific cases.

How is the choice of a structure made? Most probably according to the size of the teams. Large teams are known to be "un-manageable". The limit, frequently mentioned by many laboratories managers, is around 25 to 35 research workers. Over that number, the group risks disruption. It is then necessary to divide it into several distinct research units.

Under this critical number of research workers, the team can combine known products, work out new presentations, but seems to be unable to innovate.

2. Means.

In many regards, the distribution of skills highly differentiates laboratories of the State sector. First as regards the distribution of personnel for specializations.

In pharmaceutical research, statistics of the "Ministère de l'Industrie" (J.C. Doré, 1975) give 4 persons for each basic cell: a research worker, a technician, a worker, an employee. Roles are distributed in a clear and well defined way. Pharmacy Industry employs highly qualified research workers. However, their proportion varies from one case to another,- specially regarding the basic distribution we mentioned. Several research leaders consider one highly qualified research worker for 4 technicians a good proportion.

Rigidity of roles.

In addition to objective information about qualifications and personnel distribution, it is necessary to consider the rigidity of roles and functions. The distinction between research workers and ingeneers is indeed not always clear. In our sample, we have listed 5 different functions within the various laboratories: technicians, full-time research

workers, "enseignants-chercheurs" (the Private Sector has very few of them) and young research workers taken on a temporary basis such as: students preparing a thesis of "3e cycle", trainees, research workers training after completion of their thesis.

Age distribution

Whatever the type of research or laboratory, managers have emphasized the disparity of ages. It seems essential to prevent the aging of the teams. In certain cases, considering the specialization and the structure of the laboratory, it is possible to "free" a research worker so as he might create his own team. The conditions on which this scission takes place are various and need further precision.

Equipment

The success of one laboratory over another depends upon the effectiveness of its equipment. It is even considered by some heads of research as a matter of life or death of the laboratory.One of them gives the following example:

" 2 laboratories work in the same field. One has a highly competent staff of research workers, the other has the latest equipment. The latter will succeed over the former due to the time-saving efficiency of its modern equipment". Although it was never explicitly mentioned, the importance of the equipment varies with the type of research.

3. Communication.

Communication may be established between different pharmaceutical sectors: between University and Industry, or between teams on the same sector, for instance. The frequency of communication , its formalization, the possibilities of increasing it and of establishing systematic communication between laboratories varies with each case. Some of the leaders consider that the frequency and quality of communication are one of the factors of efficiency in pharmaceutical research.In this regard, the situation is obviously very different according to the sector considered, State or Private. Departments which are functionnaly related between themselves have more communication possibilities, even though this communication is an obligation of the research work itself. Mobility has a different aspect in the State sector, as some of the research staff work both in a University setting and in a hospital setting.

4. Decision-making

Decision-making processes are very different from one laboratory [illegible] managers [illegible] of the dispute; each one thinks that his behavior is shared by the others. Decision-making processes may be analyzed at three levels:

- Relationships between the laboratory and the organization: the autonomy of the laboratory and of its leader is very diverse, and it is actualized in the nature and the frequency of activity reports as well as in the influence of organization on the research planning of the laboratory.

- Formal content of the leader's role: several possibilities are found, according to wether the leader is mainly a link between the organization and the research workers, or a man who has few relationship with the outside and whose main concern is to use his team in developing his research topics, or someone whose essential role consists in leading on innovative research team and promoting its findings.
- Style of management: whatever the organizational conditions, the classical opposition between an authoritative or democratic leadership style is to be found, i.e; between a leader who takes decisions by himself, a leader who seeks advice but takes the responsibility of his decisions, or a leader who uses participation for all important decisions.

B- The research workers

The sample of research workers who have been questioned is made up of 126 people. We shall describe their biographical characteristics then we shall present the assets and the difficulties that they have mentioned about their professional activity, and those aspects of their work which are, for them, a source of satisfaction or unsatisfaction.

1- Biographical description

Age.

Two age groups (less than 30 years, and 31 to 39 years) take in the greatest part of the sample; only 16% have more than 40 years

of age (Table 1). This is quite representative of the French research workers in the field. There was a conspicuous effort of recruitment after 1968 and it brought a lowering of the mean age of the workers while older ones were given supervising assignments.

Table 1 - Age

| | |
|---|---|
| Less than 30 years | 41% |
| Between 31 and 39 | 43% |
| Between 40 and 49 | 11% |
| 50 and more | 5% |

Sex.

Two-thirds of the questioned workers are male (66% to be precise) but this does seem to be an abnormal proportion when one takes into account the increased number of girls among student of pharmacy.

Civil Status.

More than half of the research workers are married; one third are bachelors, a few are divorced. This distribution fits well with the age profile of the sample.

Table 2 - Civil Status

| | |
|---|---|
| bachelor | 33% |
| married | 62% |
| divorced | 5% |

## Diplomas

The question about the initial training was opened. It has been the object of a content analysis which lead to a classification of Diplomas and University degrees that had been won by research workers. On the whole, six categories have been defined:

- Technical diplomas that concerned research workers who are either gone through a technical school or a IUT (i.e. Institut Universitaire de Technologie where degrees can be obtained for people having a baccalaureate and following their further studies during three years).
- Professional degrees (Pharmacy, Biology, Chemistry degrees)
- Engineering degrees
- People having two scientific diplomas in different fields (i.e. a degree in Pharmacy which has been completed by studies in Chemistry or Physics)
- Research workers having a DESS or a DEA (i.e. Degrees opened to students who follow six years after the baccalaureate)
- Research workers with the equivalent of PhD.

Distribution of the sample of workers according to their training level is presented in table 3.

Table 3 - Degrees

| | |
|---|---|
| PhD | 43% |
| Two degrees | 20% |

| | |
|---|---|
| Technical degree | 16% |
| DESS or DEA | 11% |
| Professional degree | 6% |
| Engineering degree | 4% |

We see that half of the subjects have reached a very high level of qualification. One out of two has already had a PhD. One out of five has completed his first training with another scientific specialization and one research worker out of ten is working for a doctoral degree. On the other hand, only 16% among them have only a technical degree. One should keep in mind this very high qualification and raised the question of the overqualification of the people with respect to the functions which they are being given and the responsibilities they assume.

## Functions in the laboratory

Each research worker was asked to specify which function was his in the laboratory where he was working. Answers to this question are presented in table 4

Table 4 - Functions

| | |
|---|---|
| Full time research worker | 35% |
| Research workers with teaching duty | 27% |
| Technicians | 24% |
| Research workers working for their thesis | 9% |
| Part time research workers | 5% |

Among the questioned subjects, only one out of three devotes all his time to research; one out of four has twin duties: research and teaching. Almost one out of five has a technical function in the laboratories. The others are either researchers working on their doctoral (9%) or Part-time workers (5%). Therefore, there is a great diversity in the insertion of the resarch workers within the laboratory.

The same diversity may be observed when studying the activities that are actually performed by each of the subjects. One closed question reproduced in table 5 was used in order to have the research workers themselves explain how their work time was organized. The mean and the standard deviation of the answers are presented in table 5.

Table 5 - Time Budget

| | $\bar{M}$ | $\bar{\sigma}$ |
|---|---|---|
| Experimentation and/or clinical tests | 48.4 | 32.9 |
| Training or leading other team workers | 7.1 | 10.9 |
| Teaching | 9.1 | 15.4 |
| Writing (articles,research projects, reports...) | 10.0 | 13.1 |
| Reading and documentation | 15.3 | 12.7 |
| Administration | 3.2 | 11.1 |
| Commercial activities | 2.3 | 12.9 |

These data call for some comments. One most note the very high dispersion of the answers: all the $\sigma$ are high, which means that some activities are totally absent of the time budget for some subjects, and that others devote all their time to one or two tasks.If we look at the

answers in a more detailed fashion, we see that experimentation and clinical tests represent on the whole half the workers activities. In fact, one out of ten has no direct experimentation work, one out of four subjects devotes to this less than a quarter of his time, and at the other extreme of the scale, again one out of four spends almost all his time (more than 75%) to this activity. For certain tasks, the strong dispersion comes from the fact that there are some people never doing this specific task: for instance, 68% of the subjects never do animation work nor training, 65% never teach, 84% have no administrative duties and 90% no activity of commercial type. One research worker out of five devotes one third of his time to writing articles and reports. One should mention that, as a rule, writing never requires more than half the working time of any research worker; but it is an activity which we find for every research worker, whatever its function in the laboratory.

2. Research worker attitutdes: assets and difficulties.

Two open questions asked research workers to state the "assets" which qualify them for success in their research fields and their "difficulties". Their answers have been classified according to the following themes:

Assets:

- Intellectual qualities
- Social qualities
- Knowledge
- Personality
- Interest for research
- Tenacity

Difficulties

Lack of personality qualities

Lack of specialized knowledge

Unadaptation to the laboratory social climate

Lack of laboratory means

Research workers career situation

Answer analysis and coding has been done by two psychologists in a separate fashion with 92% agreement between their judgments. Results are presented in table 6 for the assets and table 7 for the difficulties.

Table 6 - Assets (Figures give the % of Ss mentioning each asset)

| | |
|---|---|
| Personality | 38% |
| Intellectual qualities | 31% |
| Tenacity | 20% |
| Interest | 16% |
| Knowledge | 14% |
| Social qualities | 14% |
| No answer | 21% |

More than one third of the research workers rate very high the personality characteristics. The weight given to tenacity and purpose strengthens this fact: on the whole, one research worker out of two mentions some aspect of personality as an asset. Then, only one subject out of three lists an intellectual quality like method, memory, exactness or

a synthetic mind. Social qualities such as team spirit, good contact, relationship with other laboratories are seldom mentioned. Only 15% believe other-openess to be an asset. This is also true of knowledge, competence and interest for research.

Must of the difficulties are of a personal kind. Lack of specialized knowledge is an obstacle to success for more than one third of the subjects: for instance, unsufficiency of qualification, ignorance of foreign language or lack of practical training. This attitude is unexpected if we remember the very high qualification of the questioned subjects. Other restraints come from the research worker himself: no memory, a poor imagination, no order, low ambition, a lack of ease in oral expression: more than one quarter of the research workers express these difficulties. Moreover, while no subject mentions job security, material means or team climate among the assets, these themes are difficulties for almost half of the questioned subjects. As a matter of fact, one research worker out of four mentions the precarity of his job, unsecurity of his status or some financial problem. One subject out of ten says that his organization does not give him adequate equipment, and one out of ten, again, that he does not work in a stimulating climate.

Table 7 - Difficulties (% mentioned)

| | |
|---|---|
| Lack of individual specialization | 35% |
| Lack of personality qualities | 28% |
| Subject status | 25% |
| Climate | 11% |
| Equipment | 10% |

### 3. Attitudes towards work

Subjects were asked to estimate their own contribution to scientific progress. Four possibilities were offered: much, enough, a little, not at all. No research worker ventures using "much" in the scale; 64% feel they have contributed a little and 23% not at all to scientific progress. There are only 13% of the subjects optimistic enough to rate their contribution as moderately positive ("enough") for science advancement. So very few among them have a feeling of self-realization in their work and one would be justified in wondering whether they have other kinds of satisfaction. In a more precise way, one closed question offered them twelve possible sources of satisfaction to be rated on a five points scale.

In order to have quantitative results, we have given one point when the item was rated as not satisfactory, 5 points when very satisfactory and 2, 3, 4 to the intermediary positions. This has made it possible to calculate the means and standard deviations that are presented in table 8 where themes of possible satisfaction have been presented starting with the highest scores.

It is possible to distinguish three groups among the themes: a first one for which the scores of satisfaction are high, the second one, at the opposite end of the scale, for which unsatisfaction is very strongly resented and, in the middle, variables for which satisfaction is moderate or else with a strong dispersion of estimates.

In the first group, one find the feelings of realization in one's work (autonomy, improvement opportunities, self-realization) and social aspects (relationships with superiors, social contacts through professional life).

On the opposite, unsatisfaction related to professional status is strong as to external rewards (such as salary, promotion) or else internal rewards (for instance esteem, prestige that goes with professional role). Satisfactions due to team work offer an interesting case; they have a bimodal distribution: 35% of the subjects are very satisfied, 25% rather satisfied and 45% unsatisfied. In other words, either the team works smoothly or else it is a source of grievancies without intermediary solution.

Table 8 - Specific work satisfaction

| | mean | |
|---|---|---|
| Work autonomy | 3.8 | 1.2 |
| Improvement opportunities | 3.4 | 1.3 |
| Relationship with superiors | 3.2 | 1.3 |
| Work quality | 3.2 | 0.9 |
| Self realization | 3.2 | 1.2 |
| Social contacts | 3.2 | 1.2 |
| Feeling of accomplishment | 3.1 | 1.2 |
| Feeling of worthiness | 3.1 | 1.2 |
| Job security | 2.8 | 1.3 |
| Team work | 2.8 | 1.1 |
| Prestige | 2.8 | 1.2 |
| Salary | 2.3 | 1.3 |
| Promotion | | |

Another point can be added to this analysis. Research workers were asked to rate their laboratory with respect to all the research institutions they know in France or abroad. Although we have seen that, on the whole, they were disappointed with prestige, status and team functioning, we discovered that they were optimistic as to the status of their laboratory. One subject out of four (23%) puts it in the first quarter, one out of two in the middle class; and only one research worker out of four feels that the laboratory to which he belongs stands at a level below the average of pharmaceutical research laboratory. So, it might be true to speak of an organizational satisfaction of research workers: as a rule, they take some pride in the standard of the laboratory where they work and they feel that work conditions which are offered to them give them a possibility for self realization and for enrichment of social life.

C- The research workers as seen by their superiors and by themselves.

Research workers have been evaluated by the heads of their laboratories on

- Satisfaction that research workers find in their job
- General performance (with comments on the qualities or difficulties explaining their ratings)
- A list of 21 qualities (Likert 5 points scale) identical with the list used for research workers self-evaluation
- And individual improvement possibilities (with comments of the superiors on the qualities or difficulties explaining their own judgments).

The correlation between the research workers satisfaction as rated by themselves and as rated by the staff is .34 (r Bravais-Pearson; p= .01). As a matter of fact, there is a total agreement for 55% of the pairs of ratings. This may be explained by communication between research workers and their superiors who comment freely on sources of satisfaction. But ratings of proficiency are not discussed with the hierarchy; these ratings are usually reports written for specific decisions such as promotion, tenure, opening of research credit; and they are sent directly to the organization. This explains the results obtained when we compare (Table 9) the evaluations on the 21 qualities lists which are given by the subjects and by their superiors. Ratings mean by superiors are always higher than self-ratings. And the differences are significant for p= .01 in the case of 17 qualities out of the 21 rated. Research workers are more demanding for themselves than when staff members are rating their subordinates. Looking at the data in more detailed fashion, one notes that the research workers always use the whole five points scale; but the staff only rates on the three positive points. For instance, point "5" (very much under the mean) is used at least once by 27% of the research workers, but only by 5% of the staff.

How this fact is to be explained? Perhaps because workers' questionnaires were anonymous and they filled them frankly. On the opposite, the heads of laboratories gave their name and they have tried to give of themselves the image of a paternal and benevolent officer. And the same is true of the general evaluation of the research worker:no one is noted "mediocre", 16% of the subjects are at the mean, 40% good, 31% very good and 13% excellent.

Table 9 - Means of the evaluation scores (1)

| Qualities rated... | by the res. workers | by the staff |
|---|---|---|
| Enthusiasm | 2.6 | 2.1 |
| Creativity | 2.8 | 2.4 |
| Critical mind | 2.7 | 2.1 |
| Curiosity | 2.4 | 1.9 |
| Tolerance | 2.6 | 2.3 |
| Stability of temper | 2.6 | 2.1 |
| Team spirit | 2.7 | 2.2 |
| Intuition | 2.8 | 2.6 |
| Patience | 2.5 | 2.0 |
| Optimism | 2.8 | 2.4 |
| Method | 2.8 | 2.1 |
| Knowledge | 2.7 | 2.1. |
| Intellectual honesty | 2.4 | 1.9 |
| Exactness | 2.7 | 2.2 |
| Sense of observation | 2.5 | 2.3 |
| Turn for risk | 2.9 | 2.4 |
| Synthetic mind | 2.8 | 2.4 |
| Ingenuity | 2.9 | 2.5 |
| Clarity of ideas | 2.7 | 2.3 |
| Precision | 2.8 | 2.3 |
| Tenacity | 2.3 | 2.0 |

(1) 1= very much above mean
2= above mean
3= mean
4= under the mean
5= very much under the mean.

When we analyse the answers to the open question asking staff members to justify their general evaluation of the research workers, we come upon unexpected results (Table 10). Instead of coherent data (i.e. certain characteristics that constantly describe the best workers and are never used for the bad ones), we found that some qualities are used quite often to describe the good research workers as well as the average ones: for instance, personality qualities are mentioned three times out of four in each of the two categories. On the other hand, intelligence and knowledge are to be found more often with good research workers but the $Chi^2$ has a weak significance ($Chi^2$= 5.9 and 4.5; p= .05). At last, commitment has an opposite use; it is more often mentioned as a characteristic of the less than average research workers ($Chi^2$= 11.3; p= .01). Things look as if staff members are more tolerant towards the less able and less intelligent research worker when he is dedicated to the organization.

Table 10 - Research workers qualities (staff evaluation)

| Qualities | Excellent and very good research workers (N= 50) | Good and medium research workers (N=48 | |
|---|---|---|---|
| Personality | 70% | 74% | |
| Intelligence | 56% | 32% | x |
| Knowledge | 45% | 25% | x |
| Motivation | 30% | 21% | |
| Social qualities | 10% | - | |
| Commitment | 4% | 27% | xx |

x p= .05
xx p= .01

Results are different when we come to future progress evaluation. In the first place, the research workers are well differentiated by their superiors: 53% are judged as being able to progress a lot, 15% as able to progress a little and 32% are in an intermediary position. Moreover, three groups of qualities only are mentioned to justify this prediction: intelligence, personality and abilities. And if we look at Table 11, we can see that each of these qualities are more often mentioned when more progress is expected. So it seems that concurrent evaluation of the research workers is not coherently argumented by the staff but prediction of progress (which is not a threat to their position) is justified in a logical fashion.

Table 11 - Evaluation of progress and Research workers qualities.

| Qualities | Progress | | | |
|---|---|---|---|---|
| | will progress a lot (N=52) | will progress (N= 31) | will make little progress (N=15) | $Chi^2$ |
| Intelligence | 56% | 37% | 7% | 13.4 xx |
| Personality | 50% | 31% | 20% | 5.0 x |
| Knowledge | 58% | 33% | 20% | 6.2 x |

x p= .05
xx p= .01

D- Success Dimensions

1. Methodology

The correspondence factor analysis is a multi-dimentional

method of analysis which belongs to the field of descriptive statistics. It is meant to provide a description of the organization and to study the structure of sets of discontinuous data which are presented in tables of positive numbers.

The method in its principles may be summarized in the following way. Data presented in a table of positive numbers are being considered as showing a correspondence between two sets, I and J, I being the sets of the rows and J the sets of the columns of the table. The set I is taken as generating a vectorial space $R^I$ in which the elements of set J may be represented. The elements of set J give in the $R^I$ area a figure N(J) called scatter of points. The two scatters N(J) and N(I) are the geometric translation of the correspondence which is being studied.

The aim of the correspondence factor analysis is to find out the most pertinent directions of the scatter which are the main axes along which the elements of a specific set present a significant organization. From a mathematical point of view, these main directions are given by the principal axes of inertia of the scatter of points. The scatter of points has a center of gravity with respect to which the total inertia of the scatter may be expressed. This total inertia is made up of a sum of inertias which are defined with respect to orthogonal axes passing through the center of gravity. Their number is equal to number of dimensions of the initial area.

In practice, the analysis come down to (1) the calculation of

the coordinates of the scatter points on the principle axes of inertia, (2) the graphical representation of these points along the planes made up by the first axis of inertia taken by pairs and (3) the calculation of three groups of numeral indices associated with the axes and the points of the scatter:

- the contribution of each axis to the total inertia
- the contributions of the points in the scatter to the inertia with respect to the axes.
- the contribution of the points in the scatter to the total inertia.

The interpretation of the results is done at the same time by examining the contributions and by reading the graphs. The meaning of an axis is given by the distribution of points in the space and by identifying the organization of the scatter which is associated with it, as well as by the elements for which the contribution to the axis inertia is the highest. Moreover, once the analysis has been completed, it is still possible to project on the graphs other variables,- in particular, demographic variables which had not been included into the analysis.

## 2. Results

The correspondence analysis deals with 39 variables that may be classified into three categories:

1- Performance scores: publication, participation to seminars and Congresses.

2- A five point scale built to rate 21 individual qualities

3- The assets and difficulties that characterize each research worker

The results of this analysis are quite unexpected: five factors explain more 50% of the inertia (cf. Table 12). But only performance variables and also those concerning the assets and difficulties play a role in the definition of the five axes. In other words, the evaluations taken from the 21 qualities do not present a coherent structure, an internal grouping that might have allowed to use them, with some pertinence, in the second stage of the research.

Table 12- Percentage of inertia explained by the five first axes

| | % | cumulated % |
|---|---|---|
| I | 15.259 | 15.289 |
| II | 10.432 | 25.722 |
| III | 9.092 | 34.813 |
| IV | 7.566 | 42.379 |
| V | 6.772 | 49.151 |

With the contributions of the different variables to each of these axes, we may try to give a definition of them. Two axes deal obviously with the researchers' performance. They are the axis 1 which is unipolar and has been termed publication. All the variables that present contribution on this axis are performance scores,- publication, participa-

tion to scientific meeting (cf. Table 13). The axis IV named International Dimension represents only international activities: i.e. articles published in foreign journals, participation to international seminars and congresses. Here again, we find, with a strong contribution, competence taken as an asset for the research workers.

Two other axes, axis II and axis V, bring to the fore the same variable: difficulties encountered in research workers' adaptation to the social climate of the laboratory. But the pole opposite to this variable is defined in a different way in the two cases. At the second pole of axis V, we find other difficulties. So this axis shows two failure factors (that are not present simultaneously in one single research worker): on one hand, difficulties of adaptation to the social climate of the laboratory;on the other hand, problems of insertion into the organization (career and means). In the axis II, the poor adaptation to the social climate seems to have a different connotation. It goes with a strong interest for research and is in opposition with a specific psychological profile: social and intellectual qualities allied with a lack of personal resources (University degrees, specific knowledge). In order to take into account this axis heterogeneity, we have named it: Individual and social factors.In a concrete fashion, it would separate two types of research workers: those who find exclusive motivation in their work, and those who are intellectually and socially gifted but are not competent enough.

Last, axis III, called Integration, shows in a clear fashion, on its positive pole, the research workers who find a true interest in their work and who are well integrated in the organization; this would differen-

tiate them from those, on the negative pole, who have not at their disposal sufficient assets (material assets and competence).

Table 13- Correspondence analysis- Contributions (0/000 of each axis inertia)

| AXIS I: "PUBLICATIONS" | CONTRIBUTION |
|---|---|
| - Publication, french reviews | + 190 |
| - Paper national congresses | + 139 |
| - Member national congresses | + 134 |
| - Paper international congresses | + 93 |
| - Member international congresses | |
| - Publication, foreign reviews | + 90 |

| AXIS II: "PERSONAL AND SOCIAL QUALITIES" | |
|---|---|
| - Difficulties, climate | + 204 |
| - Difficulties, equipment means | - 126 |
| - Difficulties, personality | - 120 |
| - Assets, intellectual qualities | - 114 |
| - Assets, social qualities | - 99 |
| - Assets, interest for research | + 75 |

| AXIS III: "COMMITMENT" | |
|---|---|
| - Difficulties, equipment means | - 292 |
| - Assets, interest for research | + 227 |
| - Difficulties, insertion | + 198 |
| - Difficulties, climate | - 68 |
| - Assets, knowledge | - 50 |

| AXIS IV: "INTERNATIONAL INFLUENCE" | CONTRIBUTION |
|---|---|
| - Assets, knowledge | + 312 |
| - Publication, french reviews | + 181 |
| - Assets, social qualities | - 122 |
| - Member international congresses | + 48 |
| - Paper international congresses | + 45 |
| - Difficulties, personal proficiency | + 39 |

| AXIS V: "PROBLEMS" | |
|---|---|
| - Difficulties, climate | - 228 |
| - Difficulties, equipment means | + 201 |
| - Difficulties, insertion | + 126 |
| - Assets, knowledge | + 59 |

The results of this correspondence analysis call for three comments. First, the absence of a coherent structure for the list of 21 qualities tends to confirm the hypothesis which gave its start to this work. We have not been able to unfold a typology of research workers qualities taken in an independent fashion. Second, in reverse, relationship with the research task, with the research team, with the organization to which the laboratory belongs are true independent aspects of the research workers' performance. We could distinguish (on the axes II,III and V) three dimensions that seem independent and that will be used in the second part of our work: the interest for the research which is being completed; the adaptation to the laboratory climate and the insertion into the organiza-

tional system. Third, the performance of a research worker may be defined at two levels: on one hand, his activity from the point of view of publications and seminars ; and, on the other hand, his international dimension which is based on the very high level of competence he may have achieved. The diagrams (Fig. 1 and 2) which represent the axes I, II and III, help to visualize this description.

At last, it should be reminded that three demographic variables have been projected after the analysis on the graphs: they are the sex, seniority and function. But they are without close relationship with the axes as they are defined. And this is a proof that while differentiating the subjects from the point of view of their performance, of their adaptation or even of their interest, we have not measured indirectly their seniority or their qualification.

## V- Discussion and conclusion

As one could remember, the first stage of our research on "Managerial and organizational determinants of efficiency in research teams" had three main objectives:

1- to describe the organizational variables which could moderate the relationship between leadership styles and research productivity.

2- to identify the facets of leadership behavior which could be related to research productivity.

3- to identify independent aspects of research workers efficiency.

On the first point, our hypothesis was that two sectors with differing organizational characteristics could be clearly distinguished: private sector and University laboratories. This classification now appears to be too simple, for two reasons. One: there is more than a private and a state sector; as a matter of fact, most of the "public" research is done in state organizations, which have links with various Universities, but do not belong to a specific one. Two: there seem to be more significative differences between needs, structure, recruitment patterns... of laboratories due to their technology than there are differences due to their legal environment. Therefore, we have built a list of organization characteristics; and we have also set up an hypothetical classification of technology which is based on the heuristic process itself. Both will be used and tested in the next stage of the study.

On the second point,- leadership aspects-, we expected leadership behaviors to follow some common rules in the different laboratories. The situation we observed does not conform with our expectations: leader behaviors are diverse; the decision process within laboratories activity varies from autonomy to autocratic authority; the different possibilities being met in the three sectors that we have surveyed. Moreover, leaders interviewed do not seem aware of alternative ways of leadership.

It is necessary to add that, even if leader behavior is varied, there are some common points in their conduct towards research workers. All of them are well aware of their subordinates' satisfaction-unsatisfac-

tion. They rate the research workers with marked leniency. And, in order to explain research workers' level of success, they use a great variety of explanation. In other words, they are implicitly aware of the fact that people with different qualities may be, all of them, good research workers.

On the third point, results can be summarized under three headings: performance- relationships with research organization- social climate.

Performance appears as two independent axes in the correspondence analysis, showing that research workers efficiency can be described a) by their publications and participation to congress and b) by their "international weight". There seems to be two levels of proficiency,- one which enables the research worker to get visibility in the literature; another one which gives him access to international repute. These criteria will, of course, be used in the second stage of our research. And one must note that the two performance axes are independent from age, function and seniority.

But the picture is not fully described if we stop there. Relationship with the organization is a critical problem. We have seen during this first stage of the study, that the career situations of the research workers are very varied and that the responsibility given to the different subjects seem to be more related to the organizational rules than to the subjects' knowledge, seniority or experience. Moreover,

within one laboratory, different situations are to be met (in the State laboratories, specially) because research workers are very often appointed to a laboratory in one organization and paid by another one. Thus inequalities in job security, in pay levels and promotion opportunities are quite frequent. Some people accepts this situation, some do not and the quality of their work as well as their commitment to research seem to be strongly under the influence of their position within the organization. This fact came up in a repetitive fashion, through research workers attitudes as well as through their evaluations.

Social climate of the team is another critical factor and appears twice in the correspondence analysis. The picture we have, so far, is not completely clear and, at this stage of the research, we must limit ourselves to the following hypotheses (1) it is necessary for the research worker to adapt his behavior and style of work to the social climate of the team in which he works. (2) There are two ways of adaptation, one negative and one positive . Some people seems to find their balance in a strong involvment in their own research interests; other people have to adapt because they need the complementary competence and knowledge of their colleagues.

Obviously, unadaptation can also be observed but one must note that it is an independent factor, not related to performance. Theoretically, but this has to be proved, a research worker can show both good performance (publications and participation to congresses) and a poor adaptation to either the organization or the team.

To sum up, we expected that organizational determinants of research success would be a complex problem,-this expectation was fully verified.We have been unable to describe a typology of people but we have now good reasons to believe that there is a typology of adaptations to the research environment and one must say that this hypothesis fits well with the notion of organizational determinants for research behavior.

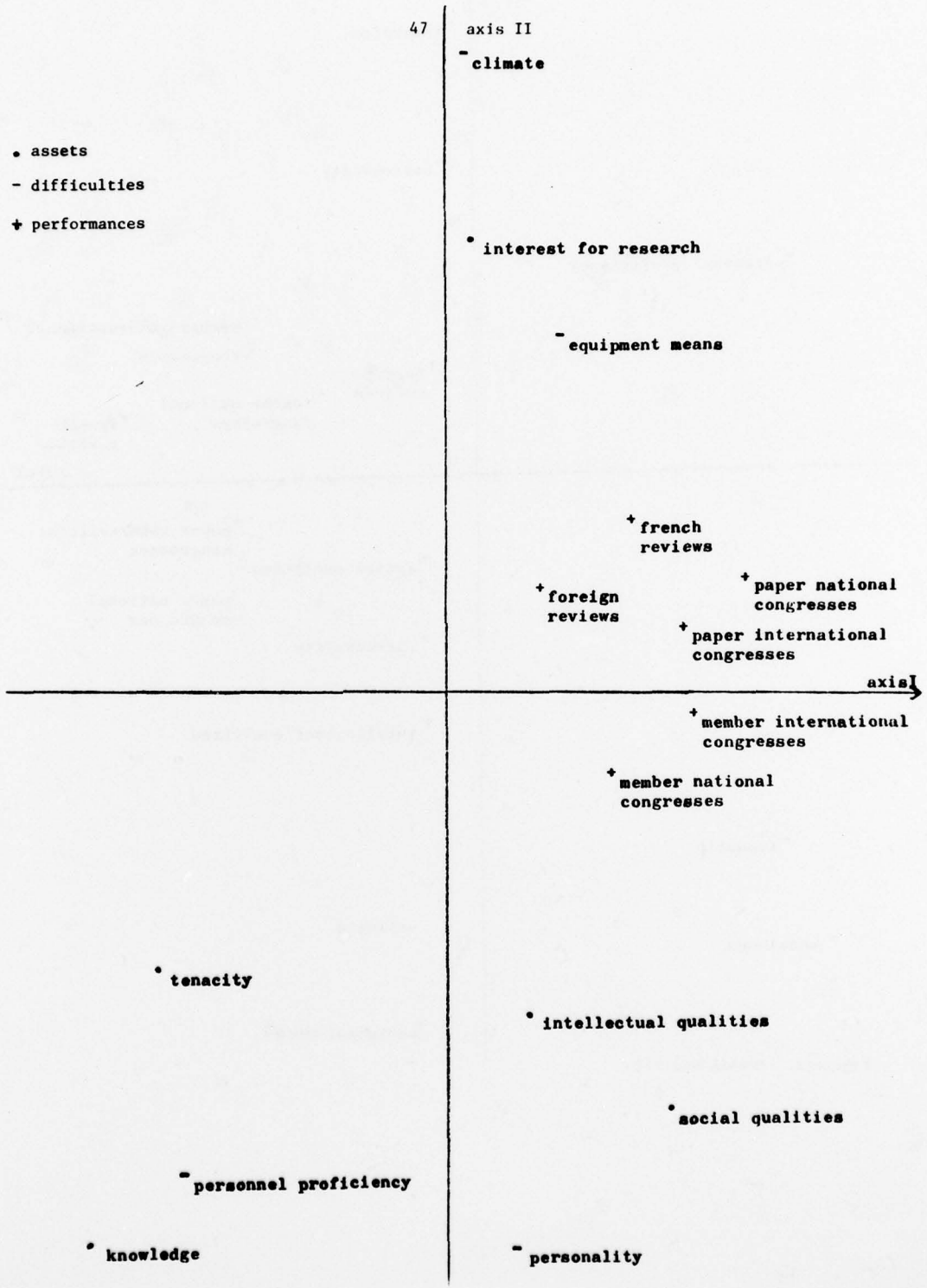


Figure 1. Axes I and II

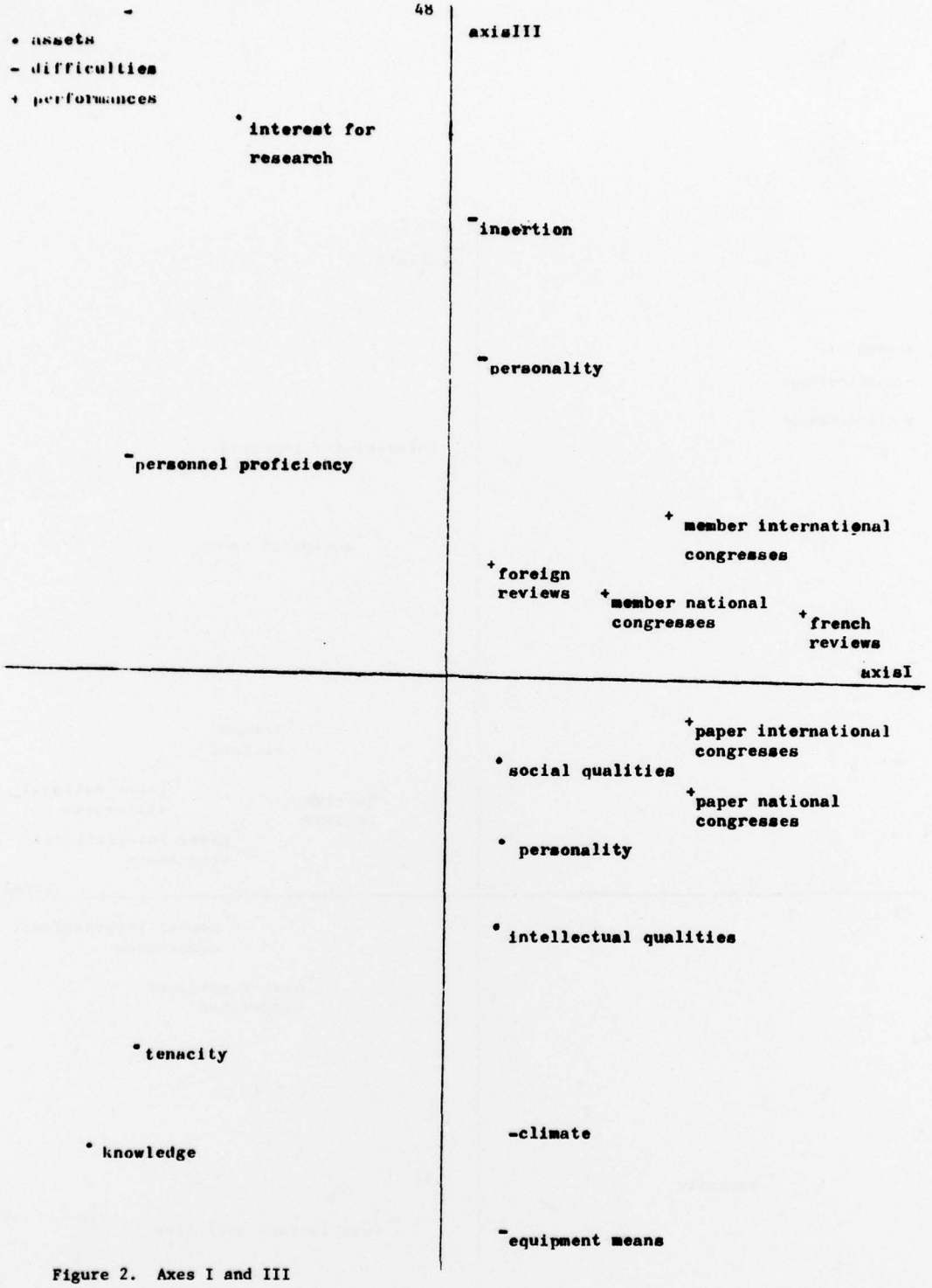


Figure 2. Axes I and III

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