Helsinki University of Technology
School of Mechanical Engineering
Department of Industrial Management

Elina Itälä

Strategic Human Resource Management of a Research Organisation
CERN as a Case Study

Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Engineering

Geneva, November 4, 1994

Supervisor
Ilkka Kauranen
Acting Associate Professor of Industrial Management

Instructor
Markus Nordberg
Master of Science
The research problem of the study is the question of how to enhance the organisational performance of a research organisation. The study concentrates on the European Laboratory for Particle Physics, CERN. The study combines research methods of literature survey and case analysis.

The study discusses factors like the mission, strategy, human resources and their management, culture and structure of CERN. A model of organisational performance is presented. It is concluded that at a research organisation standardised efficiency is not an appropriate criteria for assessment. Instead one should focus on the achievement of goals and the professional competence of the personnel.

Three cultural domains are identified inside the Organisation. These are the scientific, technological and administrative domains. Scientists' values of freedom dominate the Organisation. External pressures and the scale of accelerators induce a need for more control.

The role of strategic human resource management as an organisational filter is analysed. Three solutions are recommended to mediate between the economical pressures and the Organisation's culture. They are argued to produce the desired economical effect while being accepted by the dominant culture. First, an organisational revitalisation is needed to enhance flexibility. Second, facilitating professionals' work requires divisional federalism and service management approach. Third, strategic human resource management should be applied.
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Tutkimusongelma on tutkimusorganisaation kokonaissuorituksen parantaminen. Tutkimuksen kohde on Euroopan hiukkasfysiikan tutkimuskeskus CERN. Tiedonhankintaan käytetään kirjallisuus- ja casetutkimusta, joka perustuu haastatteluille.


Organisaation kolme osakulttuuria muodostavat tieteellisen, teknologisen ja hallinnollisen poolin. Tiedemiesten arvostama vapaus leimaa organisaation toimintatapojen. Ulkoiset rahoituspaineet sekä hiukkaskiihdyttimien valtava koko vaativat lisääntyvää kontrollia.

Preface

Carrying out organisation research is fascinating, because organisations may change overnight. I had the opportunity to carry out my thesis at CERN at the time of both CERN's 40th anniversary and an enthusiastic planning phase for its next particle collider. Within its limitations, this study wishes to contribute to the common efforts.

A little later there are dark clouds gathering on the horizon of the Organisation. The uncertainty of CERN's future is increasing, because the final decision to building the Large Hadron Collider is still pending. Even if the Large Hadron Collider would never be approved this study is an interesting document of a unique organisation.

I learned at least one thing at CERN summer student lectures. That is that all the forces of interaction are based on exchange of particles called fermions or bosons. I concluded that it applies to also other kinds of interaction. For example, regarding human communication the bosons are replaced by facts, experiences, ideas, and social rewards. I acknowledge having received a great deal from the Organisation. Also I am very glad because CERN has received this study well.

Geneva, 8th November 1994

Elina Itälä
Acknowledgements

If I was asked to summarise my working experience in Geneva I would like to say that CERN has a tangible quality owing to its people. Any help needed to carry out this study was immediately granted. I remain grateful to Marco Battaglia, Michel Bénôt, Bill Blair, Diether Blechschmidt, Frank Cliff, John Cuthbert, Michael Doran, Jean-Claude Gouache, Vincent Hatton, Friedrich Haug, Hans Hoffmann, Thierry Lagrange, Alberto Scaramelli, Ben Segal, and Marilena Streit-Bianchi. They all expressed interest in the Organisation and granted their time for interviews. My thanks go to Jaime Herrera for his expert advise on human resource management.

Most of all I would like to thank my instructors Markus Nordberg and Gilles Lindecker whose commitment to the best interests of the Organisation is admirable. I am very grateful to Sonia Escaffre for her indispensable support.

I wish to thank acting associate professor Ilkka Kauranen and professor Martti M Kaila for their friendliness and valuable advice.

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I want to acknowledge my indebtedness to Anna Dalmas who has polished the language of this study. I thank her for both her kindness and the excellent work.

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1 Introduction

1.1 Background of the study

As the world is turning in a more unpredictable fashion, organisations are facing new challenges. The world-wide economical recession of the 1990's suddenly imposes many organisations to financial constraints. Many of them react by restructuring. Organisations must ensure the achievement of their goals with less resources. This forces organisations to seek new solutions to enhance their performance.

Management has traditionally concentrated on technical and financial problems of organisations. Also enhanced human resource management is needed to cope with the ever growing complexity and competition. The only guarantee for tomorrow is to ensure that the organisation maintains an adequately skilled work force.

Recently, human resource management has gained more emphasis and various new practises have been widely taken up by companies. According to recent research, the link of human resource management to strategic management seems to be more of an exception than a rule.

1.2 Research problem

The topic of this study is organisational performance, a complex and highly general concept. The work of a number of people adds up to organisational performance.

Organisational performance is linked to the mission, strategy and tactics of the organisation. These are illustrated in the figure 1. The achievement of the mission is vital for an organisation, because it is

the justification for the organisation's existence. The mission is achieved by defining what should be done and how. The plans are carried out by distributing the tasks among the people. Appropriate co-ordinating mechanisms are used to guide the progress. Finally the joint efforts produce the desired output.

![Diagram](image)

*Figure 1*  
Steps to organisational achievement

Good organisational performance can be described as efficient and effective. Often organisational effectiveness and efficiency seem to be used as synonyms. Also either one may replace the expression 'good organisational performance'. Thus, a closer look at the two words is necessary to avoid confusion.

The stem of both words is the same. The Latin expression 'ex facere' mean to make out, to work out, and to accomplish. The difference in the meaning is that while effectiveness is related to the accomplishment of a purpose, efficiency denotes the power of acting. Drucker's view of effectiveness and efficiency distinguishes between doing the right things and doing the things right.

To avoid confusion throughout the study three new concepts are introduced by the author. These include

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- goal-oriented effectiveness
- competence-based efficiency
- standardised efficiency

Goal-oriented effectiveness is judged by the accomplishment of objectives. The proficiency of the employees is the basis for competence-based efficiency. Standardised efficiency or productivity is measured by the extent to which outputs are maximised for a given level of inputs. This is done by calculating the ratio of output and input. Standardised efficiency can be improved by increasing the power or frequency used to perform repetitive work.

The research problem is defined as how to enhance the performance of a research organisation in terms of competence-based efficiency, and goal-oriented effectiveness.

1.3 Objectives of the study

The study has both heuristical and therapeutical objectives. The study seeks to arrive at both to interesting academic results and to improve the performance of the Organisation. The primary objectives of the study are

- identifying critical factors of organisational performance of a research organisation
- suggesting actions for enhancing organisational performance of a research organisation

Partial objectives of the study derived from the primary ones are

- understanding the mission and strategy of the case organisation
- describing the organisational structure of the case organisation
- describing the organisational culture of the case organisation
- analysing the human resources of the case organisation

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- building a model of organisational performance in terms of competence-based efficiency and goal-oriented effectiveness
- setting objectives for the development of the case organisation
- building an action plan for organisational development

1.4 Scope of the study

The study concentrates on the European Laboratory for Particle Physics CERN. Hereafter, CERN will be referred to as 'the Organisation'. CERN is interesting because of the professionalism of its staff and its complex technological environment. Out of all the aspects of the Organisation, only the human resources are chosen for this study. Thus the utilisation of material and financial resources are excluded.

CERN's future project is likely be the construction a particle accelerator called the Large Hadron Collider. This study focuses on the challenge this project has already brought to CERN. All other projects presently being considered or completed at CERN are excluded from this study, because the Large Hadron Collider project is the most crucial one.

The human resources needed for the project come from both inside and from outside the Organisation. Suppliers, sub-contractors and national research institutes all co-operate closely in the accomplishment of the work. Only the staff paid and fully controlled by CERN are concerned in this study. In 1994 there are roughly 3500 employees at CERN. In addition to that CERN has registered some 5500 scientists that use the research facilities of CERN. They are paid by other research institutes or universities from all over the world. The impact of the cultural differences is excluded from this study.

The scope will not be reduced further to a specific part of CERN. This choice is based on the belief that problems encountered at the organisation level have a more significant impact than problems encountered locally. Also consciousness of these problems is harder to obtain.

1.5 Research methods

The research approach is that of clinical organisation research discussed in chapter 3. A broad view of the Organisation is maintained during the research process to prevent an exclusion of critical factors and to create an effective set of recommendations.

The study combines the research methods of

- literature survey
- case analysis

The case analysis consists of

- analysing official documents of the case organisation
- interviewing with open-ended questions
- applying Mintzberg's organisational models
- constructing a model of organisational performance
- giving a public presentation on the results with feedback through an open, round-table discussion

2 Literature review

This literature review provides the concepts and framework needed for the study. Organisations can be approached in numerous ways. The theoretical framework of this study is provided by Mintzberg's model of organisation configurations. The latest findings on human resource management are discussed.

2.1 Organisation configurations

An organisation must learn how to survive by carrying out its mission in its environment. In doing so the organisation solves many problems. The solutions and experiences form an organisation culture shared by the members of the organisation. There are three levels at which the organisation culture is manifested. These are

- artefacts
- outspoken values
- unconscious basic assumptions

The last level can be discovered only after careful probing, a type of organisational psychoanalysis. The organisation culture changes through development stages. At every stage there are different change mechanisms. Maturity stage is followed by stagnation and decline or possible reorganisation and rebirth.

Organisational change can arise and can be managed in a number of ways. Leadership is important. Different change strategies are likely to be needed according to the cultural environment as organisations reflect their social context.

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Organisations can be thought of as open systems which are constantly interacting with their environment. The external environment is the combination of social, economic, technological, and political forces that influence the organisation.\textsuperscript{7}

Mintzberg argues that the organisations face different kinds of pressures depending on their age, size, technical system, environment, and external control. Seven types of pressures are identified. When conditions favour one of these pressures the organisation is drawn to design itself using a consistent set of elements of structure, called configuration. Domination of only one pressure results in a pure type of configuration.\textsuperscript{8} These pressures and configurations are presented in table 1.

\textit{Table 1  \hspace{1cm} Seven types of organisational pressures and resulting organisation configurations and mechanisms for co-ordination \hspace{1cm} 9}

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<tr>
<th>Pressure for</th>
<th>Configuration</th>
<th>Mechanism for co-ordination</th>
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<td>direction</td>
<td>entrepreneurial</td>
<td>direct supervision</td>
</tr>
<tr>
<td>co-operation</td>
<td>missionary</td>
<td>standardisation of norms</td>
</tr>
<tr>
<td>learning</td>
<td>innovative</td>
<td>mutual adjustment</td>
</tr>
<tr>
<td>proficiency</td>
<td>professional</td>
<td>standardisation of skills</td>
</tr>
<tr>
<td>concentration</td>
<td>divisional</td>
<td>standardisation of outputs</td>
</tr>
<tr>
<td>standardised</td>
<td>standardised</td>
<td>standardisation of work</td>
</tr>
<tr>
<td>efficiency</td>
<td>politicised</td>
<td>non applicable</td>
</tr>
</tbody>
</table>

Every organised human activity gives rise to two opposite requirements of the division of labour and the co-ordination of


\textsuperscript{9} Itälä, E. 1994. Strategic human resource management of a research organisation. CERN as a case study. Otaniemi, Institute of Industrial Management, Helsinki University of Technology.
those tasks. Each configuration has a different mechanism for coordination, which are listed also in table 1.

Mutual adjustment means achieving co-ordination by informal communication. Paradoxically it is the best mechanism to deal with the simplest and most complex forms of work. Direct supervision is too autocratic and standardisation is too inflexible.\textsuperscript{10} Of all the mechanisms, mutual adjustment and direct supervision are most often encountered. Leadership and informal communication are needed to override the rigidities of standardisation.\textsuperscript{11}

According to Mintzberg, divisional structure is appropriate for large diversified organisations that operate on many markets and technologies. An organisation faced with a single market simply cannot split itself into autonomous divisions.\textsuperscript{12}

Each configuration is a life style of its own and sows the seeds of its destruction with its lack of opposite qualities. Having a hybrid structure an organisation has all the elements of healthy cultural diversity, but then it faces the problems of cultural ambiguity.\textsuperscript{13}

Rigidity is an organisational symptom of age and size. It will increase with time without treatment. Organisations which are too rigid can be described as bureauopathologies. The disease is caused by dysfunctional tightening of controls on behaviour. Rigidity leads to concentration on means at the expense of ends. This implies also mistreatment of clients and various manifestations of employee alienation.\textsuperscript{14}

2.2 Strategic human resource management

A large part of the success of any business is having the right people

\textsuperscript{12} Ibidem. Page 160
\textsuperscript{13} Ibidem Pages 263 – 268
\textsuperscript{14} Ibidem. Page 142

in the right places to implement a proper plan. Human resources, along with financial and material resources of the organisation, contribute to the delivery of the products or services.

Successful management calls for managers and human resources professionals to find the best way of using people to accomplish organisational goals and to improve organisational performance. The role of the managers and human resource professionals is to find ways to increase employee satisfaction, commitment and involvement in organisational life, while increasing organisational productivity.

Human resource management covers the use, development, assessment and reward of individual organisational members or groups. It includes the design and implementation of systems for planning, staffing, developing employees, managing careers, evaluating performance, compensating employees and smoothing labour relations. The human resource cycle is presented in the figure 2.

![Cycle of human resource management](image)

**Figure 2** Cycle of human resource management

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17 Ibidem Page 5

Principles of human resource management are fairness, respect, holistic view of organisation, service, advocacy, authority, and mediation. Human resource management not only endeavours to mediate the harsher economical imperatives of the market but also seeks to construct a moral order for the organisation.

![Three levels of human resource management](image)

*Figure 3  Three levels of human resource management*

There are three levels of human resource management presented in figure 3. These are, from short-term to long-term, operational, managerial and strategic levels.

The process of human resource management consists of:

- developing close co-operation between human resource and corporate planners
- identifying human resource needs of the organisation
- examining external events for human implications
- planning for development of human resource department
- planning for regular reviews of progress

Human resource management can increase organisational performance by motivating organisational members to outstanding work. It will lead to the ability to attract and retain the best people.

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22 Ibidem Page 59

A study of public sector organisations supports the hypothesis that organisations which give high priority to the human resource management are likely to be more effective than those whose cultures do not support it.  

Human resource management has not been used to its full potential. Although it seems that a strong and ever growing emphasis is put on personnel, the link to strategic management seems to be more the exception than the rule. Thus human resource management has been conducted primarily at the operational level failing to involve strategic and managerial levels. It has tended to be passive and reactive. Human resource management should encompass macro-organisational issues such as strategy, structure, culture and leadership.

Companies still focus on managing the tangible products rather than the intangible motivation and skills. Many firms already are or soon will be competing on competencies. Possession of competence, defined as work-related knowledge and skills, is a prerequisite for success. Human resource management seeks to bring together the rational and quantitative aspect of an organisation with its cultural and human features. The objective is to combine individualism with the capacity of teamwork.

Human resource management covers a continuum of different

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roles. The concept itself can be defined as to consist of:

- traditional personnel administration like staffing, rewarding and work design
- personnel development
- a specific management philosophy that values personnel as the major asset of an organisation and that regards human beings as able and willing to grow and develop
- the integration of the personnel function into strategic management

Strategic human resource management is a business-focused and proactive perspective. It takes a broad, integrated view of the personnel function. It seeks its links to the long-term strategies of the organisation and asks how the personnel function can help accomplish those strategies. It is believed that integrating strategy and human resource management will lead to enhanced financial performance. There is still little firm empirical data to confirm that.

Strategic planning is the process of setting organisational objectives and deciding on comprehensive programs of action which will achieve these objectives. Strategic human resource planning is the process of linking the management of human resources to the organisation's overall strategies for achieving its goals and objectives. Systematic analysis of people, jobs, the organisation, and the environment is the first step in human resources planning. Strategic planning requires three core elements which are:

- mission and strategy
- organisation structure
- human resource management


34 Ibidem Page 18

Figure 4 presents the interrelationships among the elements of the management process. Forces in the economy, in the political system, in the society and in technology all effect the management of organisational performance.

![Diagram of environmental pressures on management]

**Figure 4**  Environmental pressures on management

Strategic staffing is the process of forecasting an organisation's demand for employees and deciding on a plan of action to secure those employees through recruitment selection, promotion and transfers. Strategic compensation is the financial reward and the benefits which the organisation gives the employees in exchange for work. Rewarding policy should be informal, performance based and adjustable. Compensation is a very complicated strategic question. There must also be means of contract termination.

Strategic human resource development is the identification and growth of needed employee skills and experience for the intermediate and long-range future to support explicit corporate and

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38 Ibidem Page 485

business strategies. Companies should examine how training and development can effectively promote organisational objectives.

Figure 5 presents how the choice of a human resource strategy depends upon whether the person and the job situation are relatively stable or flexible.

![Diagram](image)

**Figure 5**  
Choice of human resource strategy

Begin's classification of four kinds of organisations is presented in figure 6.

![Diagram](image)

**Figure 6**  
Four types of organisations based on technical knowledge and environment

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39 Ibidem Page 301  
40 Ibidem Pages 40 & 59  

The organisation must change from a standardised structure towards an innovative one when its technical environment becomes dynamic. The effects of its human resource management strategy must change drastically. The biggest shift is from no integration to a strategic integration of human resource function to the overall strategy. In table 2 are listed human resource management adjustments which are required when the technical knowledge of the organisation becomes dynamic.

Table 2 Change of characteristics of human resource management system as the organisation moves from a professional to an innovative form

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Explanation</th>
<th>Professional</th>
<th>Innovative</th>
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<tr>
<td>competence</td>
<td>sufficient supply of skilled employees</td>
<td>moderate or high</td>
<td>high</td>
</tr>
<tr>
<td>productivity</td>
<td>cost consciousness of human resource management</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>financial flexibility</td>
<td>ability to adjust wage bill to reflect performance</td>
<td>low or moderate</td>
<td>high</td>
</tr>
<tr>
<td>functional flexibility</td>
<td>freedom to deploy employees across different tasks</td>
<td>low or moderate</td>
<td>high</td>
</tr>
<tr>
<td>internal numerical flexibility</td>
<td>freedom to adjust working hours of existing work force</td>
<td>moderate</td>
<td>high</td>
</tr>
</tbody>
</table>

This kind of change takes place if the economic or political environment becomes unpredictable or the knowledge environment turns increasingly complex. Standardised organisations then need to undertake the difficult task of overriding the bureaucratic tendencies and adapt to a more flexible structure.

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Ibidem Pages 387 – 389

3 Description of the clinical organisation research approach

Particle physics research seeks to break and analyse smaller and smaller constituents of matter. The research becomes heavier when deeper levels are reached. Equally, organisation research can analyse its subject even at the level of individuals.

Reductionism consists of breaking down the object of study into small, well-defined parts. According to the holistic view, however, the whole object is not identical with the sum of these parts. Consequently, the whole object can be understood by treating it as the central part of the study. In this context case research seeks to obtain a holistic view of a specific organisation.43

The research process of this case study was clinical. The needs of the Organisation had a higher priority than the possible academic outcome. Due to this problem-based situation the research programme could not be rigid.

Clinical organisation research was born in the 1980's. It combines solving practical organisation problems and scientific research. The word clinical refers to a diagnosis of an illness and treatment of the patient. This is in contrast to regulated experiments and fixed research programmes of conventional organisation research.

Clinical organisation research is based on a certain set of organisation theories. The theories don't add up to an explanatory picture of organisations. The work of a clinician is not based on theories but open observation and close co-operation with the object. A continuous appraising of feedback validates the results. The research builds on practical views yet after generalisation it has theoretical value, as well.

Organisations themselves usually have a picture of their problems.


However, the problems often merit more detailed examination. In clinical research the researcher forms his or her own impression of the organisation's problem, hence entering into confrontation with the organisation. The formation of an independent picture takes place by means of the analytical steps of the research process.44

Clinical research demands independent behaviour on the part of the researcher.45

The attitude of the researcher towards the object of research is characterised by openness and impartiality. The dialogue or interactive working method is a central feature. The research objectives are correct determination of the problem and a contribution towards finding effective solutions and their implementation. The clinically oriented researcher must take care to ensure that the bridging function between theory and practice is not neglected.46

The essence of the clinical perspective can be summarised by stating that 47

- the process is client oriented
- the inquiry is problem centred
- data are deep but not broad
- data are analysed in case conferences

The clinical research approach affected the choice of research methods. Building a quantitative model is academically interesting, but it may be totally incommensurate compared to the complex reality the Organisation is struggling with. Also exhaustive, reliable and valid data concerning the performance of the Organisation is difficult to obtain. Competence-based efficiency of the human resources in different areas is affected by innumerable factors. Also it

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46 Ibidem Page 16

is not a sum of its components but rather a product of factors. Even one missing factor might result in zero performance. Most of the factors cannot be quantified and probably not even recognised.

The organisational performance question raises immediate suspicions among the personnel. Enhancing performance may be at odds with employee security and satisfaction. These hidden factors may have serious consequences. As a result, quantitative research methods are excluded.

The research process started with a literature review. After that a series of interviews was carried out. Fourteen people were asked to grant an interview, all of which agreed. They were named by a single person, namely the supervisor of the instructor of the study, who has worked at the Organisation for 24 years. The interviewed people were chosen from different divisions in order to get a general and balanced view of CERN as an organisation. They were known to have responsibility and experience with organisational matters.

A questionnaire with open-ended questions was used as a basis for the interviews. It is presented in appendix 1. The questions were chosen to map key factors of organisational performance based on the literature review. The interviews were conducted freely and informally. The conversation was often led to personal views and other topics than the designed questions. The interviews lasted from one to three hours. The author took notes and cross-checked statements that did not seem to be unanimous through different divisions. It was agreed that statements made by individual persons would not be quoted for confidentiality reasons.

The structure of the research process was cyclical. The author started with a theory and a related hypothesis. Often the theory was not congruent with the reality of the Organisation. However, theories helped to explain the reality deductively by slotting the observations into categories. In addition, they also helped inductively by providing concepts through which new things could be seen. This enabled to make better diagnoses. As a result the synthesis emerged adding something new to both the real problems and academic

knowledge.

To understand the structure and culture of the Organisation the interviews were analysed. The future was examined with a scenario analysis. Based on the qualitative data obtained from the interviews and the literature review recommendations, conclusions were then formed.
4 Results of the case study

4.1 Introduction to the European Laboratory for Particle Physics CERN

The cost and scale of modern particle physics tools require efficient resource pooling. This is accomplished at the European Laboratory for Particle Physics CERN. It is one of the world's largest scientific laboratories. It is also an outstanding example of international collaboration. It has led the way towards transparent frontiers and financial load-sharing in science. CERN was one of the first European organisations to be set up after the Second World War, and was the very first scientific organisation ever created by sovereign states.48

The acronym CERN comes from the earlier French title "Conseil Européen pour la Recherche Nucléaire". The official name of CERN is the European Organisation for Nuclear Research.

4.1.1 CERN mission of providing research facilities

During the first half of this century, achievements in Europe dominated the world progress in physics, from the discovery of the electron to special relativity and quantum mechanics. The Second World War interrupted the advance. It was not before 1950 that the creation of a European laboratory was recommended at a United Nations' Educational, Scientific, and Cultural Organization UNESCO meeting. In 1953 the CERN convention was signed by twelve countries.

According to the convention, the Organisation shall provide for collaboration among European states in nuclear research of a pure scientific and fundamental character. The Organisation shall have

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48 CERN. 1991. CERN, European Laboratory for Particle Physics. Page 18

no concern with work for military requirements. The results of its experimental and theoretical work shall be published.49

CERN's vocation is to provide the European scientific community with the facilities needed to probe the structure of matter in ever increasing detail. Specifically, it designs, builds and operates the particle accelerators and detectors needed as tools for such research. CERN allows European physicists to work cost-effectively and with better collaboration than if each country pursued its own and much smaller programme.

CERN's governing body is the council, which meets at least twice a year. The council is the ultimate authority for all important decisions. By 1994 CERN has nineteen European member states. Finland joined CERN as a full member in 1991. Each member state has a single vote and two delegates, one representing the government, the other representing national scientific interests. Most decisions require a simple majority, although CERN council aims at a consensus as close as possible to unanimity. In financial matters a simple majority of votes and a representation of 55 per cent of the total financial contribution is necessary. This percentage is likely to be raised to 67 per cent for votes on the budget and the four-year plan.

The director-general appointed by the council is the chief executive of the Organisation, assisted by a small team of directors.50 The operational activities of the Organisation are carried out by the divisions.51 An organisation chart presenting the divisions is shown in appendix 2. Wherever possible, activities are grouped CERN-wide like administrative tasks for gains in productivity due to size. The divisions are gathered into sectors of activity supervised by one or more directors.52 These sectors are

- the research sector responsible for implementing CERN's scientific policy

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50 CERN. 1993. The Next Step. Pages 1 – 2

- the accelerators sector responsible for the operation of the various accelerators and the development of technologies directly related to them
- the technical support sector which comprises the services linked to the activities in the previous sectors
- the administrative support sector

The evolution of the CERN budget is presented in figure 7. The budget amounted to 950 million Swiss francs in 1993. Half of it covered the personnel and the other half the materials.\textsuperscript{53} On average CERN's budget accounts for 0.01 per cent of the gross national product of its member states. CERN's annual budget would enable each citizen in its member states to buy about one packet of cigarettes per year.

\begin{figure}
\centering
\includegraphics[width=0.7\textwidth]{Budget_Evolution.png}
\caption{CERN budget evolution from 1953 to 1995 in millions of Swiss francs at 1991 prices \textsuperscript{54}}
\end{figure}

In 1994 CERN operates 11 machines.\textsuperscript{55} Table 3 presents the years of commissioning of existing and planned CERN colliders.

\textsuperscript{54} CERN. 1991. CERN. European Laboratory for Particle Physics. Page 23
\textsuperscript{55} These include LINear ACcelerator LINAC, Proton Synchrotron PS, Super Proton Synchrotron SPS, Proton Synchrotron Booster, Antiproton Accumulator AA, Low Energy Antiproton Ring LEAR, Linear Injector for the Large electron positron collider LIL, Electron Positron Accumulator EPA, Antiproton COLlector ACOL, Large Electron Positron collider LEP, ISotope On-Line eSperator ISOLDE

Table 3  Years of commissioning of existing and planned CERN colliders

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Collision type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>Intersecting Storage Rings ISR</td>
<td>proton – proton</td>
</tr>
<tr>
<td>1981</td>
<td>Anti-Proton accumulator and Super Proton Synchrotron SPS</td>
<td>proton – antiproton</td>
</tr>
<tr>
<td>1989</td>
<td>Large Electron Positron Collider LEP</td>
<td>electron – positron</td>
</tr>
<tr>
<td>2004</td>
<td>Large Hadron Collider LHC</td>
<td>proton – proton</td>
</tr>
</tbody>
</table>

For the discovery of the 'W' and 'Z' carriers of the weak nuclear force, the 1984 Nobel Prize for Physics was granted to CERN scientists Carlo Rubbia and Simon van der Meer. In 1992 Georges Charpak won the prize for his development of particle detectors. Sam Ting was awarded the 1976 Nobel Laureate for the discovery of the J/psi particle. In 1988 Jack Steinberger got the same prize for the discovery of the muon neutrino.

4.1.2  CERN strategy of building the Large Hadron Collider

In 1991 CERN council stated that the Large Hadron Collider is the right machine for the future of particle physics and for CERN. With the demise of the Superconducting Super Collider SSC the significance of this statement has become even more pronounced. Extensive detector research and development work is under way. In November 1994 CERN council's final approval of the project is still pending, with two member states who have not yet cast their votes.

The estimated cost of 3 billion Swiss francs will be not much more than that of CERN's previous collider project, after adjustment to inflation. This can be partly explained by CERN's policy of recycling equipment, reuse of the experimental areas and the tunnel, and by

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57 Ibidem Page 41

the fact that yesterday's high-tech devices become today's standard components.

The Large Hadron Collider will be installed in the tunnel of 27 kilometres circumference that was built for the Large Electron Positron Collider. It will be filled with protons delivered from a chain of existing accelerators. The super-conducting magnets guide the protons during their accelerations to an energy equivalent to the mass of about 7000 protons. The beams are made to collide at the centre of experiments.

Many difficult problems must be solved to design, construct and operate the Large Hadron Collider.\textsuperscript{59} These include

- extremely powerful magnets of 9 Tesla
- high-speed electronics with a precision of $10^{-10}$ seconds
- ultra-high vacuum of $10^{-10}$ Torr
- ultra-low temperatures of 1.9 K

In the Large Hadron Collider, protons will collide at energies of $14 \times 10^{12}$ electronvolts in the centre of mass. At this energy experiments are expected to shed light on the origin of mass, electroweak symmetry breaking and the unification of the basic forces of nature.

4.2 CERN human resources and their management

4.2.1 Review of the human resources

The members of the personnel are divided into established members of the personnel and non-established members of the personnel.\textsuperscript{60} These are illustrated in the figure 8. The former consist of staff members with permanent, fixed-term or term contracts. The latter consist of

\textsuperscript{59} Ibidem Pages 31 – 34
\textsuperscript{60} CERN, 1987. Staff Rules and Regulations. 9th edition. Page 2

\textsuperscript{I}iälä, E. 1994. Strategic human resource management of a research organisation. CERN as a case study. Otaniemi, Institute of Industrial Management, Helsinki University of Technology.
There were 5500 registered unpaid associates employed by participating institutes. They are the physicist users of the Organisation, and not CERN staff members. In most cases their research at CERN is financed by the institutes and universities to which they belong. They account for over half of the particle physicists of the world. On average about 2500 of them are present at any given time at CERN in Geneva.

In addition to the personnel there are 1300 people registered as industrial support employees. They provide annually an additional effort up to 800 man-years. Industrial support is used

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62 Ibidem Page 4  
63 CERN. 1991. CERN, European Laboratory for Particle Physics. Page 27  

- to cover the part of the workload not directly related to the scientific programme like cleaning and guard duties
- to cover the part of the workload which is beyond staff resources like production of mechanical components or electronic circuits for experiments
- to temporarily replace staff absent due to illness
- to respond to seasonal peaks in the workload as, for example, during the accelerator shutdowns

At the end of 1993, there were 500 fellows, paid-associates and students employed by CERN. The staff totalled 3000 people. CERN staff are classified into five professional categories which include

- research physicists
- applied scientist and engineers
- technicians
- manual labour and craftsmen
- administrators and office staff

Figure 9  Staff by professional categories

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The distribution of the professional categories is shown in figure 9. The first category comprises about 100 research physicists who take part in research activities. There are some 800 physicists, engineers and computer specialists variously responsible for computing, for constructing, maintaining and operating the accelerators. There are about 1100 thousand technical staff. 500 craftsmen perform manual tasks that are not easily contracted out. 500 people are assigned to administration.

For historical reasons, the biggest national group is French as can be seen from table 4.

<table>
<thead>
<tr>
<th>Nationality of the staff</th>
<th>Percentage of the total staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>French</td>
<td>49%</td>
</tr>
<tr>
<td>Swiss</td>
<td>13%</td>
</tr>
<tr>
<td>British</td>
<td>10%</td>
</tr>
<tr>
<td>German</td>
<td>8%</td>
</tr>
<tr>
<td>Italian</td>
<td>7%</td>
</tr>
<tr>
<td>Other</td>
<td>13%</td>
</tr>
</tbody>
</table>

In 1992 a detailed inventory was carried out of CERN activities and the human and material resources assigned to them. As a result a database of CERN units was produced. It contains a description of human resources estimated in man-years and their distribution over the different units.67

4.2.2 Personnel management and administration

CERN's personnel division is a centralised service for the whole Organisation. It takes care of personnel administration, classification and remuneration, relations with the personnel, recruitment,

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66 Ibidem Page 11

fellows, associates, students, education services, and social affairs. The personnel division leader reports to the director of administration. Personnel management tasks are shared among the co-ordinators on a divisional basis. This kind of a structure encourages human resource professionals to act as generalists.  

Recruiting is only a problem, if the professional speciality required is rare. CERN hires people with a good training and some experience in a close technical speciality. In general people have on-the-job training at CERN.

CERN educational service offers management, technical, communication, and language courses. The management training seminars are given by expert consultants in industrial management practices. The communication courses are aimed to develop tailored communication style. In technical areas some divisions prefer external training courses, which are technically more specific.

CERN has implemented many new human resource management practices recommended in 1987. In 1991 annual interviews, Merit-Oriented Advancement Scheme MOAS, and a staff complement system were introduced. There will also be a new information tool called Human Resources Management and Payroll in 1995. It is part of an Oracle-based management information system that will include also store management and accounting. Also skills inventory database has been created. It contains information of individual qualifications, language skills and in-service training. The potential benefits of such a database to the organisational performance are significant.

Remuneration and performance appraisals
CERN salaries are fairly high, mainly due to the high living costs in Switzerland. There are also social factors that affect the attractiveness of


CERN as an employer. CERN staff have special residential status. Although possible in principle, it is actually difficult for spouses to find a job. Also integration back to their home country is more difficult after many years of absence. Only staff members benefit from the social security scheme provided by the Organisation.

The research physicists and applied physicists are paid the highest salaries, followed by professional administrators, technicians, craftsmen, and administration support personnel. Salaries of applied scientists, engineers and technicians form 70 per cent of the staff costs.72

In 1992 the Merit-Oriented Advancement Scheme was introduced. It is based on a continuum of overlapping career paths as shown in figure 10. The advancements are based on annual performance appraisals.73 The introduction of the new system created a flare-up of advancements. One grade consists of 10 – 13 salary steps. The average of advancements was beyond the desired one step per year. The major impact came from the unblocking of staff from the end of their last grade. They were promoted into a newly created exceptional advancement zone. Normal progress is one step per two years in the exceptional advancement zone.

Figure 10 Mapping of 9 career paths to 13 salary grades 74

Until 1991 a quasi-automatic annual salary step was granted to all the staff independent of their performance. Promotions from one

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salary grade to the next was performance-related. Salary levels plotted against age tended to be linear. The promotion system rewarded seniority. A very high fraction of the staff are now seniors.

In theory there is no quota for advancements. In reality the promotions are limited by the budget envelope. The number of exceptional advancements is distributed among the divisions and groups. There are very few of them to motivate all the hardworking people. The unavoidable unjustice has more effect than the loss of an infinitesimal salary increase. At CERN there is not much secret of advancement and salary levels. People are aware of each other's earnings.

In parallel with the Merit-Oriented Advancement Scheme, annual interviews were introduced as a mechanism for appraisals. Every supervisor has to discuss with the subordinates their performance, objectives and training needs. This is done by filling in a form and writing a description of the subordinate's achievements. After the interview a recommendation for an appropriate advancement is made. It is approved by supervisors of the next two levels. The whole procedure requires much time. Preparing, interviewing and writing the evaluation takes several hours per subordinate.

The annual interview forces supervisors to give feedback and discuss the work objectives with their collaborators. The comprehensive official document has to be agreed by the supervisor and the staff member concerned. Checking ensures that there are no misunderstandings due to bad communication. The documents carry records of what people have done. Annual interviews have strengthened the Organisation hierarchy as the staff discuss their career objectives with their supervisors at least once a year.

According to a survey most CERN staff are very satisfied with their work. Regarding advancements they do not consider the new system better than the old one nor very useful. The system has had a very limited or non-existent impact. Many have been disappointed by their assignments to career paths. They are also doubtful about their future perspectives regarding advancement. The clarity of the

system was criticised, too.\textsuperscript{75}

**Human resource planning**

At the divisional level personnel planning includes an analysis of scientific programmes, their technologies, required skills, professional categories and age distribution.

For years the material budget has been under constant scrutiny. So far, personnel costs have been pooled centrally. The divisions have had no direct control over the costs of personnel. The number of personnel tended to be grow until the mid-1980's. A division with better career opportunities could attract people from other divisions. For example, computing and networks division was able to attract programmers from the accelerator divisions.

To achieve savings the recruitment has been limited during the last years. The staff complement system assigns a certain level of human resources to certain units. It makes personnel evolution and costs transparent. It also guarantees a replacement of leaving staff. However, for internal transfers the receiving division has to have a vacancy before a transfer can take place.

In 1994 the sectors could allocate rotational, term contract and long-term staff autonomously among the divisions according to their staff complements. The aim is that in the near future the divisions can decide within set limits whether to carry out the work by themselves or to outsource it to external bodies. This is done by allowing divisions to manage their personnel and material budgets within a total annual allocation. Only then divisions and groups could try to optimise their personnel and materials expenditure in parallel. Also the divisions would have at least the opportunity to prepare succession plans. Young people could be hired in time to learn from the experienced ones that are due to retire in a few years.


4.2.3 Human related problems in divisions

Three problems are common to the majority of the divisions. These include

- lack of resources
- unbalanced age profile
- dilemma of permanent staff versus industrial support

Lack of resources
CERN's long-term plans define a steep decline in the staff numbers based on natural retirement. As recruitment is restricted, retiring people are not all replaced. Personnel reductions are usually distributed on a numerical basis, not necessarily based on organisational needs.

Complements are so far designed to keep a status quo among divisions. Before defining new complement levels one needs a decision for the new profile. CERN is preparing an outsourcing policy. It will determine which in-house services are going to be run down and which ones will be granted the necessary resources.

Due to the decay of resources, many people are working overtime to compensate for the lack of personnel. No overtime compensations are paid to staff at grades 10 – 14. This is accepted, because the problem is common.

The unbalanced age profile
CERN granted a great number of indefinite contracts to people hired in the period of 1962-1974. Today, some 90 per cent of the staff have an indefinite contract. Many of these people are close to retirement. CERN cannot easily deploy or discharge them even if it badly needs young expertise to ensure the continuity. Up to 50 per cent of the present staff are expected to retire by the year 2005.

The Organisation is not empowered to dismiss a staff member except for disciplinary reasons. The cost of suppression of a post is high. The current departure scheme is not attractive with its departure
allowance of 6 months basic salary. The people are better off staying at CERN with their tax free salary even if they have uninteresting jobs. Redeployment is difficult because of obsolete skills and difficulties of retraining after a certain age.

Early departures programmes used to invite voluntary early retirement. The staff might retire early and be granted a paid, unworked notice period. The cost of the programmes was high, because CERN paid a departure allowance of 12 – 24 months' basic salary to the employee and a compensation for the pension fund. All the programmes were non-directive. The result was that often the people with the highest skills and initiative decided to build a second career elsewhere. Instead, the staff who worked only moderately well were satisfied and did not wish to leave.

CERN's situation could be compared with the International Telecommunication Union ITU. Its human resource management practises are common to all United Nations specialised agencies. The system is rather rigid. At certain units even 80 per cent of the personnel have a short-term contract typically of six months. This is the biggest reason for dissatisfaction in the employment management, because the insecurity disturbs the daily life.76 At CERN the indefinite contracts provide security.

Dilemma of permanent staff versus industrial support
CERN's policy is to diminish the number of the staff. Outsourcing has been executed especially in the technical support sector through industrial service contracts. On the one hand, the advantage of industrial services is that it is relatively easy to have disqualified people replaced. On the other hand industrial services are a threat to continuity, because good people are usually lost at the end of the contract. Moreover, a certain learning period is needed, which requires additional effort and resources. Outsourcing requires budget rigidity because contracts are signed for several years at a time. So far the implementation of outsourcing has been inconsistent.


Complement target figures for sectors have been altered as the outsourcing policy is still being formulated.

4.3 Organisation analysis

4.3.1 Analysis of organisation culture

Cultural manifestations on the artefact level
CERN is situated in Geneva in Switzerland. CERN's main site in Meyrin is on the border of France and Switzerland. The reference currency and public services like post and telephone are Swiss. Most of the large accelerators and experimental areas are in Preveissin in France.

When approaching CERN, road signs are the only indication. It appears as if CERN were a village. Apart from a row of 19 European flags there are no large symbols that would welcome a visitor. Only because of CERN's 40th anniversary, did a big sign appear saying that this is the main entrance of CERN.

CERN looks like a big complex of industrial halls and office buildings. For an outsider the buildings are numbered in a confusing way. For example, building 307 is next to building 11. The numbers actually tell the construction order. One needs the code to see the logic but only a few people know it.

Most buildings look old and not too well maintained because physicists rather prefer to build first-rate scientific equipment. Expensive and smart looking buildings are regarded as vanity. On the top sixth floor of the white main building is a conference room. On the fifth floor are the offices of the director-general and the director of administration. For an outsider, visiting the fifth floor is a very prestigious event.

Hundreds of cars parked at CERN have consular or diplomatic plates. Also there are many white cars with CERN marked on them. CERN cafeteria is open from 7.00 to 1.00 daily. The library is open 24
hours a day. CERN offices are shared by many people. The names on
the doors do not include academic titles and are of different
European origins.

The outspoken values of the Organisation
CERN has been very successful in achieving its mission, thanks to
its people. Based on the interviews several explanations for their
motivation were identified.

CERN has got the biggest set of large accelerators in the world. The
operational reliability of the accelerators is excellent. The physical
facilities for a physicist are appealing and the unique working
environment is well equipped. The Organisation's scientific
programme offers a wide range of research opportunities.

The Organisation is enthusiastic about its extraordinary mission.
There is stimulating collegial interaction and a critical amount of
knowledge. The primary work of the Organisation is intellectually
very satisfying.

The professional freedom is highly esteemed by the staff. People are
rather free to work on interesting subjects. They have a lot of
independence in their work. There is a considerable amount of
delegation of responsibility. There is little supervisory control as
long as things work. Usually that is the case because of good
professional education. People are said to have a lot of initiative.

Physicists may work day and night as they are preparing for their
future careers. They are ambitious and face hard competition. They
set their goals high in hope of social recognition within the
community. The highest rewards range from invitations to
international seminars to the Nobel prize. This kind of approach to
work results in long days and deserved satisfaction. The drive is
reflected to the rest of the Organisation. Maximum effort to succeed
is expected from everybody.

CERN has a bright history of incredible technological progress and
top class physics discoveries. This successful history leads to self-

Otaniemi, Institute of Industrial Management, Helsinki University of Technology.
esteem and self-confidence. Modesty is not applicable if the proficiency is world class. The physicists find it hard to imagine a collective failure.

Basic research is considered to be ethical. The mission is non-egoist contributing to the knowledge of mankind. Basic research wants to be free of moral considerations. The scientists are not to be held responsible for the application of physics knowledge, but their duty is simply that of discovering the laws of nature.

Rationality is esteemed highly. The principles of consensus and equality are based on rationality. Consensus means that decisions are to be taken commonly and as unanimously as possible. In meetings anyone is free to express his or her thoughts. One can even write an electronic mail to the director-general criticising his decisions. There is an easy-going atmosphere that is characterised by openness and helpfulness. Communication is usually on a first-name basis, irrespective of hierarchical relations. European-based internationalism adds flavour to the work. There is no room for rigid nationalist thinking.

The features described above still do not build a satisfactory picture of the motivational factors of CERN. Those interviewed often referred to a more poetical view of CERN. Working at CERN was described as a privilege because of the opportunity of contributing to a historical scientific achievement. The Organisation concentrates and co-operates the huge intellectual resource in its pursuit of a common interest. The amount of resources needed and technological difficulties met compared to other scientific fields are distinctive. The awareness of the need to collaborate incites trustworthy behaviour. It can be compared to a social organism like a bee-hive community.

This kind of phenomenon has an historical counterpart. The famous Chartres cathedral was struck by lightning and completely burnt in 1194. A well-chronicled outburst of religious fervour.

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77 Knorr Cetina, K. Forthcoming 1995. Epistemic Cultures: How Scientists Make Sense. Bielefeld, Faculty of Sociology, University of Bielefeld. Pages 334 & 338

followed the discovery that the relic Virgin's tunic had miraculously survived unharmed. The reconstruction was completed at a breathtaking pace in only 25 years. Thousands of persons arrived as an enormous procession of ants. All together – architects, artists, workers, farmers, nobles and priests – worked to rebuild the cathedral until it was completed. They all remained anonymous. Nobody knows the names of those who built the cathedral of Chartres.

This description of the culture may sound very poetic to the people that have worked in this environment for years. They have become so accustomed to the special quality of the Organisation that they do not even realise the extraordinary nature of their work. The daily satisfaction comes from good measurements or seeing a new technology working. Even then it does not seem magnificent, only worthwhile. The daily frustrations when things do not work are the same as in any factory.

The unconscious nature of CERN mission
To become a physicist a person first needs certain characteristics. Later the profession itself has an enforcing effect on the person. Similarly, the Organisation's character is influenced by its mission. To understand the Organisation one has to study the assumptions embedded in its mission. A comparison of a medieval abbey and CERN is presented.78

Professional spirituality or intellectualty is a luxury that only few persons can afford. These people were the philosophers in the ancient Greek, monks and nuns during the middle age, philosophers again in the nineteenth century and are the scientists in the twentieth century.

Only about 200 kilometres but 900 years apart from each other are the medieval Cluny abbey and CERN. Both consist of a restricted group that has been granted the freedom to develop a specialised interest. Is there a common reason that makes possible the

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development of Cluny's sophisticated chorales and the frontier technology of CERN accelerators? A table comparing the Cluny abbey and CERN is presented paying attention to specific characteristics that are common to both of them.

<table>
<thead>
<tr>
<th>Comparison of ...</th>
<th>Cluny abbey</th>
<th>CERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical freedom</td>
<td>Donations</td>
<td>Government budget</td>
</tr>
<tr>
<td>Expression of</td>
<td>Christian culture</td>
<td>Faith in science and technology</td>
</tr>
<tr>
<td>Pioneering example of</td>
<td>Monastic organisation</td>
<td>European co-operation</td>
</tr>
<tr>
<td>The way of communicating to the subject</td>
<td>Music for prayers that occupied monks for fifteen hours a day</td>
<td>Feynman diagrams of particle interactions</td>
</tr>
<tr>
<td>Extra territoriality</td>
<td>Immunity, the Pope as the only authority</td>
<td>Immunity, exempt from taxation</td>
</tr>
<tr>
<td>Social control</td>
<td>Saints and miracles, place in heaven</td>
<td>Immortality through a Nobel prize</td>
</tr>
</tbody>
</table>

Both Cluny and CERN are examples of excellence and dedication. They concentrate society's efforts in pursuit for the ideals of their time. They benefit from political support, attract some of the most talented persons and use significant amount of resources in times of dramatic political, economical and social changes. Neither of the organisations affect directly the daily life of fewer persons than their members. Their society accepts their costs because they represent the purest expression of the leading ideology of their times.

4.3.2 Organisation classification

Using Mintzberg's terms discussed in chapter 2.1, at CERN there are needs for co-operation, concentration, learning, proficiency and standardised efficiency. CERN can be described using five consequent configurations. These configurations are
- missionary
- professional
- divisional
- innovative
- standardised

Missionary organisation
CERN is a scientific Organisation. Particle physicists are the customers of the Organisation. The theoreticians indicate what they expect to find at certain energies. The experimental physicists specify what kinds of accelerators and detectors are needed for experiments. The accelerator people in turn tell which type of machine is possible to build.

The scientists have a strong ethical drive and professional ambition. People working at CERN are themselves surprised by the good atmosphere. They say that they have nothing in common, but the interest in science. The challenge of work is greeted with enthusiasm and goodwill. CERN is mission-oriented and rational, which makes it manageable. The director-general being a renowned physicist is seen as a professional and missionary character, not so much as a manager. Actually the director-general speaks seldom to the staff, but the training of the people has conveyed the basic values at an earlier stage.

Professional organisation
CERN is a high-technology organisation. Its employees are highly skilled professionals. Some might be the only experts in their speciality. In addition to mastering a speciality, also professional flexibility is appreciated. The capability to take over another speciality is desirable for the Organisation's flexibility.

One specific feature of CERN is the close contact of its engineers with industry.\textsuperscript{79} The suppliers are usually closely followed up by CERN engineers, which requires both specialisation and diversified skills


from the engineers.

Usually the supervisors are appointed based on their technical expertise, not managerial competence. Supervisors have thus an excellent technical knowledge for making specifications and coordinating.

**Divisional organisation**

In the 1970's the structure of CERN was even more divisional when CERN consisted of two laboratories led by two directors. The divisions have their own cultures because of the nature of their work. Divisions operate very autonomously defining their needs within the budget.

Strategic planning aiming at global optimisation may be at odds with local optimisation. The divisions want as much power as possible. The balance of centralisation and decentralisation is a very delicate question. However, a strong divisional structure leads to sub-optimisation as CERN has only one user group, the physicists.

**Innovative organisation**

CERN is an innovative organisation. Carrying out particle physics research is a scientific challenge. Constructing new, front-ended accelerators is a technological challenge. Innovation is the dominating character of both a research organisation and a high-technology prototype factory.

The accelerators and detectors are CERN's core product. Nowadays CERN has seven core technologies which are magnet, cryogenic, vacuum, electronics, computing, radio-frequency and particle detecting technologies. Research and development work consists of theoretical research, making specifications, building a prototype and testing it.

Divisions that carry out research and development work have got a highly organic structure and reliance on teams. The specialised jobs

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are based on expert training. The hierarchy is loose, placing emphasis on informal communication and flexibility. CERN can be seen as a successful organisational experiment.

Standardised organisation
CERN is an old and large organisation. "[Former director-general] Carlo Rubbia tried to steer the Organisation as if it were a Ferrari, whereas it actually is a tank." Originally aiming at improved standardised efficiency the Organisation has become rigid. The administrative support sector is quite bureaucratic. The staff rules are the law and the management cannot change them easily due to agreement required from both CERN council and the staff association.

Final classification of the Organisation
Mintzberg's professional and divisional descriptions are not totally adequate regarding CERN. Some modifications to the theory are needed to describe CERN. This is done still using Mintzberg's terms.

At the organisational level CERN's structure appears to be divisional. However, the borders of divisions and groups are determined by technologies, not markets. They need to be run by experts in a highly autonomous way. Actually it should be said that CERN's structure is professional at the division level.

CERN staff look like professionals. In contrast to doctors, they are often too narrowly specialised to be totally independent in their work. Because of the complex technical environment they have to rely on group work and supervision for the direction of the work. At the individual level, the configuration is innovative, not professional.

This analysis places emphasis on the missionary aspect of the Organisation. The standardised structure is rigid. It has a negative effect on the innovative component. Standards and status quo are poison for innovations. There will be a drastic change when CERN shifts from operating the Large Electron Positron Collider to constructing the Large Hadron Collider. CERN will enforce its

innovative characteristics to cope with the new challenges.

As a conclusion, CERN is oscillating between innovative construction project phases and standardised operation phases. CERN has a strong missionary character, which is emphasised by the professional autonomy of the divisions.

4.3.3 The Organisation as an informal network

It is of vital importance to have the knowledge of the Organisation in order to work there. The two main reasons are strong organisation culture and informal networks. This chapter describes the latter.

Informal networks are based on interpersonal relationships that exist within the framework of the formal organisation. CERN's informal networks are strengthened by the professional freedom of the people. CERN works in a very unregulated way. Let us take an example of how research programmes evolve. Somebody interested in a topic gathers a group of friends with the same interest. The discussions start at informal coffee breaks. Only later does the group gain an official status and start to keep minutes of meetings. The origin of the programme was an informal network of people led by a dynamic person.

An interesting question is how the formal hierarchical structure affects the functioning of the networks. The only group that presented their organisation as a matrix was the cryogenics group. They argue that the matrix structure facilitates open communication and flexible arbitration because of absence of hierarchy. The decisions are taken at the lowest level possible. In literature there is equivocal support to the hypothesis that hierarchical organisations are less likely to be effective than those which are relatively non-hierarchical.


In an innovative high-technology organisation like CERN, the need for effective communication is great. The actual structure is open and flexible based on personal contacts. Exchange of ideas and resources can be easier on an informal basis. It is a general opinion that coffee breaks are a very efficient way of working for maximum four people. For a bigger group one has to call a meeting.

Being so unregulated, informality is a natural way to work. The communication is easy between people that know each other and get along well. However, informality has certain consequences that are not necessarily desirable to the Organisation.

There are many alliances beneath the surface. They are necessary in order to pass the bureaucratic system when things need to be done quickly. At CERN social recognition, professional credibility, good judgement and personal alliances are required to have true power. Sometimes it also seems that promotions are based on contacts rather than merits.

The strength of CERN is that it is not dependent of its leaders because the professionals are capable of taking over the responsibilities. However, individual leader choices affect to a great extent the way the groups and divisions are run. The organisation structure at CERN appears to be centred more around people than around processes or functions. Business process re-engineering could be applicable in CERN as an idea, but a profound reorganisation could hardly take place. Whole units have often been transferred in a reorganisation not to disturb the informal organisation. Typically, the reorganisation of groups or sections occurs most naturally when the leader of the team dies or retires.

The Organisation is greatly dependent on its personalities. Furthermore, the persons are strongly faithful to the Organisation. One gets sometimes the impression that the jobs are more determined by the individuals than by the specific needs of the Organisation. The freedom to choose the tasks may facilitate creativity. What finally determines the job is the informal network.

the person has. Despite evolving structures communication channels exist between old friends from past programmes.

CERN is like a primitive society of the elders that carry the culture imprinted on them. Similar to the Japanese style, the policy of career is changing jobs around the Organisation. The career usually develops horizontally over different functions rather than vertically in the line of responsibility. Long in-house careers enforce a strong organisation culture. The more well-known and established the organisation is to its people, the harder it is to change it.

4.3.4 Three cultural domains

The structure of CERN is analysed by a grouping of the divisions. Based on a distinction of tasks and culture, there can be identified three cultural domains inside CERN, namely

- a scientific domain
- a technological domain
- an administrative domain

The professional categories in the scientific domain are particle physicists and applied physicists carrying out physics research. The technological domain includes applied physicists, engineers and technicians concentrating on the accelerators. The industrial scale infrastructure support is included in the technological domain, too. Finally, there is the administrative sector consisting of clerical staff.

Inside domains people tend to have similar kinds of values, basic assumptions and views of the Organisation. For the scientific domain, the accelerators means good physics whereas the technological sector sees it as a great machine. There is mutual respect between the scientific and technological domains, but neither have respect for the administrative domain. However, the cooperation of the scientific, technological, and administrative domains is essential to organisational performance. No knowledge should rank higher than another. Each should be judged by its

contribution to the common task. The Organisation should see itself as a team.  

The scientific domain consists of four divisions carrying out the research programmes and most of research and development work. The particle physics experiment division has the 5500 users of the Organisation registered as unpaid associates. The whole domain is rather self-confident. They consider themselves special in relation to the rest of CERN. The intellectual culture described in the previous chapter originates from here. The domain is not rigidly organised. It works on a consensus basis. Personal opinions are respected. The ideas come from bottom up. Meetings are debating clubs where opinions crystallise.

In the technological domain there are technical challenges like breaking luminosity records. The structure is more hierarchical and the work is more standardised than at the scientific domain. Group leaders have some executive power, but the frame is given from the top when a new accelerator project is under way. The accelerators are running 85 per cent of the year. Reliability is important. The further one moves from the scientific domain the more industrial the work gets. However, certain CERN characteristics like a strong reliance on individuals, remain. The technological people have a direct contact with the scientists. They have the opportunity to participate to seminars on particle physics, too.

The administrative domain manages the Organisation even though the other domains do not seem to acknowledge it. The administration is often accused of slowing down the work because of its bureaucracy. The other domains even hate the administration. This seemed to be an unanimous opinion emerging from the interviews. It was claimed that bad physicists go to administration where making a career is easier. Actually there are only some 20 people with a scientific or technical degree in the administration.

Much of the cultural clash of professionals and managers stems

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from the character of their respective cultures. Physicists accept in principle order and structure enforced by the managers as long as it does not annoy them. This is not the case when the administration starts to make decisions about distributing resources.

CERN administration seems to be decentralised because of the professional autonomy of the divisions. This feature is also aligned with the French culture. The French conception of authority is absolutist. At the same time independence is valued highly. That leads to impersonal authority and avoidance of conflicts with the superiors. Thus organisations are governed by making rules.

4.3.5 Cultural dominance of physicists

At CERN there is a significant organisational transition at a deep level. The need for it has developed so slowly that it is difficult to recognise. The expression of a boiling frog effect can be used. The metaphor is of a frog that does not jump out of water that is heated slowly. It means that incremental changes have lead to unawareness of the changed environment.

CERN started as a villa of some twenty physicists. With bigger accelerators and growing financial and organisational questions administration and engineering were needed. Nowadays CERN is a huge industrial scale complex. Despite the dramatic change in the setting, the cultural beliefs are the same as that of the physicist community in the beginning. Many of the managers and leaders of CERN have a scientific background. The people that have moved into leading positions have unconsciously applied the cultural assumptions of research to managerial tasks.

There was a similar kind of slowly evolved organisational imbalance at the Finnish National Board of Taxes. In the sixties the

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personnel consisted only of lawyers. Today half of the personnel are computer experts designing information systems and programs. The organisation has turned into a large software house without realising it. The result is that the complex software organisation is managed by lawyers. The organisation had one great failure because of bad management during a technological change in 1989. Since that time the computer experts have been treated as scapegoats because the reputation of the organisation was damaged.87

Being a non-profit organisation, CERN had just to spend its budget wisely. CERN has a managerial paradigm of providing structure and order dating back to the 1950's. CERN has been able to afford it because its environment has been relatively stable. Nowadays the finances and the role of management is getting more crucial. "In view of the overall costs of the experimental programme and manpower limitations it will be mandatory to optimise the resources by effective co-ordination and standardisation. Mechanisms have to be put in place to accomplish this."88

Because of the external pressures from the member states and the scale CERN has grown into, CERN has introduced new solutions. Some good new management examples at CERN are

- outsourcing
- continuity to budgetary cycles
- centralised purchasing
- contracts regulated centrally
- management by projects
- centralised material logistics

The culture of the Organisation is lagging behind and it may take a severe crisis before the changes become significantly more favourable for managers. CERN is slow to react, because consensus is needed. Ad hoc decisions are rare. This minimises risks and indeed CERN makes very few mistakes. The actual cost of all CERN's large


projects has never exceeded the allocated resources by more than a few per cent. CERN has thus acquired a sound reputation for careful planning and reliable implementation of its technical projects.\textsuperscript{89}

CERN has been aware of most of its problems for a long time. Despite well-intended attempts, the basic problems remain as CERN's intellectuality works against itself at this point.

Firstly when a director-general wanted to hear opinions about CERN's long term plan, a manager brought up the issue of the luminosity of an accelerator. This illustrates the certain physics-related approach to strategic questions. For an outsider it looks like intellectual naïveté that does not recognise the necessity of human resources and finances.

Second, because of self-reliance embedded in the CERN culture, management does not ask for advice from external consultants. Besides, CERN seems to have a healthy suspicion of consulting companies' hourly rates.

Thirdly, there is a strong emphasis on a long-term commitment to building accelerators. The scientific goal is the primary one. As long as the first non-technological solution is laid, there is no interest in reiteration. Reassessment of organisational questions is not important. The main thing is that the administration works somehow.

The scientific domain characteristics have their complementary opposites that are listed in the table 6. Consensus, flexibility and goal-oriented effectiveness can be identified as dominating characters. The others have been rather balanced. Only recently external forces have affected the balance.

\textsuperscript{89} CERN. 1991. CERN. European Laboratory for Particle Physics. Page 24

Table 6 Complementary opposites of organisational characteristics at CERN

<table>
<thead>
<tr>
<th>Scientific domain characteristic</th>
<th>Opposing characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>intellectual naïveté which means dedication only to science</td>
<td>managerialism which means lack of sensitivity to non-economical aspects</td>
</tr>
<tr>
<td>freedom to delay decisions up to the last moment</td>
<td>planning and control</td>
</tr>
<tr>
<td>decentralisation</td>
<td>centralisation</td>
</tr>
<tr>
<td>correct consensus decision making</td>
<td>time-saving centralised decision making</td>
</tr>
<tr>
<td>flexibility</td>
<td>rigidity and standardisation</td>
</tr>
<tr>
<td>goal-oriented effectiveness</td>
<td>standardised efficiency</td>
</tr>
</tbody>
</table>

It seems that the scientific domain characteristics are the ones that yield to the accomplishment of the organisation's scientific mission. The opposing forces are the ones that aim at resource saving.

4.4 Scenario analysis

4.4.1 No Large Hadron Collider and a decline of CERN

Based on the impression obtained from the interviews, without the goal of building the Large Hadron Collider the Organisation will be in serious trouble. The project of doubling the energy of the Large Electron Positron Collider is only a temporary challenge. Preliminary studies for a linear collider have already been started at CERN, but that plan will not be realistic for many years.

At the moment the insecurity of the future has a negative effect on the motivation of CERN staff. Without application of creativity and a clear perception of direction, the intellectual tension cannot be maintained. This implies organisational decline, because of the loss of competence. The experts are fascinated by the challenges the Organisation can offer them. They are likely to leave the Organisation in search of challenge and satisfaction elsewhere. Once
these people are lost, their recuperation is hard even with a strong appealing mission like the Large Hadron Collider.

4.4.2 The Large Hadron Collider and its risks

The Large Hadron Collider project will make the different domains of the Organisation work together in close co-operation. There will be either a project structure or a new division for central parts of the accelerator like the magnets and cryogenics. The construction project will be followed by the operating and maintenance phase.

CERN has accumulated many years of expertise in building accelerators and particle detectors. Anyway, the people will be learning together about an accelerator which has never been built before. In the technological domain there will be a need for special competencies and appropriate staffing. That could partially be achieved by retraining.

It is believed that with their commitment the people will pass the critical mass needed to solve unforeseen technological difficulties. The way CERN has built accelerators owes much to the feeling of submitting oneself totally to a great common goal. The record of working without sleep at CERN is at least 72 hours. This kind of drive is expected to take over when the next construction project starts.

The scale and complexity of the Large Hadron Collider is bigger than ever in all respects. The Large Hadron Collider is a real technological challenge compared to, for instance, the Large Electron Positron Collider. Also its detectors will be more difficult, because electron collisions are simple compared to massive proton collisions. Also the collision intensity and the rate of observing events will be many orders of magnitude higher.

New trends distinguish the way the Large Hadron Collider will be built compared to the Large Electron Positron Collider. Firstly, more technical responsibility will be given to industry and institutes. The

need for technological innovation on many fronts is enormous. There are not enough resources to do everything in-house. The experienced CERN technicians and engineers will work mainly as co-ordinators rather than developing prototypes themselves. Partnership with industry will be essential.

Secondly, despite the plans for the Large Hadron Collider, the external mobility net flow is expected to be negative. To streamline the Organisation, non-core functions are planned to be outsourced. The foreseen decline of staff numbers by the year 2005 is roughly 20 per cent.

Thirdly, the average age of the staff is 49 years. Their age profile is presented in figure 11. Over half of the staff have served more than twenty years. The motivation, flexibility and physical endurance needed for an intense construction project is thus not assured. The experience of staff is needed to reduce the life cycle costs of technical solutions, not only the direct project costs. Also they are needed to support the inexperienced young ones in problem solving.

![Age profile of CERN staff](image)

*Figure 11  Age profile of CERN staff*

Fourthly, the size of collaborations has increased as illustrated in table 7. Usually physics experiments are carried out by organising two groups in parallel searching for consistent results. The two major collaborations each will have some 1200-1400 physicists. This is probably the ultimate limit for the size. Collaborations are self-managing, but there are already overlapping functions. In addition to co-ordinating committees, CERN could provide for the collaborations infrastructure support such as electronic document exchange, teleconferencing and hypertext facilities.

**Table 7**  
**Number of people and institutions at major CERN collaborations**

<table>
<thead>
<tr>
<th>Experiment name</th>
<th>Year</th>
<th>Finding</th>
<th>People</th>
<th>Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bubble chamber Gargamelle</td>
<td>1973</td>
<td>neutral currents</td>
<td>55</td>
<td>7</td>
</tr>
<tr>
<td>Underground Area UA1</td>
<td>1983</td>
<td>W and Z discovery</td>
<td>136</td>
<td>15</td>
</tr>
<tr>
<td>DELPHI 90 Collaboration</td>
<td>1994</td>
<td>number of neutrinos</td>
<td>567</td>
<td>55</td>
</tr>
<tr>
<td>CMS 91 Collaboration</td>
<td>2004</td>
<td>top quark, Higgs boson</td>
<td>1300</td>
<td>160</td>
</tr>
</tbody>
</table>

As can be seen from figure 12 the growth of the collaborations has been exponential. At the same time the number of CERN users has grown linearly from under 1000 to 5500 people.

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90 Large Electron Positron Collider experiment called Detector with Lepton, Photon and Hadron Identification DEPLHI  
91 Large Hadron Collider experiment called Compact Muon Solenoid; estimated year of commissioning; estimated number of collaborators; expected findings

Fifthly, the member states have come forward with new demands. Two new conflicting factors that influence how the accelerator components and detectors will be built are:

- a balanced distribution of industrial and technological returns among all the member states
- cost consciousness because of a very limited budget

Sixthly, there will be a large number of financially weak non-member states from outside Europe participating. Their large contribution and commitment raises new questions.

CERN is aware of these new factors and has started to try to meet the challenges. Still there is a strong self-reliance. CERN trusts the potential of its accumulated knowledge. However, there is a threat that CERN underestimates the challenge of the Large Hadron Collider under these boundary conditions.

There is already a worrying example of the technical difficulties of doubling the energy of the Large Electron Positron Collider. All the

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factors mentioned above might lead to a crisis if CERN should encounter technical problems it could not be able to solve. Most likely at that point CERN would not start analysing the organisational reasons for it. It could try harder various solutions or change its objectives. For example, CERN could concentrate on more accurate measurements. However, the Organisation's self-esteem and image would be damaged. It might have a serious impact also on the image of the particle physics community. Figure 13 summarises CERN's position.

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly proficient staff</td>
<td>Lack of resources</td>
</tr>
<tr>
<td>Long-time experience</td>
<td>Unbalanced age profile</td>
</tr>
<tr>
<td>Enthusiasm provided by the mission</td>
<td>Cultural stagnation</td>
</tr>
<tr>
<td>Flexibility and informality</td>
<td>Lack of professional management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Hadron Collider and</td>
<td>No Large Hadron Collider</td>
</tr>
<tr>
<td>- a rejuvenating project</td>
<td>A technical or scientific failure of the Large Hadron Collider</td>
</tr>
<tr>
<td>- new physics discoveries</td>
<td></td>
</tr>
<tr>
<td>New member states</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 13*  
*Strengths, Weaknesses, Opportunities and Threats SWOT analysis of CERN*

### 4.5 A model of organisational performance

A clear description of organisational performance, effectiveness and efficiency cannot be found in the literature. Lists of factors of
organisational performance easily approach 50 items. They seem to include all aspects of an organisation. One can find either long detailed or short general lists of organisation characteristics. For example, organisational performance depends upon

- employee characteristics affecting job performance
- managerial policies and practices
- organisational characteristics like structure and technology
- characteristics of the internal and external environment

A stereotype of an efficient and effective organisation is a national post office that carries out a simple repetitive task in a standardised way. In a research organisation the question of standardised efficiency is not appropriate. Efforts to measure it have failed, because there is no absolute measure for the intangible output. Based on the case analysis a suitable model of organisational performance for a research organisation is presented.

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CERN's organisational performance depends on the number of staff. Given the present resources CERN has to concentrate on the way these are used to carry out the organisation's mission. In figure 14 the factors of organisational performance are broken down to goal-oriented effectiveness and competence-based efficiency. In other words the factors are the ability to accomplish a goal and the working potential of the organisation.

<table>
<thead>
<tr>
<th>Organisational performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal-oriented effectiveness</td>
</tr>
<tr>
<td>Direction</td>
</tr>
</tbody>
</table>

*Figure 14  Factors of organisational performance*

Goal-oriented effectiveness distinguishes the idea of an objective and the efforts to achieve it. The objective can be provided by a strong mission or by a management. The organisation's individual forces must be aligned to a common direction. To achieve that there must be good communication throughout the organisation.

In a research organisation the power to achieve goals is determined by the competence of the organisation. Competence-based efficiency of the organisation consists of the number of people, their motivation, proficiency and team working skills.
To further develop the conceptual tool, a simplified graphical model of goal-oriented effectiveness and competence-based efficiency is presented in figure 15. The organisation members may share a vision. The Organisation's present and desired positions are be placed in a space of which two dimensions are determined by the vision. The speed of the organisation denotes competence-based efficiency. The deviation from the direction of the vision is linked to goal-oriented effectiveness.

![Graphical Model](image)

**Figure 15** A graphical model of organisational goal-oriented effectiveness and competence-based efficiency

The two dimensions are not totally independent. Enhancing goal-oriented effectiveness will also enforce competence-based efficiency, because the feedback from results will motivate the people to work harder. The feedback also facilitates learning of professional skills and team working methods. On the individual level, proficient efficiency and goal-oriented effectiveness are usually linked. Knowing how to do it and knowing what to do are usually mastered by the same professional.

On the organisational level, the competence-based efficiency and goal-oriented effectiveness are less interdependent, but still coupled in the hands of centralised decision-making. Only the management has the formal power to affect consciously both the competence-based efficiency and goal-oriented effectiveness of the organisation.

Its task is to set the objectives, formulate the strategy, make plans and design the organisation of people. All these affect the goal-oriented effectiveness. Also the management has the power to select, reward and develop the personnel thus affecting the competence-based efficiency of the organisation.

The matrix in figure 16, developed by the author, classifies organisations according to combinations of goal-oriented effectiveness and competence-based efficiency. The organisation types are named as 'successful', 'confused', 'desperate', and 'fossil'.

Efficiency

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Desperate</td>
<td>Confused</td>
</tr>
<tr>
<td>Low</td>
<td>Organisation</td>
<td>Fossil Organisation</td>
</tr>
</tbody>
</table>

Figure 16 Four types of organisations based on goal-oriented effectiveness and competence-based efficiency

The characteristics of the combinations are described in table 8.
Table 8  **Descriptions of the four types of organisations based on goal-oriented effectiveness and competence-based efficiency**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful organisation</td>
<td>In an ideal case the vision is shared by all the members of the organisation. The organisation moves straight to its goal with maximum speed and minimum effort.</td>
</tr>
<tr>
<td>Confused organisation</td>
<td>There is no vision or the vision is not shared. The organisation is confused about its direction. The incremental forces of the organisation point in different directions, which reduces the collective power of the organisation.</td>
</tr>
<tr>
<td>Desperate organisation</td>
<td>The task of the organisation would be clear but the organisation does not have the competence to carry out its task.</td>
</tr>
<tr>
<td>Fossil organisation</td>
<td>The organisation has no clear perception of its direction. The organisation's competence has been lost, as well. This kind of situation is possible in old self-sustaining organisations that face no competition.</td>
</tr>
</tbody>
</table>

How can CERN as a research organisation be classified using this model? CERN operates on the forefront of high-technology and particle physics. The only way to correct technical solutions or sound scientific results is to study many alternatives. It does not require only several trials and errors but also lengthy discussions. Using the terms introduced above, CERN starts as a 'confused organisation'. It concentrates all its efforts in communication and innovative teamwork to find the right direction. At this stage it looks like a 'desperate organisation', because nothing visible is carried out. Once the correct ideas are identified and the necessary competencies have been obtained CERN performs the work like a 'successful organisation'.

As a conclusion, the performance of a research organisation should be judged by the accomplishment of its objectives. The competence of the professionals determines how efficient the organisation is.

5 Limitations of the study

The interviews represented evenly all the functions of the Organisation. Only divisions linked to physics theory and previous accelerator projects were not presented in the sample. Because the interviewed people represented different divisions every interview added something new. The data gathering process could have continued for a long time, because of the size of the Organisation.

The data gathered could have been more organised by recording the interviews or rewriting the notes. The data was not systematic in all parts, but this was due to unexpected findings.

The data sources were not totally unbiased. The interviews had to be interpreted taking into account the experience, tasks at the Organisation, personality, and possibly hidden motives of the interviewee. Cross-checking took place whenever doubts arose.

Cultural differences encountered during the study caused some apprehensions. National differences were visible in the data. The author made an conscious effort to understand matters that were not parts of the Finnish culture.

The picture derived from the interviews was not coherent because of the heterogeneous ensemble of the interviewed people. The author excluded unreliable data based on personal judgement. Often the assumed reasons for the bias of the data added some information to the study. The processing of the data lead to a coherent picture of the Organisation.

The results of the study were presented to receive feedback of their correctness. A presentation was given to 27 people ranging from group leaders to members of the directorate. It was followed by a lively discussion. Apart from the presentation many people read the manuscript and commented on it. They had an adequate knowledge of the case organisation to point out errors in the data. In principle they accepted the findings and agreed to the recommendations.
The reproducibility of the results is questionable. Mapping the whole space of the research problem is almost an impossible task. Also the situation changes with time. Just the intervention of the author might have initiated a process that leads to a next stage of development. Igniting change is a desirable outcome of this kind of study. Some support may lie in the surprise momentum. If the results can surprise people they can change their way of thinking.

The narrowing of the scope did not really occur, because even to the end the Organisation was treated as a whole. One could ask whether the results are too general to be used for a particular application.

The assumptions made during the research process were those of the clinical organisation research. Organisations are seen as dynamic, open and highly complex systems. There is no single objective truth on a matter like a specific organisation culture. Only different interpretations and applicable solutions can be found. False interpretation of the data could partially lead to erroneous results and recommendations. However, the recommendations are not expected to really harm the Organisation, even if they are not taken into account correctly.

6 Recommendations

CERN as an organisation is very unique. Thus there cannot be found any textbook examples on how CERN should evolve. CERN has to find solutions to unique problems like what is an appropriate organisation structure for building the Large Hadron Collider. This study will mainly contribute by pointing to a direction that is believed to be the most effective one based on the different analyses.

These recommendations are based on ideas found in the literature. The ideas have been selected and tailored to meet the Organisation's needs and to form a holistic approach to the situation. These recommendations form a viable procedure that should still be further developed in an inventive and imaginative way. As soon as the Large Hadron Collider is approved these recommendations should be taken into consideration rapidly, because the process of implementation is long and difficult. The most important recommendations are presented in chapter 6.3.

6.1 Organisational revitalisation

CERN has a proud history of 40 years. After dynamic stages of organisational birth and growth, the Organisation has reached the maturity stage of its life cycle. Maturity is characterised by a strong culture, institutionalisation of values, evolutionary changes, inertia, and by organisational rigidity. If an organisation shields itself against changes in its environment, the organisation is in danger of moving into decline stage.\textsuperscript{97} The longevity of a healthy state of maturity is probably best explained by strong ideology of the organisation.\textsuperscript{98}

There are warning examples of big weak organisations that do not have such a strong mission or a dynamic technological environment as CERN has. They are like big ships that cruise at a constant speed in the same direction. Internal and environmental

\textsuperscript{98} Ibidem Page 293

changes are monitored, but no action is taken. Instead the organisations try to manipulate their environments or shield themselves from environmental impacts.

CERN is no longer the isolated island it used to be. The turbulence of its environment has reached CERN's gates. To be able to react to emerging external and internal needs, the Organisation must cherish its flexibility and cultural diversity. These revitalise and strengthen the Organisation. The opposing forces of standardisation at CERN are

- the innovative construction projects
- federal autonomy of the divisions
- missionary freedom

More project-orientation leads to flatter and more flexible organisation structure. The extent of project-orientation can be looked at as a position on a continuum between a traditional hierarchical line organisation and a flexible, network-like organisation structure.\textsuperscript{99}

Decentralisation means that the centre delegates duties out while it remains in overall control. The professional autonomy of the divisions should not be understood as decentralisation, but federalism. Federalism implies a variety of individual groups allied together under a common flag with some shared identity. It seeks to combine autonomy with co-operation. The concept of federalism offers a way to deal with the paradoxes of power and control.\textsuperscript{100} In federalism the centre's power is given to it, in a sort of reverse delegation. The centre, therefore, does not direct or control so much as co-ordinate, advise, influence and suggest. The federal organisation requires a change in management philosophy.\textsuperscript{101}

Regarding the missionary freedom, CERN staff are privileged to


participate in the particle physics research for a common good. Because of this privilege CERN staff are supposed to be

- responsible
- efficient
- ethical

The first stems from democratic values. The financial objective provides the impetus for managerialism movement. Ethical means that the research should be in pursuit of common good.\textsuperscript{102}

In the end organisations must rely on individual judgement and personal responsibility. Organisations need sufficient external controls so that meaningful readjustment exists should unethical behaviour occur. Apart from that organisations need only a foundation of ethics laws and basic accountability systems. If managerial systems and reforms are harmful for the original values then these reforms should be reconsidered.\textsuperscript{103}

CERN should strive for self-managing staff. The people should have such internalised values of their organisation that they would be able to make good judgements in a fuzzy environment.

Loss of mission may occur if the staff find that too many of the managerial reforms focus only on numbers and procedures. The reforms should not lose sight of the people and values.\textsuperscript{104} The primary goal of the Organisation is not cost savings but rather meeting real technological and scientific goals.

Success in developing high-performance organisations capable of addressing multiple challenges is more dependent on capturing the minds and creative energies of individuals than on perfecting rules and managerial systems. A commitment to values and ethics must become a way of being and not merely a control mechanism.\textsuperscript{105}

\textsuperscript{103} Ibidem Pages 275 – 277
\textsuperscript{104} Ibidem Page 275
\textsuperscript{105} Ibidem Page 275

6.2 Service management approach

Managerialism connotes a negative style of management. It bases its poor judgements solely on analysis of financial facts or standardised efficiency measurements. These often have nothing to do with the complex reality of a high-technology organisation. Also managerialism may be associated with a dialectic sociological paradigm that sees organisations as instruments of domination.\textsuperscript{106}

An example of managerial human resource tactics at a research centre can be found at the Technical Research Centre of Finland.\textsuperscript{107} The organisation employs 1600 scientists, 700 technical support people and 500 administrators. An analysis revealed that some laboratories were out-of-date. In 1994 the centre reorganised all its functions. The scientific personnel was automatically invited for their 'new' jobs. The non-scientific personnel was asked to apply for their jobs. However, 250 posts were suppressed. For 90 people another job was created. For the rest tangible support in looking for a new job was provided. After a period of six months 70 people have been dismissed so far.

The reorganisation has improved the image of the organisation. It has been an important step towards a profit-oriented organisation. However, the way the reorganisation was carried out raised objection. Among the non-scientific personnel the insecurity still affects the working atmosphere. This effect can not be measured, so the managerial human resource management seems successful according to its own criteria.

The organisational transition mentioned in chapter 4.3.5 can be referred to as organisational rebirth. That topic is not very well discussed in the literature. The Western culture does not see death


\textsuperscript{107} Tellervo Aaltonen. Head of Personnel Services. Technical Research Centre of Finland VTT. 1994-06-29

as a prerequisite for birth. Thus the question of organisational rebirth is rejected because of the partial death embedded in it. Schein suggests that organisational rebirth needs an internal new force that takes over gradually.¹⁰⁸

This new force that should subtly be introduced at CERN, are wise managers. They can be recognised by the fact that they are accepted by the Organisation. The Organisation will approve of only those managers who are committed to the best of the Organisation and understand what is expected from managers.

Good management should be invisible and smooth things down. The role of the management should be to help the professionals achieve the goal of the Organisation. The approach should shift from 'sit back and calculate' to 'dive in and commit'. CERN needs helpful, tactful, intelligent, communicative, intuitive and innovative managers. Managers should try to avoid direct use of power. They should redefine their job as coaches or advisors. They should trust the power of team work.

CERN needs management that could smoothly provide more competence-based efficiency and goal-oriented effectiveness. It should not try to change the unique and effective solutions the Organisation has developed over the years. To avoid that, knowing and understanding the unique nature of the Organisation is a prerequisite. At the same time the managers should be able to provide co-ordination and control. This might diminish the politicised character of the Organisation.

CERN has had many dedicated managers, but fewer visionary leaders. There are examples of devoted men that were accepted by the Organisation and launched a lot of new things. CERN should be conscious that the choice of people holding key posts in the Organisation affects most its performance. It should analyse to what extent its personnel choices have been politicised. It should find new


approaches for recruiting. It needs right people to bring vitality to the culture, but they must also be placed in the right positions.

CERN can acquire professional managers by training the old or recruiting new people. The hired professional managers should be given internal support while preserving external expertise. CERN should start to cultivate managers in-house. It should select and specifically train a group of young persons outside CERN to have a broad view of organisational problems typical to large research organisations. It should also train them on the special character of the Organisation sending them to work in different divisions.

According to a study conducted at a big international firm the highest leadership potential is correlated strongest with a capacity to envision facts and problems in a wider context. It requires the ability to see the large picture and to link possibilities with reality into constructive action.\(^\text{109}\)

Leadership potential can be judged using four criteria which are \(^\text{110}\)

- conceptual competence including vision, synthesis, professional knowledge and business directedness
- operational competence including decisiveness and individual control
- interpersonal competence including network directedness, negotiating skills, personal influence and verbal skills
- achievement motivation including ambition, professional interest and emotional control


6.3 Strategic human resource management

6.3.1 Role of strategic human resource management

The factors influencing CERN’s organisational performance are presented in figure 17. The accomplishment of the scientific mission is the justification of the Organisation’s existence. This is achieved by the organisational performance. The organisational performance is influenced strongly by the unconscious assumptions of the organisation culture. These assumptions facilitate the work of the Organisation. Originally they were the solutions that were found to be effective in the past.

![Figure 17](image)

**Figure 17** Factors influencing CERN’s organisational performance

At the end of the 1980's CERN met new kinds of external pressures. For example, the member states want more precise information on how the budget is spent.

A managerial way of introducing external pressures to the Organisation may harm the competence of the Organisation. Most likely that approach will be a waste of energy because of resistance.

rooted in the organisation culture. However, the Organisation cannot ignore these pressures. A filter for arbitrating this conflict is needed. Taking into account CERN’s specific culture and position as discussed earlier, strategic human resource management is suggested. A particular model of strategic human resource management is presented in figure 18.

Strategic human resource management can act as a mediator between different organisational forces. It should take into account the requirements of the scientific strategy and organisation culture. It can use softer methods to influence the competence-based efficiency and goal-oriented effectiveness of the Organisation. It will do so also indirectly by influencing the organisation culture. An example is the low degree of employee participation in the management of the Organisation. Human resource management may well share power when co-operation is possible.\textsuperscript{111}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{diagram.png}
\caption{Strategic human resource management as a filter between organisational forces}
\end{figure}

\textsuperscript{111} Horwitz, F. 1990. HRM: An ideological perspective. Personnel review. Volume 19, number 2. Page 8

\textsuperscript{111} Itälä, E. 1994. Strategic human resource management of a research organisation. CERN as a case study. Otaniemi, Institute of Industrial Management, Helsinki University of Technology.
6.3.2 Human resource vision

At the beginning of the 21st century CERN is the world's leading particle physics laboratory offering research facilities to the majority of the world's particle physicists. The success of CERN is based on CERN's unique accelerator installations. They are highly reliable providing particles at technologically amazing energy and luminosity at affordable costs. CERN has a rich variety of research programmes and strong user orientation.

This has been achieved by an advanced approach to human resource management. After years of dedicated management CERN staff are highly skilled in the core areas, motivated and satisfied. To solve problems efficiently they are able to combine their knowledge flexibly. The age profile is balanced. The Organisation is highly innovative, but also efficient and effective. The three cultural domains of the Organisation co-operate in a balanced way.

6.3.3 Human resource management strategy

The field of human resource management is quickly evolving under external boundary conditions. Especially in research organisations, few examples and models of strategic human resource management can be found.

The strategy to achieve the vision is straightforward. It is an integrated set of human resource management practices that are placed in the core of the overall strategy. Human resources is the most potential area for enhancement of the organisational performance.

Human resource management is the link between the Organisation and the individual employees. Its inexact nature makes implementation often perplexing. Being a new philosophy it needs acceptance to be implemented successfully.

Human resource management provides a holistic view of the

Organisation. In an ideal organisation the aims of individuals are coupled with the aims of the whole organisation. Competence-based efficiency can be obtained by real satisfaction of its members. Systems need to be developed to enable employees to meet both their personal needs and those of the Organisation.\textsuperscript{112} These systems will need to ensure

- a reasonable degree of work security and mobility
- individual identity
- consistency of remuneration
- that skills and jobs meet
- collaborative individualism
- flexible structure

CERN has not officially managed its human resources but has relied up to now on its abundance and self-managing capabilities. CERN needs a strategic redefinition of its human resources. The staff is the core of the Organisation and their skills are its strategic asset. From this statement one can derive the rest.

There has to be a mental shift that places importance on people. To achieve that there has to be effective communication. Director-general Christopher Llewellyn Smith's comments on CERN training is a good example in the right direction.\textsuperscript{113} Finally, the mental shift must lead to visible changes.

A strategic question is the competence of the Organisation. To enhance competence-based efficiency CERN needs internal mobility, training and rejuvenation. Skills resource management has several advantages and new views presented in table 9.


Table 9  Advantages of skills management and ways to achieve them

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>cost minimisation</td>
<td>all skills used</td>
</tr>
<tr>
<td>quality</td>
<td>range of skills</td>
</tr>
<tr>
<td>flexibility</td>
<td>skills learning</td>
</tr>
</tbody>
</table>

CERN urgently needs succession planning to ensure continuity of irreplaceable skills. Succession planning should not be only replacement planning but active development of successors.\(^{114}\) The Large Hadron Collider is a strategic opportunity for CERN to balance its age profile and assure continuity. The know-how and expertise in building accelerators will not be lost if the Large Hadron Collider provides a mutual learning-by-doing period for overlapping old and new generations. CERN should recognise its strategic skills, build apprentice teams and enhance supervising.

The key strategic question is timing. If the Large Hadron Collider is approved the old generation will build it with some new people hired. If the Large Hadron Collider is cancelled or delayed there will be no overlapping of the two generations. CERN’s well-established expertise obtained from its previous accelerator projects will be seriously weakened as the majority of staff retire.

Managing humans must be done in a caring and innovative way. For example, the solution to the age profile problem should be to identify the strengths of the older staff members and harness their experience to use of the Organisation. As a group, older workers are valuable and viable human resources. They bring loyalty, commitment, responsibility, and a vast experience in problem solving. The interaction between younger and older workers can be a symbiotic one.


6.4 Suggestion for an action plan

The director-general and the directorate should make a decision of adopting a new approach to CERN human resource management. CERN should launch a programme to establish new practices. A policy paper alone is not enough to bring into effect such a significant change. A clear vision is more important than detailed, written strategies.\(^{115}\)

Implementing strategic human resource management has many steps. It consists of planning at top level, analysing the needed human resource tasks, identifying gaps between personnel function and divisions, altering the reward systems and designing liaison between human resource management and divisions.\(^{116}\)

CERN should launch a programme which consists of\(^ {117}\)

- a systematic analysis the staff, their work, the Organisation and its environment
- setting of objectives
- planning with a multi-disciplined design team
- rigid implementation
- continuous evaluation
- immediate corrective actions
- feedback of the progress

Prerequisites for success are many when planning for a major organisational change. There needs to be coalition-building so that the key persons are aware and approve of the necessity of the change. There must be collaborative leadership and top level commitment. There must be good, open communication about the changes to the organisation.\(^ {118}\)

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\(^{118}\) Dr Pekka Tarjanne. Secretary General. International Telecommunication Union ITU. Geneva. 1994-09-08

CERN needs an our commitment statement for shared beliefs and values that will empower and motivate the entire Organisation to high-quality performance. The importance of the non-scientific domains needs to be emphasised.

The change should start visibly, because the staff need to be reassured. The human resources should be put into the strategic position they deserve. This implies that there should be a unit or a director for personnel and organisation matters close to the director-general. Only clear organisational power to act enables solving human problems in a managerial proactive way.

For a change to be possible there should be first an inevitable necessity to change and secondly psychological security guaranteed. People should be convinced of the benefits of a change. A successful change comprises the three stages of unfreezing, movement and refreezing. A demostration programme could provide an example and also a smaller risk learning opportunity. It involves holistic changes introduced at a single site with the goal of developing organisational capabilities. In a smaller scale project team spirit, communication and understanding are easier to achieve.

The benefits of the programme would be that CERN's organisational performance will be improved. It might be a critical factor in the successful accomplishment of building the Large Hadron Collider. Other implications of the programme might be a positive surprise. CERN would become a world leader even in this field among other research centres.

A lot of the time and full commitment of CERN management will be needed. The programme is designed to be appealing to all parties.


If minimum resistance is achieved the risks of the programme would be rather small. The programme would most likely succeed.

Whether CERN implements the recommendations depends on many things. These include the pressures for change and the change potential of the Organisation. The probability for successful development work is at its highest, when the Organisation is not under too much pressure. Then the resources can be directed to the programme. However, usually the most significant changes take place during times of crisis.

Organisational inertia is the next problem after the decision of launching a programme. CERN's intellectuality makes the Organisation flexible with a high potential for change. Problems can be overruled by the strong will, competence and energy of team work.

6.5 Recommendations for further studies

This is a preliminary study that has pointed out directions that could prove to be interesting and relevant regarding the organisational performance of CERN. The statements in the study have been approved by several persons. Still it cannot be concluded that the study is a precise description of the Organisation. Because the Organisation is much more complex than any approach can reveal, all studies will probably remain as crude simplifications and mere models of the reality.

For further studies the cultural and clinical views used in this study are recommended. Further developing the model of organisational performance could prove useful. A more detailed and partly quantitative method of assessing organisational performance using the models developed might be worthwhile. The advanced model could be used for a comparative study of other similar kinds of organisations. Also it would be interesting to study the organisational changes at CERN after the final decision of the Large Hadron Collider.

7 Conclusions

The relevance of the study relating to the needs of the Organisation seems to be good. The significance of the study remains open as long as these findings are not implemented. The study might have a crucial impact on the Organisation if a programme based on the recommendations were announced and carried out decisively.

The models of organisational performance and human resource management were developed at CERN only. Both models should be tested and validated for other organisations. They might be applicable to research and development organisations without modifications.

Human resource management as a concept seems to be based on a contradiction. The unpredictability and complexity of human factors often makes the well-intended rational efforts to control them fail. However, human resource management seeks to analyse, plan, control, and develop personnel characteristics. Naturally this can seldom be carried out without surprises. The unexpected factors seem to restrain the successful implementation of a crucial task.

Human resource management presents a challenge for both the academic and industrial world. New knowledge should be sought through research. Companies should develop their human resource functions for the common benefit of the employees and the organisations.

During the writing process the author received frequent corrections to expressions. This illustrates the sensitive nature of the research topic. Usually there were several ways of stating a fact but only few tactful ones. Also a rule seemed to be that no absolute statements were approved. Many statements in the study could not take a clear, strong side on the matter. Instead they had to be placed between even opposite ways of seeing the matter.

During the study the concept of balance became central. According to Oriental wisdom opposites do not belong to different categories but are extreme poles of a single whole. Neither is associated with moral values. What is good is the dynamic balance between the two. What is harmful is imbalance. The growth, prosperity and survival of any organism depends on striking a dynamic balance between complementary opposites.\textsuperscript{122}

Idealistically, maximisation is an inappropriate concept for organisations. Instead of trying to maximise anything an organisation should seek to maintain at least a minimal threshold of desirable attributes. In practice, many organisational aspects cannot be measured, monitored nor controlled. Thus the minimal threshold cannot be determined.

Based on the importance of balance it can be concluded that the standardised form of an organisation originates from the devil. Or balancing the statement, it originates from people. Established habits and personal pigeonholes provide security. Often standardisation means the decrease of learning and development. However, stemming from the psychological insecurity and laziness of human beings this often happens. The same phenomenon is reproduced at the organisational level.

Developing organisations would probably yield to most astonishing results if deep levels of individual minds could be reached changing fundamental attitudes and abilities. If that could be possible the ethical considerations of human resource management would become rather interesting.

\textsuperscript{122} Capra, F. 1982. The turning point. London, Wildwood House. Pages 17 – 18

8 Summary

The topic of the study is human resource management of a research organisation. The research problem was how to enhance organisational performance. The objective was to identify factors that influence the performance.

The scope of the study was restricted one case organisation, the European Laboratory for Particle Physics CERN. Only the permanent staff assigned to CERN's main future project were selected as the research object.

The research approach was that of clinical organisation research. The research methods combined literature survey and a qualitative case analysis consisting of interviewing and applying Mintzberg's organisational models.

In the literature review organisation culture and Mintzberg's organisation configurations were discussed. An overview of strategic human resource management was presented. The confronting tasks of smoothing labour relations and using people to carry out the mission of the organisation were recognised.

CERN's mission is to provide particle physicists with research facilities. CERN's next strategic project of building the Large Hadron Collider was described. The staff that will carry out the task were analysed. Threats to performance of the Organisation were found to be the lack of human resources, loss of in-house expertise because of outsourcing and retirement of about half of the staff in the next 10 years, non-optimised inter-divisional synergy and organisational rigidity. New personnel administration tools have been introduced in recent years, namely a performance appraisal and divisional human resource planning systems.

The Organisation was argued to have a strong missionary feature. Modifications to Mintzberg's theory were that the organisation is professional at the divisional level. The Organisation was claimed to

oscillate between standardised operation phases and innovative construction project phases.

The extraordinary motivation of the people was argued to be derived from the mission of the Organisation. The shared values include freedom, equality, rationality and self-exploitation for a common aim. A strong informal network of interpersonal contacts within the Organisation was identified.

In addition to the scientific domain two other cultural domains were identified. These are the administrative domain and the technological domain working together as a high-technology accelerator enterprise. The co-operation of the three domains was claimed to be unbalanced because of the dominance of the scientific domain. The dominance of scientists' values is due to the majority of managers with a physicist background.

It was concluded that the assumptions of the intellectual organisation culture are effective in the scientific domain. However, it is not evident that the whole CERN could be any more granted the same freedom as the scientific domain.

The incremental growth of the organisation over decades did not demand earlier a change from emphasis on physics to management. By 1994 external economical pressures have been introduced to the Organisation through the financing member states. This has recently lead to adoption of common industrial practices.

The factors of organisational performance were categorised to goal-oriented effectiveness and competence-based efficiency. Standardised efficiency of a research organisation was found to be partly sacrificed for the sake of its goal-oriented effectiveness. The need for communication requires a lot of time. Communication provides goal-oriented effectiveness as a consensus of the direction is obtained. An intellectual organisation can accomplish its objectives only through stages of temporary confusion and paralysis.

The future project of the Large Hadron Collider was estimated to be
a crucial change agent for the Organisation. Factors like technological challenges, declining and ageing staff, size of the collaborations, economical pressures, non-member states participation and the emphasised role of the industry were addressed. A warning not to underestimate the difficulties relating to the project was stated.

Cultural revitalisation was recommended through an emphasis on the mission and values. The balance of professional freedom and control needs organisational federalism and service management approach. The principle of professional freedom must continue to dominate, because it is the strength of the Organisation.

The conflict of the organisation culture with internal and external need for control has to be smoothed. To achieve that strategic human resource management was suggested. People should be presented as the strategic asset of the Organisation. Aligning an integrated human resource management with the strategy of the Organisation was proposed. An action plan was presented. Optimal implementation of the programme was discussed.

For further studies the cultural and clinical views used in this study were recommended. A further development of the model of organisational performance was regarded interesting. A comparative study of other research organisations was proposed. A follow-up study of CERN was also suggested.
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Appendices

Appendix 1  General interviews of CERN units – the questionnaire

- Mission and history of the unit or division
- Human resources by professions
- Technical system
- The most essential tool taken on an isolated island
- Contribution to the Large Hadron Collider
- Closest partners within CERN
- Planning and control systems
- Training and specialisation of jobs
- How are decisions made? Who is in charge of control?
- How significant is the informal organisation?
- What are the basic values taught to newcomers?

Appendix 2  Organisation chart of CERN