Managing Science

Management for R&D Laboratories

Claude Gelès
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Managing Science

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About the Authors

Claude Gelès

Claude Gelès received Master's Degrees in Aeronautics and Electronics from the Paris National School of Civil Aviation in 1961, after a three-year interruption to serve in the French Air Force during the Algerian war. He became an expert in International Cooperation in 1963 at the National Political Science Foundation in Paris. He then joined the French Atomic Energy Commission (CEA) and worked on the construction of nuclear reactors. In 1964, he was sent by CEA to the European Laboratory for Particle Physics (CERN) as a visiting scientist and group leader for the French 81-cm hydrogen bubble chamber. He was asked by CERN to join its senior staff in 1967, and was in charge of the layout and installation of the Big European Bubble Chamber (BEBC). In 1970, he joined the management of the Track Chamber Division. In 1975, he organized the European Hybrid Spectrometer Collaboration (EHS) and worked on the design of the Rapid Cycling Bubble Chamber and the construction of helium and water Cerenkov counters. As assistant to the Director for Administration in 1982, he was appointed Coordinator for Industrial Support before becoming Deputy to the Department Leader of the newly created Management Information Department. In 1985, he was appointed Leader of the Site Management Group; in this position he helped solve problems linked to civil engineering, construction and maintenance as well as management of General Services. In 1993, he was made Assistant to the Technical Director. In 1994, he joined with Christian Roche and Carlo Rubbia on the Energy Amplifier project and the TARC experiment (Transmutation by Adiabatic Resonance Crossing). He is now involved in the design of a High Resolution Spallation Driven Facility to measure neutron cross sections from 1 eV to 250 MeV.

Gilles Lindecker

Gilles Lindecker received a Master's Degree in Mathematics in 1964, and Postgraduate Diplomas in Statistics and Computer Science in 1966, from Lyon University. After completing his military service, in 1968 he joined a large French steel corporation as a computer engineer. He was hired by CERN (European Laboratory for Particle Physics) in mid-1970 to assist the head of the Program Office, a Director-General's Unit in charge of medium- and long-range planning for the Laboratory. In 1981, he was made head of the forecast, statistics, planning and budget group; in 1990, he was appointed Deputy to the Associate Director for Forecast and Planning; and in 1994, he became head of the Strategic Planning Office at CERN. He was an active participant in Carlo Rubbia's project on the Energy Amplifier. Lindecker is a member of several scientific committees in France and Switzerland, and has published articles in technical and managerial European Journals. He has been continuously involved in lecturing in parallel with his professional activities, with particular focus on statistics and organizational methods. More recently, he has been teaching courses at the U.S. Particle Accelerator School on management techniques applied to scientific laboratories.

Melvin Month

Melvin Month received his Ph.D. in Physics from McGill University in 1964 and his MBA from Hofstra University in 1971. In 1966, he joined Brookhaven National Laboratory, where he began a research career in the theory of particle beams and accelerators. Recognizing the importance of management in accelerator laboratories as a result of their complexity, size and advanced technology, he turned his attention during the 1970s toward management areas. From 1979 to 1983, he served in Washington, DC, in the U.S. Department of Energy helping in the administration of the High Energy Physics Program. In 1980, after serving on an accelerator R&D DOE panel, he perceived a growing need for education in this technology-dominated field of accelerators. Soon after, he started the U.S. Particle Accelerator School (USPAS) and become its first director. As part of his varied school activities, he initiated the Prize for Achievement in Accelerator Physics and Technology in 1985, and in 1987, he began a new type of program whereby students can take courses in accelerator physics for graduate credit. In 1997, Indiana University, in partnership with the USPAS, initiated a Master's Degree in Beam Physics and Technology, the first such program. In conjunction with his USPAS directorship, Month has become more active in service to the physics community. In late 1985, he organized the APS Topical Group on Particle Beam Physics and as its secretary-treasurer worked toward enhancing the status of the Topical Group to an APS Division, which became a reality in November 1989.

Christian Roche

Christian Roche in 1965 received Master's Degrees in Applied Physics from Toulouse University and in Electrical Engineering from Toulouse National Superior School of Engineering. In 1967, he obtained a Bachelor's Degree in Arts from Toulouse University and a Postgraduate Diploma in Business Administration from Paris University. In 1967, he joined the European Laboratory for Particle Physics (CERN) as a staff member. He was given technical tasks, in particular in the accelerator sector, until 1973, when he was made head of the Program Office in the Director-General's Office. He returned to studying management and in 1979, received a Doctorate Degree in Business Administration from Paris-Dauphine University. In 1983, he was appointed leader of the newly created Management Information Department at CERN and became a member of the Management Board. In 1986, he became Deputy, for Administrative Matters, to the Research Director. In 1987, he was invited by the DOE High Energy Physics Director to spend a sabbatical leave in Washington, DC. In 1988, the Director-General designate of CERN, Carlo Rubbia, invited Roche to join his team for the duration of his mandate (1989–1993). Roche first served as Adviser to the Director-General and was subsequently appointed Associate Director for Forecasting and Planning. Besides his activities as a member of the Directorate, he was the CERN coordinator for relations with the American continent. At the end of Rubbia's mandate, Roche joined the collaboration created by Rubbia on the Energy Amplifier, a project aimed at using tools and techniques from high energy physics to produce cleaner nuclear energy and to transmute nuclear waste. He has contributed to the definition of the strategy for this project and was also an internal consultant to the CERN management. In 1999, Roche returned full time to management and is currently participating, with the Director, in establishing a new sector for technology transfer and scientific computing.

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Preface

"Management is an academic discipline worthy of its place in the curricula of many of the great universities of the world." That sounds like a motherhood statement if there ever was one. It shouldn't really cause any controversy. Let us ask you first: Did it raise any hackles on you? If no, this book is for you. If yes, this book is certainly for you.

We, the authors, Claude Gelès, Gilles Lindecker, Mel Month, and Christian Roche, have for more than four decades been involved with the management of scientific laboratories. We are all educated in technical areas, and over these years we have been deeply associated with scientists and other professionals. Although our information on this point is only anecdotal, it is our collective view that scientists tend not to respect management as a scholarly field on a par with the hard sciences—or with sociology or economics for that matter.

We, on the other hand, have come to appreciate the intellectual content as well as the practical value of management, its conceptual framework, its principles and ideas, and its practice, taking special account of human affairs. With this motivating us, we embarked on a project to put our knowledge and experience to work on a university-quality graduate-level course in the management of scientific laboratories. With courses at UC San Diego, MIT, and Vanderbilt under our belts, this plan has culminated in the present work. It was quite a journey. We have tried our best to capture the complex nature, the multidisciplinary nature, and the essential pragmatic quality of the management enterprise as we discovered it.

Energizing us throughout was the thought of how we might be of service to future generations of scientists and other professionals in their efforts to manage a growing, open-ended, and unruly science that always seems to go in unexpected directions, to reach into uncharted waters.

To undertake our daunting task, we made a thorough search of the literature. At first, we felt comfortable with the words of international gurus of management who taught ways to make the organization work to perfection. Soon, however, it dawned on us that applying their lessons would imply a massive change in the way laboratories are managed, for example, changing the nature of the lab's facility users as well as of the funding agency. Such was the price of success. Discarding the notion of perfection, we set out sights lower. We thought we could at least find some management recipes that would help us be more effective as managers. There was no dearth of books written by gurus. After going through the painful exercise of scanning information among platitudes, generalities, and pseudoscientific demonstrations, we weren't much closer to being better managers. Frustration set in. Whatever useful recipes we found, and there were some, they tended to be applicable for the most part to production-dominated or profit-making organizations. For high-flux, project-oriented, separately funded enterprises such as scientific labs, they had only limited value.

By and large, the management principles and approaches designed for the business sector tended to be suited to organizations characterized by repetitive tasks and mass production. Rightly so, because any errors here can be multiplicative, thereby amplifying any consequences in time and money. On the other hand, in scientific laboratories, the environment that must be managed is highlighted by research and development. The focus is totally different. However, as the laboratories have entered a new era, that of Big Science, with its big facilities, the significance of component production in large quantities (e.g., magnets, vacuum chambers, radio-frequency cavities, etc.), with the resulting potential for a loss multiplier effect, has surely reduced the difference between management thought and practice for business and that for science.

The fundamental difference we must take into account is the difference between management that is oriented toward mass production and consumption and management dedicated to research and development (R&D). Two implications stand out. The first is the nature of change in the organization and the environment. For example, production line changes are critical in industry; whereas, in science, change tends to be reflected in facility upgrades, new facilities, and the introduction of forefront technologies. Although in either case it is the demand for change that must guide management, the two forms of management are very different.

The second implication is the difference in the way performance is manifested and evaluated. In business, a long history has led to the translation of performance into currency. This is a profound mechanism and has culminated in the recognition of the paramount significance of a single criterion spanning the corporate world: profit. In the science laboratory, no such criterion exists. A model for the measurement of performance in laboratories analogous to profit or short-term added value in industry has not even been contemplated, although today, with failures in the labs becoming visible, there appears to be a push in this direction. In spite of this, an ultimate performance measure for science labs, akin to profit, is yet to be conceived.

Scientific laboratories are, at their core, knowledge-producing institutions. To remain at the forefront, projects and their related R&D are both intrinsic to the culture of the laboratories. New technologies and successful projects push forward the frontiers of science. Without such flux, science stagnates.

In a sense it is knowledge and its rate of enhancement that is the currency of science institutions. You can see that this is not a straightforward situation. In for-profit business, the profit compared to the investment gives a rate of return. In the science laboratory, how can you compare the output knowledge to the input funds? How do you measure the equivalent rate of return? It is the difficulty of answering such questions, coupled with the increasing technical difficulty in operating at the frontiers, that has led to questions about the accountability of the science community and of the labs in particular.

The management of a scientific lab must take into account its many unique aspects, as well as its special character and culture. It is a singular combination of the academy and business, being halfway between a university campus and an industrial plant. It is responsible to the science community for operating large and complex instruments around the clock over extended periods. It is responsible for conceiving and developing new technologies and ideas to sustain its primary purpose of producing new scientific knowledge. It must do this and remain fully open to the outside world, both physically and culturally. To do all this—to operate 24 hours a day, to build projects with the proper R&D, to respond to and advise the science community, to answer to the government for its funding and for the significance of its science output, and to maintain and educate the personnel to accomplish this—is the function of the management of the laboratories.

The purpose of our book is to present the basic principles and methods of management to run a knowledge-based institution. The scientific laboratory is a suitable archetype for such an organization, although many of the ideas and issues apply to not-for-profit organizations in general and even to for-profit ones. In particular, we have tried to include the following:

- Introduction to the principles, tools, and techniques of management from long-term strategy to administration to day-to-day operations
- Introduction to the management of organizational flux—new technology, new projects, new laboratories, mission changes, project failure mode, and laboratory decline
- Description and assessment (with direct, practical insight) of the dominant forces in knowledge-oriented organizations and of the problem of performance measures
- Description and analysis of scientific laboratory policy, strategy, and politics and the interplay with laboratory customers and missions
- Description of the informal organization, the management of organizational stress, and the related question of accountability.

Our objective is to give the reader a comprehensive understanding of the basic management tools applicable to scientific laboratories. It is our intent that the book be used by acting managers as a reference manual or as a guide to decisions and actions. It is our hope that many of the book's sections may be useful in industrial or corporate labs in addition to government and university labs. In particular, our book is aimed at the following groups:

- Scientists and engineers who want to acquire the basic knowledge needed to manage teams, projects, and/or laboratories efficiently
- Students graduating in science and engineering who recognize the value of managerial skills in the age of Big Science
- Scientists, engineers, administrators, and managers at government, university, and corporate laboratories who will consider it useful to find a compilation of basic principles and guidelines in managing scientific laboratories.

The scope and content of this book represent the first attempt to provide a single document where the interested reader can find the basics for managing a scientific laboratory, or more generally a not-for-profit organization.

In particular, this book is meant to introduce various aspects of not-for-profit scientific organizations or laboratories. In simple terms, not-for-profit organizations are taken to be undertakings that receive input in money but provide an output that is difficult to measure in terms of money. Their output can be the development of basic knowledge or technology knowledge. It can also be the transfer of scientific or technological knowledge to economic partners in industry.

We have divided the book into two major sections. Part I is called The Management Structures. It describes the organization and the role of management. What is the purpose of the organization? How is its mandate arrived at? How is it authorized and funded? What is the nature of its internal and external connections? And so on. In addition, this part describes how the management works to achieve the organization's mission and how the structures relate to each other and to the outside environment.

The Chapters of Part I

- Raisons d'Être. The reasons for undertaking a not-for-profit organization. The motivations to build it, the internal and external conditions required, and the correct timing.
- Institutions and Decision-Making Systems. What elements, factors, and independent structures determine such organizations' development, creation, and operation? How does the external world perceive and influence them?
- Organization and Communication. What is the nature and essence of the administration? How are functions organized? How do structures interact? What organizational methods are available? What are the internal and external interfaces? How do structures communicate?

- Policy Implementation. How is the future of the organization to be built? What are the factors to be understood and applied to this end? How is the organization to be sustained as the future intrudes, with or without our participation?
- Project Methodology and Management. How to realize strategic plans.
- Infrasfructure. How to create and maintain the formal structures comprising the organization. What is the nature of the environment? Does it serve the purposes of the undertaking?
- Human Resources Management. People are a fundamental asset. How is a vigorous, effective, and efficient staff to be maintained? What is the optimum administrative system designed for personnel management?
- Financial Statements. How are the organization's funds spent? What are the special aspects in spending taxpayer money?
- Cost Assessment and Management. How and why costs occur. How costs can be monitored and reduced.
- Logistics. What are the formal structures for managing the seemingly mundane day-to-day activities? How do they work?
- General Services. How to keep the quality of life and the lifestyle of the organization in line with currently acceptable standards.
- Supply Chain. How to get what you need from the outside environment, including industry and suppliers.

Part II of our book is called The Human Drama. It deals with the people that make up the organization and the effort to build coherent acting units. Here we introduce the concept of organization deviancy, a state of the organization resulting from a buildup of workplace behavior that not only does not help the organization in furthering its mission but is actually hurtful. That such deviancy ensues from apparently harmless or even seemingly helpful self-interest is one of the surprising ironies that arise in exploring the human side of the organization.

The Chapters of Part II

- The Psychosocial Life. How human behavior can become a dominant factor in the organization. How it can sometimes defy logic and lead to failure.
- Performance. How to identify, measure, and assess the successes and failures of an organization.
- Knowledge. An organizational characterization of the multifaceted subject of knowledge.
- Money. An organizational treatment of money, the fuel that energizes the organization. It may also be the fuel for sinister functions and may serve to undermine and even destroy the organization.

- Judgment. An exploration of the human side of decisions and actions. What is the right decision? What makes a leader?
- Epilogue. A summary of the nature of the origins of stagnation and failure.

Much of the material in this book is based on our experience in our professional lives. We have tried, however, to broaden and extend our views and observations to encompass a more complete understanding of the complex subject of management. We will consider ourselves successful if, after you complete your study of our book, you will want to try your hand at it. Perhaps you can manage a project. Perhaps you can build a facility. Perhaps you can lead a group. Or, perhaps you are so ambitious as to believe that you can run an entire scientific laboratory.

If you haven't had management experience, you're probably fooling yourself. But even in that case, you never know. As U.S. President Reagan said in voicing approval for the now defunct Supercollider project, "Throw deep."

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GLAUDE GELÈS
GILLES LINDECKER
MEL MONTH
CHRISTIAN ROCHE

September 1999

Introduction

It is not uncommon to hear individuals, supervisors, administrators, statesmen, managers, and leaders of all types claim that complex issues are at stake or that tough decisions must be taken. That's after all why they're paid the big bucks. But on the floor far from the halls of power, the reaction to such utterances is a kind of cynicism. If you listen, you can hear the sneering: "He looks out for number one" or "He takes care of his friends." This is nothing more or less than the polarization of class. You can let such a situation slide, you can ignore it, you can deny it, but management will sooner or later have to deal with it. It may be on your terms or on others' terms, but ultimately it will be faced.

It is this type of situation, with two sides, both right and both wrong, that we are trying to shed some light on here. The process through which such concerns and related organizational ones may be dealt with we refer to *pragmatic management*.

Many problems encountered in the organization at the level of individuals have their origins in larger social issues, even philosophical in character. Understanding, sometimes even recognizing, the larger issue could prove crucial in coming to a satisfactory resolution. This is the essential function of operational management: solutions through awareness. To make decisions, to take actions, you should know what you're dealing with. We refer to operational management to distinguish it from top management, whose essential function is to provide vision and steer the course of the organization into the future.

What are some of these larger societal questions? Some of them have reached the popular media. Each has a life of its own. They vary in intensity and time periodicity. They appear for a while—some for longer, some for shorter durations. Then they fade from the public's gaze, only to return later. Some lose intensity, perhaps disappear, but even these might still be lurking, perhaps returning a year or more later.

Let us look at a few of the obvious ones. Keep in mind that they are products of the times. On the issue of "gays in the U.S. military," the polarization is between those supporting the dominance of individual rights and privacy and those who believe that group responsibility and religious tenets should be predominant concerns. On the issue of "sexual harassment," it is a woman's vulnerability on the one hand and a man's need to express a macho-type character on the other. In the case of "affirmative action," it is preference and quotas versus past grievances and their correction. Then there is the U.S. national education problem, with one side pushing for an emphasis on excellence and the other for lifting the disadvantaged. Although these are national questions, the polarization in the populace finds its way and seeps into the organization, generically speaking, at all levels. The organization is confronted by these issues and is changed by them. In fact, the particular ones referred to, with strong media attention, are more or less being dealt with.

These cases are recognizable because their philosophical underpinnings are analyzed daily. Even though people disagree, some level of fairness through rational means—for example, certain rules and regulations—can be instituted. This is happening and there is reason for optimism. This may be a lesson for us that openness, venting an issue that may appear complex, may be a help in approaching some manner of resolution. Of course, we should not jump to the conclusion that there is no room for secrecy, privacy, and privileged information.

We should not, however, underestimate the impact of such issues on individuals. As part of a group, a person could be put under enormous pressure, and the sum total of the effects of all these social pressures could have a significant impact on an organization. Do you remember, "Which side are you on babe?" or "If you're not part of the solution, then you're part of the problem"? These sayings show that people are influenced by a myriad of social factors in their lives. The rules and regulations devised often must take account of group dynamics. Even an issue characterized as a simple polarization is not simple.

Within an organization, situations of the same general class exist but are not characterized by a simple polarization. Because they may not be analyzed daily, their underlying essence may not be straightforwardly decipherable. More often than not, the core of the problem may be in the history of the people involved and of the organization itself. Therefore the details, the particulars, tend to be hidden. Management methods to search out the deeper causes are an important ingredient of pragmatic management. Bear in mind that the results of such searches could be to bring the question to the light of day or, alternatively, to let sleeping dogs lie. The actions based on knowledge retrieved are not necessarily predetermined by the search itself.

Take the question of a salary raise or promotion. If the situation were fully rational, the problem would be simple. Find out what the individual is actually doing and compare this with his job description. One problem is that people giving you information might bend or shade the truth or even lie, but straightforward consistency checks could handle this. But there is a deeper reason why such seemingly simple cases could indeed be tough or complex. That is history. It could be your history or it could be past decisions made by others that intrude. In this type of personnel case, decisions could have been made that strongly limit your action. Others could have been rejected or promoted in the past under criteria different from those you're working under today. Perhaps certain individuals have too low salaries. How can you raise X now? In an organization of more than a few people, past actions accumulate. The result is a kind of secrecy. The issue becomes complex not because the current situation is not simple, but because the past has intruded and is interfering.

What we have tried to do in our book is to address this type of management question. We all know that such questions are not easy and are not amenable to fully rational discourse. However, rather than looking for simple answers, which perhaps don't exist, we have tried to provide the basis for analyzing such issues through a system of description and analysis that we call pragmatic management.

We hope this book will help managers to deal with such complex issues and tough decisions without just giving up and ultimately tossing a coin and depending on chance and serendipity.

This book represents the views of the authors but not necessarily those of their employers or any other third party.

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Part I

The Management Structures

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1

Raisons d'Être

1.1 INTRODUCTION

A scientific laboratory is created with the objective of performing a specific type of research (as defined by the so-called Frascati Manual of 1980; see Appendix 1.1 in this chapter). It can be a multipurpose organization or laboratory aimed at providing several large facilities to a scientific community and establishing a kind of club or forum for this community. It can also be a large, expensive facility, directly used by a scientific community, or a basic instrument requiring further ad hoc installations. The initiator of the idea can be a person, a group of persons, a community, a nation, or a group of nations. The project can be developed from scratch or built within an existing setup.

Such a large undertaking may require a significant fraction of the wealth of its sponsors. Therefore, economic problems will need to be confronted. Above a certain level of resources, in particular under difficult economic conditions, political aspects may become crucial. Also, large installations, wherever they are built, create social spin-offs. Recent experiences show that the managerial, economic, political, and social aspects of such an undertaking can outweigh the scientific and technical aspects. The common criteria for assessing the benefits of a research laboratory as defined in 1975 by the Science and Engineering Research Council of the United Kingdom (SERC) provide a good example of this trend (see Appendix 1.2). Therefore, management tools must be created or developed.

When a scientific laboratory is established, it becomes an asset to the nation or group of nations that have invested in its creation and operation and to the region housing it. Again, any decision on maintaining, extending, or killing it may depend on many factors besides scientific justification.

Examples will be taken from large laboratories funded mainly by public money and devoted essentially to basic research. This may appear restrictive, but because profit or return on investment cannot be used as a yardstick to measure the cost/efficiency, the problems of justification, objectives, and strategy are far more complex and should therefore cover most situations, in particular those relating to smaller units or to other (nonprofit) performance/knowledge-oriented organizations.

1.2 CREATION OF A SCIENTIFIC LABORATORY

A scientific laboratory, when it is the first to be built in its field, is normally created when the public and politicians face a major problem for which no solution is offered by existing knowledge. Examples of major problems are:

- Medical (fear of a disease or an epidemic)
- Environmental (earthquake, storm, flood, pollution)
- Social (unemployment, brain-drain)
- Military (war or preparation for war, energy independence)

Once initiated in a field, the process becomes smoother: The next laboratory does not need a catastrophe to bring it to life, because the argument of competition at the national or international level or the argument of complementarity takes over.

In few, if any, fields (except for astronomy, which conjures up romantic dreams for most people) have large scientific laboratories been created just because scientists felt they were worth exploring:

- The large high-energy physics (HEP) laboratories ultimately derive from the Manhattan Project and Los Alamos Laboratory, created to make the atomic bomb during World War II.
- The Conseil Européan pour la Recherche Nucléaire (CERN) was built to stop the brain-drain of European physicists in the 1950s and as a symbol of the new relations between European nations.

Of course, these laboratories were created also because the related scientific community had its plans ready to proceed at the "politically correct" time. Therefore, the questions to be answered when embarking on the creation of a new laboratory are as follows:

- Is there an organized community ready to propose, build, and support the laboratory?
- Is the general economic situation in good shape?
- What are the possible supporting lobbies?