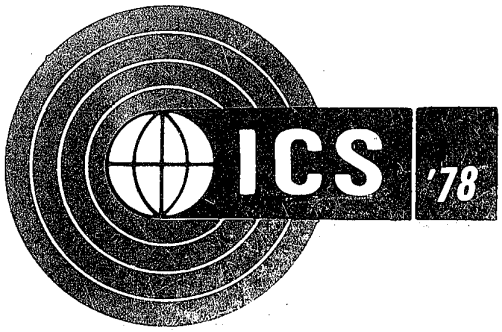

一九七八年國際計算機會議論文集

第一册

PROCEEDINGS OF INTERNATIONAL COMPUTER SYMPOSIUM 1978

VOLUME ONE

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MANAGEMENT RESPONSIBILITY PATTERNS & INFORMATION SYSTEMS DESIGN COMPUTER-BASED ECODEVELOPMENT PLANNING PROJECTS IN BRAZIL

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The management of scientific projects is still in the artesan phase, with knowledge and skills being gained generally by experience and sometimes with advice of a mentor. New management styles and theories are slow to reach the average scientific manager. This paper reports on a case study analysis of an ecodevelopment planning project in Brazil using a theoretical framework for the analysis of scientific team-work developed by Quintella and Flores, based on three principal functions, Analysis, Modelling and Data Management Systems Design & Maintenance. The first part of the paper provides the conceptual frame work including team organization for projects involving modelling and systems design. The remainder of the paper is then devoted to a description and analysis of the case study which was a regional planning study of a virgin area in the Amazonas basin, with dimensions similar to those of France. The need for environmental protection in the Amazonas is by now well appreciated and this was a major focus of the study.

INTRODUCTION

Problems in the field of management of scientific projects are by no means trivial. In particular those dealing with a large amount of data and aiming at planning and/or controlling projects such as those of socio-economic ecodevelopment, in which one needs to reconcile conflicting multiple objectives, are extremely difficult. In regional ecodevelopment projects some of the factors that may be conflicting are: natural resources utilization and preservation, industrial benefit and pollution control etc. Systems design cannot be carried out in such a case using only a single viewpoint such as that of economic profitability by examining all appropriate criteria. This ideal proposition, however, is a problem of huge magnitude and there is no known method for its resolution. But it does become necessary to try to solve the problem. An additional factor is that the large amount of data generally involved makes the use of computers vital in the planning and controlling of such projects. Moreover, limited budgets can benefit from the use of modelling for detailed and methodical planning, including especially the analysis of alternatives.

These types of projects call for a new style of management and the trifunctional structure proposed in Quintella 77/1[1] and Quintella 77/2[2] which is discussed here in greater detail appear to answer a number of problems caused by the special characteristics of computer-based ecodevelopment planning projects.

1. TRIFUNCTIONAL MANAGEMENT - A METHOD OF INTRODUCING MODELLING IN RESEARCH PROJECTS

The team's structure for research and control in environmental systems proposed by Quintella and Flores[1&2] is applicable in general to research projects with a large amount of data to be handled by computer. Such a structure is essentially made up of a fixed part and of a variable part, following the nomenclature of Quintella and Flores, as follows:

(1) Three major specialized functions defined as follows:

- Analysis : the research, collection and storing of information related to the present situation.
- Modelling: development and utilization of models for the design, forecasting and control of all kinds of systems utilized in the project.
- Data Management Systems Design and Maintenance: their application in the treatment of the data.

These functions and their relationships with the environment are shown in Figure 1, following Quintela[2].

(2) Activities are, defined by Quintella, tasks necessary for the achievement of the project's objective which are executed and managed by specialized functions carried out by project team members. Six major activities were identified by Quintella[1] as follows:

- Planning : i.e., all those activities of forecasting of time for project complexion, of estimation of the necessary resources and the logical scheduling of the other activities.
- Project Control: i.e., all those activities aimed at checking that other activities are being carried out in accordance to plans and taking corrective actions as necessary.
- Production : i.e., all those activities aimed at achieving the main goal of the project.
- Data Handling : i.e., all those activities aimed at collecting, storing, treating and using all pertinent data in the project by manual computerized

or other means.

- Documentation : i.e., all those activities aimed at preserving the memory of managerial and technical know-how developed in a project.
- Reporting : i.e., all those activities aimed at informing out-siders of the results and achievements of the project.

The team organization is then determined firstly by a general structural framework which consists of the three major functions and the six principal activities. This general "fixed", structural framework is then broken down for operational purposes into a set of sub-functions, and sub-activities depending upon the specific project objectives, or in Lemma form "the specific objectives govern the variable part".

The variable part thus consists of a set of multiple objectives, a set of sub-functions, a set of sub-activities, a set of relations that correspond to the assignement responsibilities of activities to functions and sub-activities to sub-functions.

Fixed Part	{F}	(functions)
	{A}	(activities)
	LEMMA:	"specific objectives govern the variable part"
Variable Part	{f}	(sub-functions)
	{a}	(sub-activities)
	{R}, {r}	(assignment of responsibilities)
	{O}	(multiple objectives)

The way in which the objectives govern the variable part vary from project to project, nevertheless, the general pattern may be summarized by the following flowchart, Figure 3.

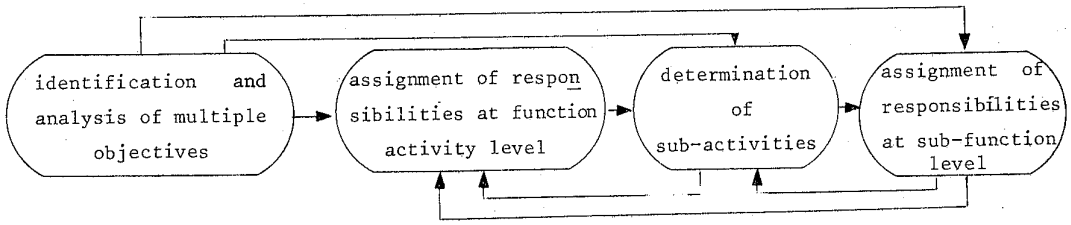


FIGURE 3

FIGURE 1

THE MAJOR FUNCTIONS AND THEIR DEPENDENCE UPON THE ENVIRONMENT

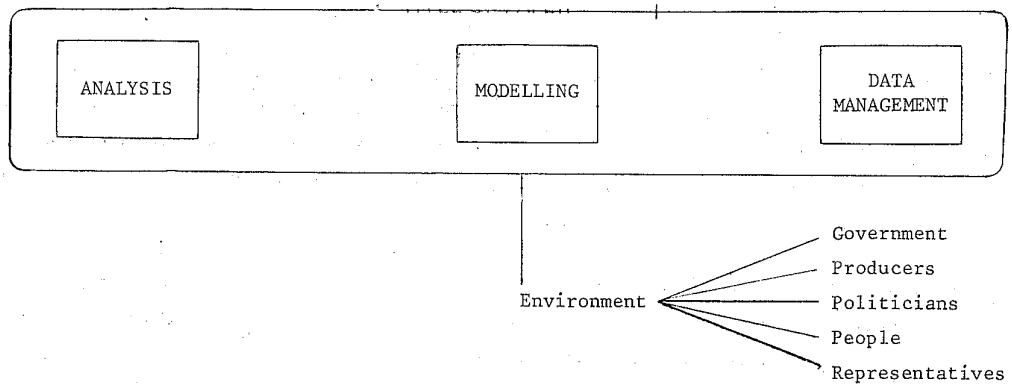
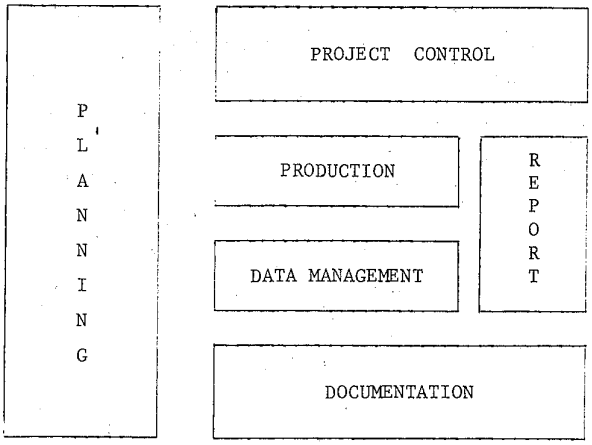


FIGURE 2

THE SIX PRINCIPAL ACTIVITIES



The distribution of responsibilities is done according to the philosophy of diffused responsibility, i.e. no responsibility is solely assigned to any function and vice versa. As regards responsibilities for the project management and execution we may understand this philosophy in the following manner: no single function or group is solely assigned management responsibilities (or execution responsibilities).

The consequence of this philosophy together with the concept of trifunctional management are being investigated and partial results point to the following conclusions:

a. greater involvement by team members with a consequently higher motivation, greater satisfaction with democratic atmosphere.

b. substancial savings with the use of modelling and more rational use of computers.

c. strict data-base administrator and environmental administrator such as is traditionally understood, are disappearing to be replaced by more eclectic management.

2. ECODEVELOPMENT PROBLEMS

The concept of ecodevelopment appeared from an attempt at redefining the notion of development strictly bound by profit and productivity. In a definition proposed by Ignacy Sachs[3], the main characteristics were the following:

- social utilization of local resources by the local population.
- long term planning taking into account the future generations.
- reduction of pollution through recycling.
- use of solar energy (especially in tropical countries).
- development of "ad hoc" ecotechniques.
- strengthening of institutions which foster public participation.
- inclusion of the main concepts of public participation in regular education.

As has been extensibely pointed out in recent literature it is particularly important to pay attention to ecological problems in Brazil. In particular, a number of projects related

to environmental control are being undertaken. However, an effective methodology of dealing with such problems has not yet been developed. Moreover, such projects are not yet integrated in an overall economic development plan.

Among the various problems posed by such ecodevelopment projects are those of designing adequate information systems for the research team and the management of the teams. Although they seem to be distinct problems, they are very much interwoven. Both problems are briefly studied in this paper; further details of the conceptual approach are presented in Quintella[4&5]

3. GUIDELINES FOR INFORMATION SYSTEM DESIGN IN AN ECODEVELOPMENT PROJECT

One of the most important steps that must be carried out within the preliminary stages of an ecodevelopment project is the I.S. design and its corresponding data base.

Clearly two important parts exist:

a. the conceptual definition of the information Systems (the infological approach to the problem) in which one builds up mechanisms for data management and a taxonomy of real world data.

b. the data base definition and implementation of the information System (the datalogical approach to the problem) in which one defines in concrete terms the conceptual definition previously carried out.

The process of infological treatment of the problem consists in: identifying the main information sources for the resolution of the problem together with a number of tasks and mechanisms to be carried out in order to extract from such sources the necessary data for the implementation of a data base and its corresponding information system.

In the specific case of ecodevelopment projects one can identify three main sources of information:

a. the natural environment

b. the techno-cultural environment

c. the social environment

By natural environment we understand all information concerning hydrology, vegetation, geology, zoology and potential land use.

By techno-cultural environment we understand all information concerning the structure of energy, agriculture, industry, transport, housing, water control and land organization.

By social environment we understand all information concerning history, demography, health and welfare, education food and institutions.

4. DISTRIBUTION OF RESPONSIBILITY IN ECODEVELOPMENT PROJECTS

The two responsibilities in a project are: management and execution. Traditionally to each responsibility corresponds a set of distinct people. Distributed responsibility, as far as we understand, means to define a number of functions and a number of activities in the project in such a manner that no responsibility is solely assigned to any one function and vice versa.

In view of this concept it is clear that the following goals (see table 4.1) govern an ecodevelopment regional project.

TABLE 4.1

GOALS	ACTIVITIES MAINLY RELATED	FUNCTIONS MAINLY INVOLVED
1. Economic-ecologic modelling of the region	planning data handling	modelling data management
2. Monitoring of main environmental and economic alternations	monitoring data handling	analysis (data management)
3. Production of state reports of the region	monitoring (reports)	analysis data management

In order to design an information system from an infological viewpoint to assist members of an ecodevelopment project to achieve such goals we must find a function that maps the information sources (information object system) into the data kinds defined in Quintella & Flores[2] (data object system). Such data kinds are the following:

a. economic industrial data (spatialy and temporally located)

b. environmental data (land/air/water)

c. other environmental data (hydrological, meteorological, etc.)

d. 'legal' data (public laws, funds available etc.)

e. classical socio-cultural data (population, income, housing)

The function that maps the information sources into the data kinds is the set of sub-activities described below:

SUB-ACTIVITIES	ACTIVITIES MAINLY INVOLVED	
Data collection	Planning Documentation	Data handling
Assessment of environmental impact and institutions	Planning Production	Project control
Identification of critical issues (locations, resources, etc.)	Planning Data handling	Project control
Identification of current technical, legal and managerial weakness, alternative techniques & absence of information	Planning Data handling	Documentation
Project proposal and project selection	Planning Documentation	Production

Clearly as one can easily observe the planning activity is present as an origin of every sub-activity. Hence special attention must be given to this sub-activity.

5. A BRAZILIAN CASE STUDY OF AN ECODEVELOPMENT PALNNING PROJECT

This section consists firstly of a brief description of the project setting, objectives and scope and then a more detailed description of modelling in an Operational Research sub-project of a major ecodevelopment planning study.

In 1974 Sondotecnica S/A, a leading Brazilian Engineering Consulting firm, was commissioned by SUDAM (Superintendency for the Development of the Amazon) to produce an integrated development plan for the valleys of the Tapajos and Xingu rivers. The area is in the state of Para in northern Amazon as shown in the map (Figure 4). The area is bordered by similar areas for which studies were also commissioned by SUDAM, in order to create an overall master plan for the entire region's development. The Amazon basin forms half of Brazil's total land area and also includes much of the territory of neighboring countries. It is remarkably rich in fauna and wild life and the oxygen conversion carried out by the trees of the jungle make the region the world's largest 'lung'. Largely unmapped until recent surveys using advanced aerial photography, the Amazon still retains many of its secrets. Historically development in the region has been largely uncontrolled, resulting in serious damage to the ecological system and to the local Indian population. This has led to the decision to undertake a planned programme of development which will protect the ecological balance and leave large areas free for Indian reserves and wildlife purposes. The development is also seen as a means for resettling population from the poor but densely-populated North East region of Brazil. The Transamazonic highway now runs from East to West across the region, and there is a North-South highway also.

This section deals with the operational research contribution to a study which took over three years in all, and the overall structure of the study should be briefly described. The first part of the study was to collect data on the regions, such as:

- soil types
- vegetation
- mineral resources
- physical characteristics of terrain
- existing and planned transport links
- towns, villages and infrastructure
- political, legal and environmental constraints
- potential products and markets
- population

These data were collected and documented over the first eighteen months of the project to form a basis for the subsequent analysis.

The second part of the study was the design of agricultural, industrial, forestry and mineral enterprises in a range of sizes suitable for the regions and the available markets. This was followed by a similar exercise to design standard units of social infrastructure, such as schools, agricultura. training, medical services, etc. needed to support the population working in the producer units.

FIGURE 4

STUDY AREA

The third part of the study was the analysis of resources, markets, producers and infrastructure by a mathematical model and to produce an optimal integrated development plan over a 25 year planning period.

The total study was thus directed at providing government policy makers with a quantitative basis for determining plans and budget allocations for the controlled socio-economic development of a large virgin territory.

This is, as far as we know, the first study of this kind to have been designed and implemented as a part of the decision-making process. A World Bank study[6] of the agricultural sector in Portugal compared the results of a mathematical programming approach with recommendations arrived at previously by the usual World Bank methodology. Another World Bank study[7] was begun in the North-East region of Brazil but was not used in decision-making, partly because of data problems. The theoretical approach was described by Samuelson[8] under the name of the spatial equilibrium programming model.

The basic issues for the modelling work were:

a. What should be the structural socio-economic characteristics of the region following a twenty-five year development period?

b. How should the development proceed over the twenty-five year planning horizon?

The modelling work proved vital in the detailed specification of the information needed which had mainly already been collected but required further processing and maintenance. The systems design aspect will not be analysed in depth in this paper but its importance is clear.

The Operational Research study will now be described in three parts: team composition, responsibilities and results. In the subsequent sections we shall then analyse the project in terms of the conceptual approach developed above.

The team consisted of four members, as follows:

- A leading O.R. specialist, at that time teaching at the London School of Economics and now Professor at the University of Kent in Centerbury part-time on the sub-project. His role was in the initial conceptualization of the mathematical model, technical supervision and specialist contribution throughout the sub-project on a part-time basis.

- A Senior O.R. consultant working full-time in Brazil for the duration of the sub-pro

ject. He took the major role in the actual execution of the project as regards model formalization, data specification, computer program selection and computer analysis.

- An economist resident in Brazil employed by Sondotecnica who had been involved in the overall project; full-time on the project. His basic role was to participate in the project as a whole, to provide that any necessary information on supplementary resources would be provided, to maintain linkage with the client agency and to provide a "follow-up" continuity and capability for the usage of the model.

- A professor from a Rio de Janeiro University, part-time on the project whose major role was to provide general counsel and support to the two other O.R. members of the team in the model development.

The project was supervised by the overall project manager who provided senior liaison with the client agency and other sections of the project staff. He had been involved in the initial project planning which included the development of a model as a key part of the entire study.

The execution of the sub-project was carried out under considerable time-pressure since it was begun later than schedule but the final deadline was fixed due to contractual reasons with severe penalties in the case of non-complexion.

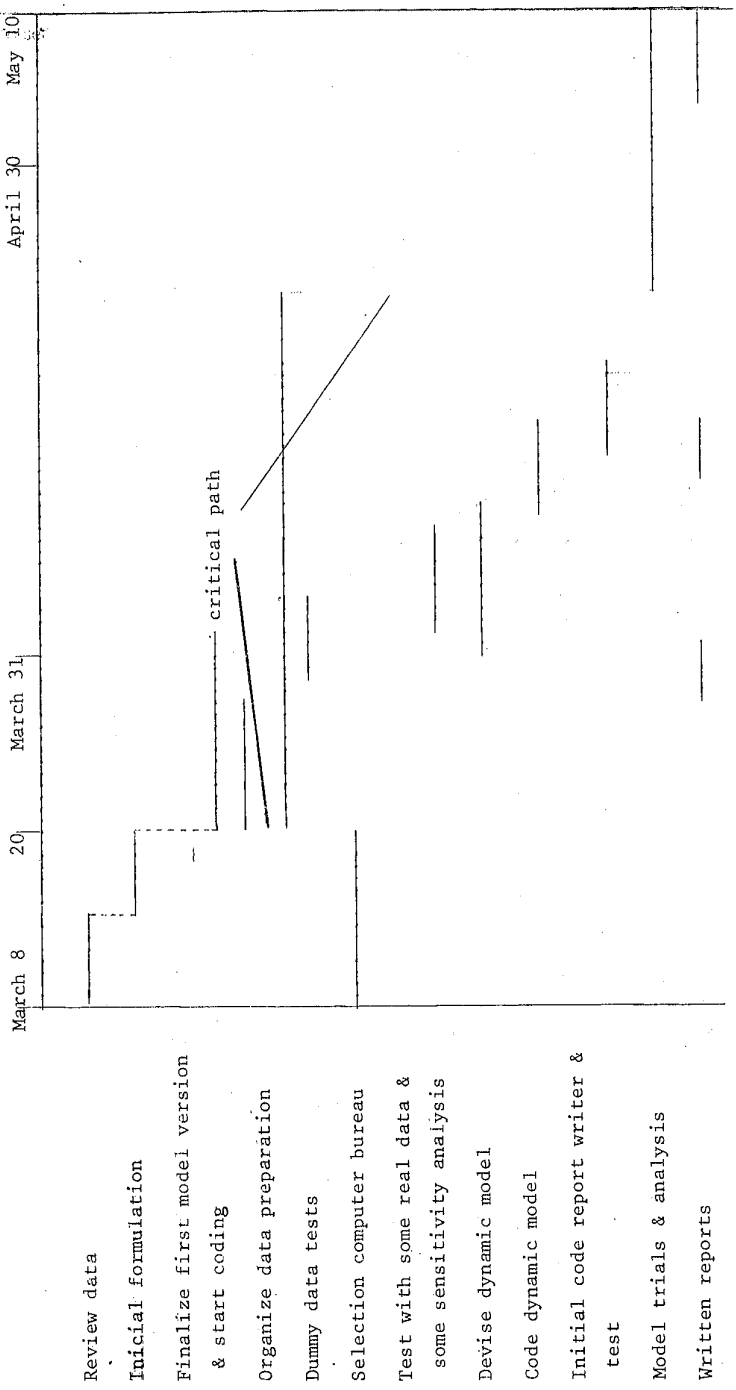
The design of the infrastructural units and the provision of suitable data in this area had not been completed by the beginning of the sub-project and they were on the critical path. The O.R. team was able to suggest acceptable simplifications in these stages as the work drew near to a critical pointo which saved over-running.

The schedule, as shown in final version in Figure 5, was constantly referred to and updated. Schedules in our experience are drawn up for a variety of reasons not all connected with administrative management. In this case, however, if the team had become distracted from the schedule, delays would have been unavoidable so the only way was to lodk onto the critical path, concentrate on the next task and hope that the deadline would be met.

The study was carried out with a high level of informality of team work. There was no formal assignment of project manager although the O.R. professor from L.S.E. was generally perceived as being primarily responsible. The two full-time team members in fact assumed most of the responsibility for ensuring that time cost and quality objectives were met, with all members assisting with the motivation and pressure internally is discussed further in the next section.

FIGURA 5

PROJECT SCHEDULE



The subproject was completed as schedule with satisfactory results in that the overall project was finished in the contractual time period. The modelling approach finally used differed considerably from the initial concept as developed at the proposal approach which had a high focus on transportation issues, the final model being a multi-period linear programming model involving:

- land and mineral resource utilization, using experience curve concepts.
- urban and rural development, specially social infrastructure
- transportation
- markets: domestic and export.

There was no single variable to optimise, the problem being to obtain a suitable compromise between conflicting objectives such as regional value added and unskilled employment, the latter arising from the social problem of Brazil's North-East. This type of trade-off is always present in socio-economic planning and at some point a difficult trade-off has to be made. The implementation of the porject is now under way although delayed by Brazil's economic slow down following the oil-crisis.

6. ANALYSIS OF THE CASE STUDY

The sub-project under analysis comprised only a small part of the total framework presented in the sections 1, 2, 3 e 4. Analysis of this sub-project nonetheless permit some extension and refinement of the overall conceptual framework.

In terms of the six activities Planning, Control, Report, Monitoring, Data Handling and Documentation all but Monitoring were involved although the only first level activity was of course Planning by the nature of the entire project which was a feasibility planning study. At the secondary level however all of the activities except monitoring were involved. Of the three functions defined earlier, Analysis, Modelling and Data Management Systems Design, the sub-project contained only one principal function Modelling.

The relative weights of the related functions is very difficult to estimate but did not differ significantly from the scheme presented in Quintela & Flores[2], i.e.

	Analysis	Modelling	Data Management System
Planning	20%	60%	20%

Beginning with regard to the goals/objectives, related activities and functions involved the situation is again a simpler on than the general framework presented earlier, consisting essentially of just one.

OBJECTIVES	ACTIVITIES MAINLY RELATED	FUNCTIONS MAINLY INVOLVED
Provide Planning advice for regional development decision making by the responsible of Government Agency	Planning	Modelling

We shall now take the analysis a stage further than the original conceptual framework and consider the roles of the individual team members with particular regard to the distribution of responsibilities. For the five people involved in the sub-project, the following table provides estimates of their proportionate involvment.

		Residence	Analysis	Modelling	Data Management System
Total Project Manager	A	Brasil	90%	5%	5%
Economist	B	Brasil	70%	25%	5%
Operational Research 1	C	U.K.	5%	80%	15%
Operational Research 2	D	U.K.	0	100%	0
Operational Research 3	E	Brasil	0	100%	0

Some key additional responsibilities should also be noted:

- linkage of the modelling function with the analysis and data management systems design was solely carried out by members A, B & C.
- orientation and help for the foreigners new to the Brazilian environment both generally in the broad cultural sense and also with regard to the available scientific-technical computing service support - this was carried out by members E and B.

detailed responsibilities of the team; this will now be discussed at some length.

We have already seen that at the primary level of analysis the team's work may be categorized as planning, but for our analysis of the subproject has in principle, two basic parts, management and execution and we could use the same conceptual scheme to analyse them. For comparative purposes we shall first consider one of the classical management views[9] that management consists of the following functions:

- Planning
- Organization
- Staffing
- Directing and Leading
- Controlling

Final responsibility for each of these functions belonged of course to the overall Project Manager, but in practice almost all aspects of these functions were delegated to the other team members with considerable sharing of responsibilities. The situation was similar for other management functions schemes such as Mintzberg, 1973[10]. However, it would be confusing if the analysis were to continue with the Koontz & O'Donnel definitions or those of Mintzberg so we shall return to the Quintella/Flores terminology.

At the secondary detailed level of functional/activity analysis the distribution of responsibilities is indicated below:

ESTIMATES OF ACTIVITY DISTRIBUTION

	A	B	C	D	E	TOTAL
Planning	10	10	50	20	10	100%
Control	20	20	40	15	5	100%
Reporting	10	10	10	70	0	100%
Data Handling	0	30	0	70	0	100%
Documentation	5	30	15	45	5	100%

Coordination of these activities among the various team members was achieved principally by members B and C with the others participating as the need arose. In this case the rather loose arrangement worked well.

7. CONCLUSIONS

The concept of distributed responsibility as conceived by Quintella & Flores appeared, on a post-hoc analysis,to have been used successfully in practice in the case study described. However considerable additional support from additional cases is necessary before firm conclusions can be drawn. In addition it is appropriate to call attention to the fact that other complementary theoretical frameworks can be applied to analyse the case; for example the rapidly developing body of theory and knowledge on matrix organizations[11], [12] appears a potentially useful approach to analysing what in a sense are "mini-matrix organizations" as analysed in Hemsley[13].

One general conclusion can however be drawn that the management of small teams of highly qualified professionals working on research problems is a rich potential study area for management theorists and one which has been little studied so far.

Managers and members of such teams have had to learn by experience, generally from both sucesses and failures, how to deal with the peculiar problems of very special and complex research projects with high levels of uncertainty and difficulty.

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