COMMISSION OF THE EUROPEAN COMMUNITIES

COM (88) 173 final
Brussels, 5 April 1988

Communication from the Commission to the Council and the Parliament concerning the final programme assessment of the Microelectronics Programme (Council Regulation 3744/81)

Communication from the Commission to the Council and the Parliament concerning the final programme assessment of the Microelectronics Programme (Council Regulation 3744/81)

I. THE INDEPENDENT PROGRAMME ASSESSMENT

1. In its Regulation 3744/81 of 7th December 1981, amended by Commission Regulation 397/83 of 17th February 1983, the Council adopted a programme for Community actions in the field of microelectronics technology (hereinafter referred to as the MEL Programme). The duration of the programme was for four years beginning in 1982. A budgetary envelope of 40 MECU was foreseen for the MEL Programme, of which 39.2 MECU were allocated to the projects. Following two open calls for proposals, a total of 15 transnational collaborative projects were approved involving 62 different organizations.

2. In accordance with the Council Regulation four annual progress reports of the MEL Programme have been established by the Commission[1]. Following the completion of the Programme, the Commission set up an independent assessment team, led by Professor R. Van Overstraeten, President of IMEC vzw and member of the ESPRIT Advisory Board.

   The assessment was carried out by means of face-to-face interviews and a mailed questionnaire. A total of 31 organizations provided input at face-to-face meetings. Questionnaire responses were obtained from 76 participants in the MEL Programme. The views expressed and opinions of the organizations interviewed were collected, collated and used as the basis for the conclusions derived by the assessment team and the recommendations submitted to the Commission.

---

(1) COM (83) 564 of 7th October 1983
COM (84) 567 of 23rd October 1984
COM (85) 776 of 27th December 1985
COM (87) 22 of 2nd February 1987

3. The team assessed in particular:

(i) Programme Implementation and Administration:

- the call for proposals
- the proposal evaluation
- the launching of projects
- the monitoring of projects (technical and financial)
- the interaction between the Commission and the Contractors
- the Community contribution (motivation, level of funding, optimisation of utilisation)

(ii) Achievements:

- the overall programme technical objectives (CAD and Equipment)
- the exploitation of results
- the impact

(iii) Broader Community Interests:

- transnational cooperation
- transfer of know-how within projects
- dissemination of results
- interaction with other Community and/or national programmes

4. The final programme assessment, submitted to the Commission on 15th December 1987, is annexed. The main conclusions and recommendations of this assessment may be summarized in the following way:

(i) The programme has been successful. With a few exceptions, all of the projects achieved their specified objectives, particularly in terms of advances in technology and scientific know-how. The pioneering nature of the MEL Programme for the management of transnational collaborative projects has been taken into account.

(ii) As the first collaborative industrial R&D programme funded by the Commission in the field of Information Technology, the MEL Programme paved the way, in

terms of criteria for participation and management methods, for later ongoing initiatives such as the ESPRIT Programme.

(iii) Certain deficiencies in the proposal evaluation and project management which occured in the initial stages of the Programme were generally considered to have been remedied in the light of experience.

(iv) The assessment recommended that the number of partners in projects be restricted to five, except in special cases such as standardization actions.

(v) For the future development of such collaborative programmes, the assessment also recommended that a 50 % level of Community funding should be the norm.

(vi) The assessment stressed the continuing need which exists for Europe to have a capability to supply the manufacturing and test equipment necessary for advanced VLSI fabrication.

(vii) In the light of the very high costs associated with the commercialization of technologies developed within the MEL Programme, it was suggested that some form of support could be provided by the Community for the exploitation phase, perhaps within the framework of the ESPRIT Programme.

5. The Commission regards the final Programme assessment of the MEL Programme as a well conducted and highly useful operation. It is the first in-depth review of a completed Community R&D Programme in the Information Technology area. The methodology used for obtaining inputs from the industrial and academic spheres - a methodology which has already been used in respect to the mid-term review of ESPRIT[2] - ensures that the conclusions and recommendations reached by the assessment team accurately reflect the preoccupations and priorities identified by the programme participants.

The Commission has accepted the report produced for the final programme assessment of the MEL Programme. It considers the findings and recommendations which it contains in greater detail below and describes the consequences of the assessment for its future activities.

---

(2) COM (85) 616 final of 19th November 1985

II. PROGRAMME IMPLEMENTATION AND ADMINISTRATION

1. The results of the assessment show that the MEL Programme was successful in meeting its objectives. While modest in its conception and volume, the MEL Programme proved to be an efficient allocation of resources. The technical results would appear to be impressive, and to be of a very focussed nature.

2. The cooperations engendered by the Programme worked extremely well, and the experience gained by firms and academic institutions initiating transnational cooperation has had an impact beyond the Programme itself. Seven new start-up companies have been formed to exploit some of the results stemming from MEL projects and participants agree that the Programme has played an important role in developing a CAD for VLSI Community in Europe.

3. The transnational collaboration in the MEL Programme, by operating successfully, demonstrated that this was a mechanism which could be applied to more ambitious research programmes of broader scope. The MEL Programme could therefore be said to have paved the way, in terms of concepts and criteria for participation and management methods, for later ongoing Community initiatives such as ESPRIT.

4. Concerning the overall management of the Programme, the Commission recognizes that at the outset of the programme some shortcomings were experienced which were later remedied by the application of more rigorous management techniques. These shortcomings resulted mainly from an insufficient number of staff allocated to manage the Programme. In effect, the fact that the Programme suffered from inadequate and late availability of posts has been a valuable experience for the Commission, since it has given rise to the practice, for later programmes, to create temporary posts from the research budget for the management of the Programme. Had proper manning levels been available at the time the initial decision was taken, and in particular the assignment of full-time project officers, we are confident that many of the shortcomings would not have arisen.

5. The Commission has in particular taken note of the finding that only three-quarters of participants expressed themselves content with the tendering procedures. It should be pointed out that the assessment addresses with hindsight administrative procedures of a pioneering nature and which were subsequently improved in the light of accumulated professional experience, with greater stress being laid in particular on the interaction between the Commission services and participants or potential

participants. The Commission admits that there were deficiencies in the first of the two calls for proposals, notably in the feedback to the applicants/proposers. It is also the case that the Commission learned from the experience gained in the MEL Programme to ensure that in later programmes in the IT sector an improved level of information to interested parties has been a significant element. Nowadays, feedback with proposers has been improved, facilities for companies identifying other partners have been created, and evaluations are being conducted to a strict timetable.

6. It is apparent from the findings of the assessment that there was a certain discrepency between the expectations of industrial concerns and those of academic participants as to the results to be achieved. It should be pointed out that the Programme, as conceived and executed, was industrially-oriented, and that academia was gradually able to make the necessary adjustments. This is evidenced by many participants' realization that it was preferable to use an industrialist as project manager. The conclusion that academia has a significant role to play, with its interest being complementary to the orientation of industry, is one which the Commission appreciated. The role of academia has therefore been safeguarded, in later R&D programmes such as ESPRIT, by introducing modified criteria for participation, more suited to the structures and capabilities of participants with a university and non-industrial background.

III. CONSEQUENCES OF THE ASSESSMENT FOR MANAGEMENT ASPECTS OF OTHER PROGRAMMES

1. The Commission has noted the finding that considerable difficulty was encountered in the effective management of large projects. However the example cited (Project MR - 04) is misleading, since 22 out of the 28 participants were in fact sub-contractors, necessary for the execution of the technical tasks. The Commission recognizes the need for streamlining participation wherever feasible, since this enables the individual project to be more dynamic. The Commission therefore accepts the recommendation contained in the assessment that the number of partners in projects should as a rule be restricted to five, except in exceptional circumstances such as standardization initiatives.

2. The Commission has noted the view expressed by participants that there was a need for improved dissemination of information between the projects. This view previously voiced in the ESPRIT mid-term Review, has led directly to the strengthening of this activity within collaborative R&D programmes of the Community.

The Commission is conscious that these programmes have been laying the ground for technology transfer, mainly by means of information dissemination activities and the wider access to results which is permitted. The Commission's general policy is that information dissemination activities must build on experience gained and results achieved during the execution of individual programmes. These activities include inter alia the organization of regular information exchange fora, special interest groups and workshops on specific topics addressing a technical audience, as indeed was the case for the CAVE workshops within the MEL Programme. These events combine reporting of results, general information exchange, identification of topics of common interest and preparation of potential collaboration, be it inside or outside the programme concerned.

3. The Commission is pleased that the involvement of users has had a positive impact, and accepts that future projects should involve users as well as suppliers. This is particularly the case in the preparation of standards, and in application projects, where users' participation should be foreseen from conception through to execution.

4. The Commission has noted with great interest that many participants were concerned with variable funding ranging from 30% to 50% and suggested that split-cost funding should be the norm. The Commission, in the light of experience gained in the MEL Programme, where 30% funding was generally considered to be inadequate, has concluded that differential funding is inappropriate, and that a 50% Community contribution should be the norm for all precompetitive industrially-oriented R&D projects, with participants meeting the other 50%. In the case of academic institutions, alternatively, 100% funding of marginal cost may be foreseen.

IV. RECOMMENDATIONS OF THE ASSESSMENT CONCERNING COMMUNITY POLICY IN THE MICROELECTRONICS SECTOR

1. The Commission shares the view, expressed in the assessment, that the increased availability of engineers skilled in the use of CAD for the design of complex ICs

would improve Europe's capability to develop and exploit such technologies. It is for this reason that the Commission has taken up initiatives in the context of ESPRIT II and is planning action on the promotion of high level professional training in areas of particular concern to the Community. It should be emphasized that a highly focussed effort is required and specific strategic areas must be identified to benefit from such an action. Currently, Microelectronics and Computer Integrated Manufacturing have been pinpointed as specific sectors where action concerning skills and education is likely to have the most impact, not just for the IT industry, but also, because of their wide-ranging applications, to the European economy as a whole.

2. The Commission accepts the observation that a continuing need exists for Europe to have a capability in manufacturing and test equipment for VLSI, and is conscious that efforts in this area are still sub-critical. Therefore, this area of concern has been taken up and incorporated into the ESPRIT II work programme, where a large increase of resources is foreseen. Further resources may have to be devoted to new activities on this topic in the light of the initial results achieved.

3. Whilst appreciating that there are very high costs involved in commercialising the technologies developed within the MEL Programme, the Commission rejects the suggestion, put forward in the assessment, of providing financial Community support for the commercial exploitation phase of such technologies. The Commission appreciates the specific problems besetting this key sector for European industry, but does not feel that down-stream intervention in the commercial cycle would offer long-term viability for the MEL industry. The Commission, while rejecting public funding as the solution to solving the supply-and-demand and structural difficulties encountered by the European MEL industry in the face of fierce competition from Japan and the USA, is nevertheless examining alternative methods of contributing to improving the position and self-confidence of the industry. The Commission consequently intends to submit to Council in the course of 1988 a report containing proposals for measures which it considers necessary and appropriate to enable the MEL industry in Europe to maintain its competitiveness by 1992 and beyond.

CONTENTS LIST

ASSESSMENT OF THE MICROELECTRONICS PROGRAMME

(COUNCIL REGULATION 3744/81)

EXECUTIVE SUMMARY

The microelectronics (MEL) programme was prepared by the Commission in the late seventies and early eighties in order to take advantage of collaborative research and development to contribute to an increase in the competitiveness of Europe in the strategically and economically important field of microelectronics.

. The MEL programme was the first collaborative R&D programme funded by the Commission in this field.

The European Strategic Programme of Research in Information Technology (ESPRIT) that was subsequently launched by the Commission benefited from the experience gained by the staff of the Commission and by the contractors.

. In particular the MEL experience was very helpful to ESPRIT during its definition phase.

Unlike the broader based ESPRIT programme, the MEL programme was restricted to two fields.

. Computer Aided Design of VLSI.

. Equipment for manufacturing and testing VLSI.

Following the call for proposals (Council regulation No 3744/81) and subsequent evaluation, a total of 15 projects were approved involving 95 participants from the member states, and a total funding level by the Commission of 40 MECUS.

. The funding provided by the Commission varied from 30% to 50% of the project costs and averaged 42% across all projects.

. The duration of the MEL programme was 4 years commencing 1982.

In accordance with the Council recommendation annual assessment reports of the MEL programme have been carried out.

. This 1987 report, is the final assessment and has been carried out for the Commission by an independent assessment team lead by Professor Van Overstraeten.

The assessment is based upon a series of face to face interviews with 31 contractors and the 76 responses to the questionnaire that was mailed to all 95 participants.

The findings and conclusions from the assessment may be summarised as follows:

(i) **Bearing in mind the pioneering nature of the MEL programme when it was originally started in 1981, the consensus view is that it has been successful.**

(ii) **With a few notable exceptions, all of the projects are achieving their specified objectives particularly in terms of advances in technology and scientific know-how.**

. Where deviations occurred they were based upon an agreed revision of the project objectives resulting primarily from unforeseen technical difficulties.

. In one instance the project was terminated prematurely for technical and financial reasons.

(iii) **A major success of the programme was the demonstration that transnational collaborative R&D programmes can be successfully implemented in the European environment.**

(iv) **A further success was the bringing together of industrial and academic research laboratories leading to a closer understanding between the research workers involved and facilitating the transfer of know-how.**

(v) **Cooperation between the Commission and the participants in the MEL programme was good.**

. The overhead resulting from the management by the Commission was considered reasonable.

(vi) **There was almost unanimous agreement among participants that the MEL programme had helped to narrow the know-how gap between Europe and the US and Japan.**

(vii) **In terms of exploitation, the MEL programme led to the development of a number of new technologies and products in the CAD and equipment fields which are now being used internally by the partners or further developed for commercial exploitation by the partners or by new start-up companies.**

. Examples include: (See the Project Status Reports in Annex 2):

- the use of the Cascade environment for the design of VLSI - Project MR-01
- the ESCAPADE algorithmic test bed for semiconductor devices - Project MR-02
- the CAD software for verification of MOS VLSI - Project MR-03
- the CAD system for VLSI circuit design for telecommunications applications - Project MR-04

- the VLSI tester - Project MR-05
- computer aids for the verification and compilation of VLSI - Project MR-06
- the 2D and 3D modelling of MOS devices - Project MR-07
- the High Resolution Electron Beam lithographic equipment - Project MR-08
- the Hierarchical VLSI design system - Project MR-09
- equipment and packages for high pin count VLSI - Project MR-10
- the Refractory Metal Deposition Process and equipment - Project MR-11
- the Plasma Ion Etching Systems - Project MR-12
- the CAD system for VLSI testing - Project MR-13
- the Burn-in systems for Complex ICs - Project MR-14
- the Electron-beam testing equipment for VLSI - Project MR-15

(viii) **A total of 6 new start up companies have been formed to exploit some of the results stemming from the MEL projects.**

. APSIS, and ARCARD in France.

. ANACAD, DRC, DOLPHIN and GSD in Germany.

(ix) **The MEL programme has played a most important role in developing a CAD community in Europe and in promoting and enhancing the state of knowledge and general know-how associated with these most important design tools for VLSI.**

. This will have a long term effect on both suppliers and users of complex ICs.

(x) **During the course of the programme information on CAD was disseminated by means of 9 CAVE workshops which were held at 6 monthly intervals and attended by more than 500 experts.**

(xi) **The view was expressed that there was a need for improved dissemination of information between the projects in the programme.**

(xii) **The limited funding provided according to the intentions of the Community could only have a small effect on the competitive status of the Community's microelectronics industry in terms of its dependency upon the USA and Japan for the supply of VLSI CAD tools and manufacturing equipment for VLSI.**

. A higher funding level could have led to a larger impact.

(xiii) **The increased availability of engineers skilled in the use of CAD for the design of complex ICs resulting from the MEL programme will improve Europe's capability to develop and exploit such products in advanced equipment and systems.**

(xiv) **In some cases, the participants commented that in the future, the definition of the objectives of the projects has to be undertaken with care and subjected to timely adjustment to ensure that the technologies developed remain competitive with state-of-the-art products.**

(xv) **Both academia and industry have significant roles to play in the projects with the longer-term, more fundamental interest of academia being complementary to the shorter-term product orientation of industry.**

(xvi) **The involvement of users had a positive impact and where appropriate future projects should involve users as well as suppliers (i.e. manufacturers) with the users participating as partners and receiving financial support on an equivalent basis.**

- The user-supplier interaction should be clearly defined at the commencement of the project.

(xvii) **The total level of funding provided by the Commission varied from 30% to 50% of the total project costs.**

- Many participants considered that 50% funding should be the norm.

- Academic institutions considered 50% funding of their research activities to be insufficient and suggested 100% funding by the Commission and/or the industrial partners, for the longer term research.

- A majority of participants suggested that the total funding levels were insufficient.

(xviii) **It was recommended that the number of partners in projects be restricted to five except where there are very good reasons for more partners such as in projects involving standardisation issues.**

(xix) **With the existence of the ESPRIT programme of pre competitive R&D, there is no longer a need for a separate programme to support the basic microelectronics technologies.**

- The work plan for ESPRIT-II contains research projects in CAD for VLSI and Manufacturing Equipment for VLSI some of which are continuations, and extensions of the work started in the MEL programme.

(xx) **Because of the very high costs associated with the commercialisation of technologies developed within the MEL programme, industry has questioned whether some form of support could be provided by the Commission for this exploitation phase.**

- It is suggested that there should be a separate programme to support the development of pre-production prototypes based upon the technologies developed within the MEL programme (and also within ESPRIT).

(xxi) **A continuing need exists for Europe to have a capability to supply the manufacturing and test equipment necessary to fabricate advanced VLSI.**

(xxii) **As commented by many participants, the largest impact of the MEL programme could be the creation, in Europe, of an informed CAD community, and the increased European capability in this area.**

- This will be particularly important in the future as the equipment and systems companies increasingly become involved in designing on silicon (eg for Application Specific IC's) which is one of the central issues in ESPRIT - II.

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

On 7th December 1981, the Council adopted Regulation No 3744/81 on Community actions in the field of microelectronics technology.

. It was amended in 1983 (Regulation No 397/83) in relation to the list of projects which were categorised and concentrated into two areas.

- Computer Aided Design for Very Large Scale Integrated Circuits (CAD for VLSI).

- Equipment for Manufacturing and Testing VLSI.

This regulation was a result of the concern of the Commission to increase the competitiveness of Europe in the field of microelectronics.

. The aid granted should aim at furthering a balanced market and the competition situation in Europe and should stress the importance of adequate dissemination of the results of the projects and any products that may follow.

This report is submitted to the Commission, as an independent and objective assessment of the MEL programme covering the activities specified within Regulations 3744/81 and 397/83.

. The report is based upon a survey and evaluation of the 15 projects that were supported financially within the terms of reference of these regulations.

- The survey was carried out (see section 2) by a combination of face-to-face interviews and a mailed questionnaire.

. The report is structured in the following way:

- Section 0 - The Executive Summary

- Section 1 - The Introduction

- Section 2 - The Organisation of the Evaluation

- Section 3 - The Evaluation Findings

- Section 4 - Conclusions and Recommendations for the future

- Annex 1 - Programme Overview

- Annex 2 - Project status reports

- Annex 3 - Overview of Questionnaire response

- Annex 4 - Summary of questionnaire findings

1.2 PROGRAMME IMPLEMENTATION

As a result of two calls for proposals the 15 projects listed in Annex 1 were launched varying in size from 0.75 M ECU to 24 M ECU.

- 8 projects were concerned with CAD for VLSI and 7 projects were concerned with equipment for manufacturing and testing VLSI.

- These projects were launched in two batches (early 1983 and early 1984) and involved a total of 62 organisations within the Community.

  - Some organisations participated in more than one project thus resulting in a total of 95 participants.

- Monitoring of the progress of individual projects was the responsibility of Commission staff supported and assisted in many cases by external experts and advisers.

At the commencement of the programme a Consultative Committee was established to assist the Commission with the implementation of the Programme.

- This Committee comprised representatives of the Member States assisted by experts.

As specified in the Council regulation, the essential features of the MEL Programme are:

- The provision of financial support for specified projects in the form of subsidies normally covering 30% of the costs of their execution but possibly as much as 50%.

- The total financial support provided shall be restricted to a maximum of 40 MECU.

- The projects eligible for aid shall be in line with the specifications set out in the technical annex and carried out within the Community.

  - The Technical Annex to the Regulation specifies projects concerned with CAD for VLSI and equipment for manufacturing and testing VLSI.

- The CAD projects shall involve universities, research centres or firms established in different member states, together with users.

- The equipment projects shall involve research centres, manufacturers or industrial users in different member states.

. In the above cases the minimum number of users involved in a project was agreed with the Consultative Committee and set at 2.

. Great importance is attached to the dissemination of information both in the CAD and equipment projects.

. Contracts shall be placed between the Commission and every participant which place great emphasis on:

- The management of the project clear definition of responsibilities between partners and nomination, by every contractor and partner, of a Project Manager (PM) and Deputy Project Manager (DPM).

- Technical and financial control and verification by the participation of Commission representatives in project management and/or review meetings and the involvement of one or two project advisors.

- The submission of regular (i.e. 6 monthly) progress reports and statements of expenditure incurred to date.

- The ownership of all know-how, copyrights patents or similar rights by the contractors and right of the Commission to publish the final report.

- The undertaking by the contractors to exploit, or secure exploitation of, or take adequate measures for the commercialisation or diffusion of the results of the project in order to satisfy the needs of The Community.

- The confidentiality of all information of industrial and commercial secret nature that may be delivered to the Commission in the performance of the contract.

- In the event that the Contractors fail to exploit the results of the projects within one year of the acceptance of the final report, by the Commission, they shall grant non-exclusive licences to any person or organisation of the Community who applies for them to enable the results to be utilised in accordance with Community interests.

The two calls for proposals (first quarters of 1982 and 1983) resulted in the submission of 50 proposals for joint projects.

. These proposals were evaluated by teams of experts drawn from industry, research establishments and academia.

. The results of the evaluations were submitted, discussed and agreed with the Consultative Committee.

Dissemination of the results has been ensured by the publication of final reports, publication of papers and delivery of lectures.

- In the case of CAD for VLSI, the Commission has sponsored CAVE (CAD for VLSI in Europe) workshops which are held twice a year.

  - These workshops are used for the dissemination of the results of the CAD projects and as a forum for discussing new ideas and fostering working relations between experts of the Community Countries.

  - To date, a total of 9 workshops have been held involving a total of 506 expert participants, from the member states.

2.0 ORGANISATION OF THE ASSESSMENT

2.1 AIM OF THE ASSESSMENT

The aim of the evaluation was to undertake an assessment of the implementation and achievements of the MEL programme by comparing the results obtained with the objectives set out in the Council Regulation 3744/81 and paying particular attention to:

. A Programme implementation and administration

- The call for proposals.
- The proposal evaluation.
- The launching of Projects.
- The monitoring of projects (technical and financial)
- The interaction between the Commission and the Contractor.
- The Community contribution (motivation, level of funding, optimisation of utilisation)

. B Achievements

- The overall programme technical objectives (CAD and Equipment)
- The exploitation of results
- The impact.

. C Broader Community interests

- Transnational cooperation
- Transfer of know-how within projects
- Dissemination of results
- Interaction with other Community and/or national programmes.

2.2 METHODOLOGY

The methodology used for the evaluation involved a mix of mailed questionnaires and face-to-face interviews with senior representatives (e.g. project managers) of the participating organisations.

. A semi-structured questionnaire was distributed to all 95 organisations participating in the programme and 76 returns were received.

. Face-to-face interviews were conducted with 31 contractors.

. An overview of the questionnaire responses and interview programme is given in Annex 3 and the findings are summarised in Annex 4.

The questionnaire responses and interview reports were analysed and the findings are presented in sections 3 and 4 of this report.

. Section 3 contains a summary of the results of the analysis of the findings of the evaluation which are given in detail in Annex 4.

. Section 4 draws conclusions and recommendations from this analyses.

3.0 ASSESSMENT FINDINGS

The conclusions of this assessment are based on the analysis of the answers to the questionnaire, on the reports made by the experts after their interviews with the contractors and on a number of discussions with members of the Commission.

. A detailed analysis of the questionnaire responses is given in Annex 4.

In accordance with the terms of reference of this assessment, the conclusions are presented under three main subject headings:

. Programme implementation and administration.

. Achievements of the programme.

. Broader Community interests.

3.1 PROGRAMME IMPLEMENTATION AND ADMINISTRATION

3.1.1 The Call for Proposals, Evaluation and Tendering Procedures

In general the tendering procedures used were considered to be good by 66% of respondents (i.e. 48 out of the 73 returns). (c.f Annex 4 question F16)

. The complete analysis showed

Good	48 returns	66%
Average	7 returns	10%
Poor	18 returns	24%

Comments made on the tendering process included:

. The short time in some cases between the call for tenders and due date for the proposals.

  - Since this was the first Commission programme in microelectronics, the organisations submitting proposals had to spend time identifying partners and reaching agreement with them.

. The long time taken, in some cases, to evaluate the proposals and select the projects.

  - In addition some of the universities expressed criticism at the selection criteria used by the Commission, the view being expressed that they could have been more severe with more emphasis placed on the **quality** and **originality** of the proposals.

. Criticisms were also made by two participants of the scarcity of information during the tendering procedure, and of particular concern were:

  - the lack of feedback information on rejected projects,

  - the delays in informing companies of the rejection of their proposals and reasons for rejection,

  - the failure of communicate the results of the evaluation in writing.

3.1.2 Launching of Projects

Due to the restriction on the level of funding that was available it was decided by the Advisory Committee to place the emphasis on Computer Aided Design for VLSI and manufacturing equipment for VLSI.

. It is recognised that CAD tools will play an enormous role in the future development of microelectronics and that it is essential for Europe to have the tools available and the necessary skilled workforce able to use these tools.

. Most of the equipment used in the fabrication of advanced ICs is imported from the US and/or Japan. To obviate this dependance on foreign suppliers it is considered desirable that Europe has an indigenous capability and where possible exploits its particular strengths (e.g. in electron beam technology).

In most cases the projects were launched smoothly with attention being given to the detailed specification of the individual tasks and allocation of responsibilities between the partners.

. As in all projects, the better the initial planning of the project, the better the implementation.

The appointment of strong experienced project managers was clearly essential to the success of projects.

. This is particularly so for the prime contractor.

. The most successful projects were those in which the project manager came from industry and in several instances the view was expressed that it was preferable to use an industrialist as the project manager.

Equally important was the continuity of project manager through the duration of the project.

. Five instances occurred where, because of commercial pressures, the project manager changed several times during the three year duration of the project.

  - In one particular project for example there were five project managers during the life of the project.

. It is clearly important that every effort should be made by industry to ensure the commitment and continuity of the project managers.

Considerable difficulty was experienced in the effective management of the larger projects involving many contractors. (Particularly MR-04 which had 28 participants.)

. In such projects there is a clear risk that some of the partners do not feel involved and carry out their allocated work independently of the others and with minimum interaction.

  - Since they can not see the overall strategy, such partners may get easily lost.

. To overcome this problem it is recommended from the outset that professional management techniques be used on the large projects.

. In addition it is considered to be important that such projects be organised in a clearly defined pyramidal structure with delegation of responsibilities down the pyramid and clearly defined reporting paths.

  - In this way the involvement of all the partners is ensured and their role in the total project is clearly defined.

In projects involving users as well as suppliers and researchers it proved to be very difficult to achieve substantial user involvement.

. This was particularly the case where the role of the users was to evaluate products (hardware or software) developed within the programme.

  - In several instances because the development of the products was delayed, the involvement of the users was delayed.

It is strongly recommended that users should be involved from the beginning of the project and participate in the setting of task objectives and timescales.

At the commencement of most projects, briefing meetings were held involving all the project participants.

. This seems to be an essential means of launching complex multi-partner projects as is evidenced by the fact that those projects starting with such meetings had less trouble.

It is considered essential therefore that every project should be launched with a suitable kick-off meeting involving all participants (from industry, research establishment and academia) as well as Commission representatives.

. At this meeting it is essential that a clear understanding be established on:

  - the detailed scientific and technical objectives of the project and expected deliverables.
  - the allocation of tasks
  - the management of the project.
  - the organisation of the project including distribution of tasks, reporting procedures, means of communication, and cost control.

. Equally important it is desirable that milestones be established against which the progress of the project may be monitored.

It was also strongly recommended by many of its participants that the number of partners be restricted to a maximum of four or five except where there are very good reasons for more participants.

. In those projects involving a large number of participants (particularly MR-04 which had 28) it proved to be extremely difficult to achieve the required degree of communication, coordination, interaction and management control.

. The participation of larger numbers of organisations can be justified in those projects concerned with standardisation issues.

3.1.3 Project Monitoring

To provide effective project monitoring it is important that milestones should be built into the original project plan.

. This was not always the case thus making it difficult to monitor the progress of the project against the plan and against the incurred expenditure.

The contracts from the Commission called for the submission of a 6 monthly report on the project.

. A number of contractors, particularly from the academic environment, considered that the burden associated with the preparation of such reports was too heavy and suggested an alternative in which the written report was alternated with a workshop.

  - In general the industry participants more readily recognised and accepted the need for a regular reporting system.

To improve the reporting system and make it more acceptable to the partners it may be possible to introduce a highly structured pre-formatted reporting system in which activities, achievements and expenditure are reported against the plan and major problems and set backs highlighted.

The monitoring of the projects was undertaken by a Commission representative assisted in many instances by one or more external advisor.

. External expert advisors were also involved in the proposal evaluation process.

According to the survey (Question F17), 84% of the respondents were of the view that the involvement of external advisors was favourable (i.e. beneficial).

. Responses to question F17 on the involvement of external advisors were:

	No. of responses	Percentage
Good	36	84%
Average	1	2%
Poor	6	14%

. Of concern is the large number of contractors who did not have or see advisors.

Comments made on the involvement of advisors suggests that although in some cases they made significant and important contributions to the projects in others they should have taken a more active role.

. In some instances the project participants regretted that the advisers were not more severe and critical.

On balance the use of critical external advisors had a beneficial effect on those projects that made use of them.

. It is clearly important that the advisor has the necessary detailed understanding of the project and the technologies involved and of worldwide developments in the field.

  - In addition it is most important that the advisor commands the respect of the project team and is able to influence the course of the project.

3.1.4 Commission - Contractor Interaction and Community Contribution

In response to question F3 concerning cooperation with the Commission (Annex A4), the clear majority of contractors (68%) considered that it was very good.

. 28% considered that the cooperation was good and only 4% (i.e. 3 responses) that it was poor.

On the question of the overheads resulting from the management, by the Commission (i.e. F4) a large majority (i.e. 71%) of respondents considered that it was reasonable.

. The overhead was considered to be high by 23% and too high by 6% of the respondents.

The funding levels reported by the respondents varied from 30% to 50% as is shown by the responses to question B11.

. Analysis of the responses to question B11 shows that 29% of the organisations received funding from the Community that was between 40 and 60% of that available from own and/or national sources and this corresponds to between 29 and 37% of the total project funding.

. Most contractors considered 50% funding to be the norm, although 63% of respondents suggested that the funding levels were insufficient.

. For universities and other academic institutes a 50% funding level was considered inadequate as it was frequently very difficult for them to provide the other 50% funding.

  - Several academic institutes requested a funding level of 100% for their more speculative long-term research. This was justified on the basis that there could be no commercial return to the institute as a result of the commercialisation and exploitation of the results of the project.

  - Alternatively it was suggested by several academics that industry should be asked to finance the involvement of Universities.

Also of concern, particularly to the Universities and Academic Institutions were the delays in payments that have arisen.

. In general the academic environment does not have the financial resources to bridge this period of negative cash flow.

It was generally agreed by the participants that in those cases where there was genuine user participation in the specification and evaluation of new products, the benefits to the project were positive.

. In the future it is strongly recommended that where there is user participation in the projects then an allowance should be made for the cost-shared funding of this participation which should be on the same basis as for other participants.

3.2 PROGRAMME ACHIEVEMENTS

3.2.1 Overall Technical Objectives

The project status summaries given in Annex 2 show that all 15 programmes have been or are nearly completed.

. In a number of cases there were unavoidable delays in the work programme which led to an extension of the elapsed time.

. In a few cases it was necessary to modify the terms of reference and objectives of the projects as a consequence of the findings that came to light during the early stages of the projects.

  - Such changes are to be expected in a research environment.

. In one instance on the agreement of the partners and the Commission, the project was prematurely terminated for technical and financial reasons.

One measure of the success achieved in reaching the technical objectives and in furthering the European know-how and state-of-the-art in CAD and equipment for manufacturing VLSI is the number of publications, papers and seminars.

. The responses to questions B1, B2 and B3 indicated that the following has been achieved: (See Annex A4)

  - Publications

Number of contractors publishing alone	34
Number of contractors publishing jointly	17

  - Papers

Number of contractors presenting alone	43
Number of contractors presenting jointly	16

  - Seminars

Number of seminars presented alone	27
Number of seminars presented jointly	13

. The total number of publications and papers exceeds 100, the vast majority, by far, coming from Universities and research institutes rather than industry.

. Of some concern is the fact that only 30% of these publications and papers have joint authorship of the project partners.

  - This indicates that many of the participants see the programme as a means of enhancing their own know-how and standing in the technical community.

The survey carried out shows that a total of 12 patents have been applied for as a result of work carried out within the programme.

. 11 of these patents are in the names of individual organisations and 1 is a joint application.

Other measures of the achievement of technical objectives are the statements made concerning the exploitation of the results of the projects.

. In several projects the work has resulted in the development and evaluation of prototype products which are to be commercialised and marketed by either the project partners or by start-up companies specifically formed to exploit the technologies.

. In many other projects, it is the intention of the partners to use the technologies developed in-house.

  - This is particularly the case for the projects concerned with CAD for VLSI which resulted in the development of many new CAD tools (including VLSI test software) which are being incorporated into the design systems being used by the participants.

The new technologies and products developed and being exploited include:

. New CAD tools and compilers

. VLSI test software

. New IC packaging systems for high pin count devices.

. A new IC tester

. A new deposition system

. An improved electron beam system

. A reactive-ion etcher

. An I.C. burn-in system

. An electron beam tester.

Although the objectives set for the individual projects were considered to be realistic advanced targets at the commencement of the MEL programme, by the time of their completion, the technologies and products developed were considered by most partners to be state-of-the-art (i.e. abreast of and comparable in performance to commercially available products) rather than leading edge.

. The response to question C concerning the competitive environment and comparative status of the technology developed vis-a-vis the US and Japan was:

Behind	8%
Abreast of	55%
Ahead of	36%

. It must be commented however that in many instances the competing technologies were appearing in commercial products.

There was almost unanimous agreement among the participants that the MEL programme had helped to narrow the know-how gap between Europe and the US and Japan.

. The scale of the programme however was too small to have a significant impact on the dependency of Europe upon the US and Japan for the supply of CAD tools and manufacturing equipment for VLSI.

. In a few selected cases there may be opportunities for the export to the US and Japan of products derived from the technologies developed within the MEL programme.

3.2.2 Exploitation of Results

CAD for VLSI

The results of the CAD projects are software packages that can be used by the developers of the design tools.

. These packages are not debugged, nor user friendly, nor ready, as yet, to be incorporated into commercial products.

. Additional work is required to commercialise these products.

To convert these products into commercial software packages will require an effort which is several times that required to develop the initial "research" prototypes.

. Most of these prototypes are being used internally by the project partners (particularly the large companies) who are incorporating the tools into integrated design systems.

. In three cases only, are the products being developed into commercially available CAD tools and in some instances this commercialisation is being undertaken by entrepreneurial start-up companies.

The commercialisation phase of the exploitation of the technologies developed within the MEL programme requires a large up-front investment which many companies (particularly the small and medium sized establishments) find difficult to finance.

. Several such companies expressed the wish that funding should be made available to assist this phase of exploitation.

The MEL programme has resulted in the development of a number of design technologies that are either being used internally by the partners involved in the projects, or are being prepared for commercial exploitaition.

. In the case of CAD for VLSI, the tools developed are being integrated into and used in the VLSI design process used by the partners.

  - Examples exist of the innovative developments being used by the participants and commercially exploited by the partners. In some instances new start-up companies have been formed to exploit the technologies.

The exploitation of the results of the programme represents a small but positive impact on the European semiconductor industry insofar that it has led to new CAD technologies being used and developed into commercial products.

. Although positive, this impact will be small in terms of the total effect on the European Microelectronics business.

  - Europe will continue to be largely dependent upon the US and Japan for the supply of advanced tools for CAD for VLSI.

As commented by many of the participants, the largest impact of the MEL programme could be in the creation, in Europe, of a CAD community.

. Through the CAD projects hundreds of engineers and research workers have worked together to develop advanced CAD tools for VLSI.

  - This has had the effect of informing and educating the participants about CAD, of advancing the state of knowledge in CAD across the member states of the Community and in the case of the Universities, of increasing the output of trained CAD specialists.

. Of great importance, the members of this CAD community are now aware of the interests and capabilities of their European colleagues.

This increased European capability in CAD will be most important for the future, particularly in connection with the design of Application Specific ICs (ASICs).

. Increasingly the design of ASICs is being undertaken by the users (i.e. the equipment and system companies) who will need to be able to design on Silicon if they are to compete.

  - The need for a capability in CAD exists in Europe irrespective of whether the design tools are sourced from Europe or from the US and Japan.

A measure of the interest in and need for the CAD capability in Europe may be judged by the series of 6 monthly workshops that were held during the course of the programme.

. These CAVE workshops (Computer Aided Design for VLSI in Europe) were presented by the programme participants as a means of disseminating information about Computer Aided Design of VLSI throughout the member states.

. A total of nine workshops were held over a four year period (May 1983 - May 1987) and were attended by 506 leading experts and CAD specialists from the member states (214 from university and 292 from industry and research establishments).

. The subjects' covered by the CAVE workshops are listed in Exhibit 1.

<u>Equipment for VLSI Manufacture</u>

As part of the equipment programme for the manufacture of VLSI several products have been developed which will be marketed after a suitable commercialisation phase.

. These include:

  - an IC packaging system and associated equipment for manufacturing high pin-count devices
  - an IC for testing high pin count packaging
  - a new deposition system for refractory metals
  - an improved e-beam system for high resolution lithography
  - a reactive ion etcher for the fabrication of VLSI devices
  - a burn-in and testing system for complex ICs
  - an electron beam testing system for VLSI
  - a VLSI tester.

In general these products are comparable in performance with state-of-the-art products being supplied by US and Japanese semiconductor equipment manufacturers.

- In three instances the users expressed concern that the equipment developed was not more advanced in terms of performance.

- In one instance (MR-05) the project was prematurely terminated.

Considerable uncertainty exists over the cost competitiveness of these products and in some instances it is already clear that the European equipment will be considerably more expensive than the US/Japanese equivalents.

- The question of economies of scale must be a significant factor which leads to a reduction in the average unit manufacturing cost of similar products by US and Japanese suppliers.

- Despite this, the availability of certain items of manufacturing equipment from European sources and the possibility of exporting this equipment will make a positive contribution to the total European microelectronics industry.

Commission support during the commercialisation phase of the exploitation process was also requested by the equipment industry.

3.2.3 Industrial Property Rights (IPRs)

The contract between the Commission and the participants contains clauses concerning the ownership of the Industrial Property Rights.

The participants in the programme were questioned on the matter of the industrial property rights (Question E1) and responded very positively that no problems had been encountered either with the Commission or with the partners.

- Problems with the Commission?

Yes	2 respondents	(3%)
No	69 respondents	(97%)

- Problems with partners?

Yes	9 respondents	(13%)
No	64 respondents	(87%)

3.3 BROADER COMMUNITY INTEREST

3.3.1 Transnational Cooperation

As was explicitly stated during the interviews with the participants and is clearly shown in the responses to questions D.3 and D.4, "The transnational cooperation has worked well".

- The responses to the question (D.3) concerning **the working of transnational cooperation** indicated that it was considered to be very good by 21% of respondents, good by 67%, with only 12% stating that it was poor.

- The question (D.4) concerning **the benefits from the participation of partners** also had a very positive response.

  - 93% of respondents stated that the benefits from the participants of partners was positive and only 7% indicated the reverse.

Transnational cooperation clearly implies the introduction of overheads and inefficiencies associated with the dispersed geographic locations of the project partners.

- The majority of respondents (i.e. 75%) considered that the **overhead cost resulting from the cooperational characteristic** of the programme was less than 20%. (See Annex A4)

- The **additional cost introduced by the dispersed locations of the participants** was considered to be less than 20% by 64% of the respondents.

3.3.2 Transfer of Know-How Within Projects

In general the transfer of know-how within projects was considered adequate and few major problems were encountered by any of the participants.

- The problems that did occur were associated with the participants working in remote locations on sub-tasks within the overall project framework.

  - This problem particularly arose in those projects involving many contractors each working on its own particular sub-task and not fully informed or aware of the status of the total project and relationship between the various sub-tasks and the total objectives.

This communication problem can be improved by reducing the number of participants in the projects, by using improved management techniques and by the greater use of workshops.

. The onus for ensuring adequate communication between the project partners falls on the project manager and it is his responsibility to set up the necessary communication and reporting channels whilst at the same time recognising the need to control and minimise the administrative overheads.

The use of the CAVE workshops (see section 3.2.3) was clearly an important and successful means of ensuring communication within the CAD community.

3.3.3 Interaction With Other Community and/or National Programmes

For many contractors, this Community programme was a first opportunity to start and participate in a transnational cooperative programme of cost-shared Research and Development involving industry, universities and research institutions.

. For several universities this programme was the first opportunity to be exposed to industrial problems and the differing work-ethos found between industrial R&D and academic research.

The increased awareness and understanding resulting from the interaction between and working together of the engineers and scientists from industry, and academia across the member states of the Community has to be of great benefit and value to all concerned.

The MEL programme was the first Community programme in the field of Information Technology that was aimed at the provision of support to enable the European industry become more competitive with and less dependent upon the US and Japan.

. The experience gained in the MEL programme provided the foundation upon which the much larger and more widely based ESPRIT programme was based.

  - As shown in exhibit 2, the first phase of ESPRIT was launched in 1985, i.e. three years after the launch of the MEL programme and is now being followed by the second phase in 1988.

  - Many of the procedures used in ESPRIT are based upon the experiences of the MEL programme.

RELATIONSHIP BETWEEN THE MICRO-ELECTRONICS PROGRAMME (3744/81) AND ESPRIT (130/84)

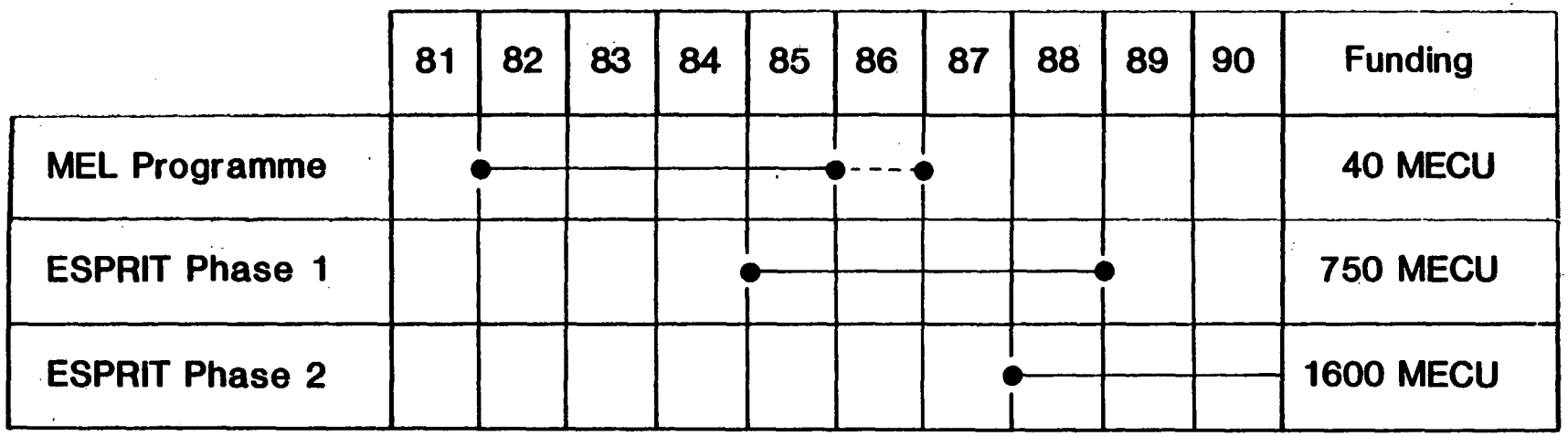


EXHIBIT 2

37

Several contractors commented on the lack of knowledge of and communication between the various projects within the MEL programme.

. It is considered highly desirable that better communication be established between the projects within the programme by means of:

  - a programme status report produced on a 6 monthly basis and distributed to all participants

  - an annual conference.

In addition to the actual organisational aspects of ESPRIT several of the projects supported within the MEL programme are being enhanced and further developed on a multinational basis within the ESPRIT programme.

. In such instances the MEL project provided the initial stepping stones and foundations upon which subsequent ESPRIT projects were based.

  - Frequently the results of the MEL programme are carried over directly into ESPRIT.

. The relationship between the MEL and ESPRIT projects is as follows:

MEL Projects	ESPRIT Projects
MR-02	962,1062
MR-03	97,1058
MR-04	802,962
MR-06	490
MR-07	962
MR-09	991
MR-10	830
MR-11	554,1125
MR-15	271,241

In some instances the MEL projects have been the basis and starting points for a number of projects undertaken within the national support programmes - (eg Alvey in the UK).

4.0 CONCLUSIONS AND RECOMMENDATIONS FOR THE FUTURE

Bearing in mind the pioneering nature of the MEL programme when it was originally started in 1981, the consensus view is that it has been successful in the following.

- Demonstrating that and showing how commercially competitive companies in different member states can work together in a collaborative manner, on research and development to the mutual benefit of all parties

- Demonstrating that and showing how industry, research organisations and university research laboratories can work together.

- Developing the awareness, knowledge of and working relationship between CAD researchers and practitioners in Europe.

- Enhancing the status of European know-how and specialist skills in CAD for VLSI.

- In selected areas, showing that community support can assist the development of leading edge technologies for subsequent commercial exploitation.

- In selected areas, showing that Community support can assist European industry in catching up and maintaining state-of-the-art technology.

What the programme has not done is to show that the provision of this limited support for R&D would have a sufficient impact and reduce the continuing dependance of Europe upon the US and Japan for the supply of CAD and equipment for the manufacture and testing of VLSI.

- The funding level was much too low for this aim to be realised.

- Adequate R&D is only one small, but necessary, part of the total business strategy that is needed to capture and sustain an effective competitive position and market share.

  - In particular significant additional financial investment is required for the commercialisation of the technologies developed and their exploitation in worldwide markets.

The MEL programme has also shown that funding should be channeled into those niche areas where it can have the maximum impact.

- The level of funding provided within the MEL programme was much too low to support R&D across the entire range of technologies relevant to microelectronics.

- The decision to focus support into just two areas (i.e. CAD and equipment for the manufacture and testing of VLSI) was a correct one.

. In the chosen areas, the objectives of the R&D programmes must be clearly thought through, taking account of developments in competing technologies, to ensure that when completed, the technologies developed are competitive in worldwide terms.

Consideration should also be given to the impact of "economies-of-scale" on the ability of European companies to compete in worldwide markets.

. Even if European companies have competitive technologies available they will find it extremely difficult to compete on cost terms with US and Japanese manufacturers who in general are serving a larger market and benefiting from the economies-of-scale that result.

. Although this argument is particularly applicable to the equipment companies it also applied to the CAD (i.e software) companies where the development costs have to be recovered from the sales achieved.

Other conclusions and recommendations to emerge from the survey include

4.1 TRANSPARENCY OF PROPOSAL EVALUATIONS

Some concern was expressed at the quality of the evaluation mechanism and it is strongly recommended that:

. "The evaluation of the project proposals should be done with emphasis on clearly defined objectives, on the quality of the teams and on the prospects for the implementation of the results."

- The evaluation procedures used in ESPRIT reflect these recommendations.

4.2 THE COMPOSITION OF THE CONSORTIA

The industrial and academic laboratories have different outlooks and methods of working which are complementary to each other.

. The industrial laboratories emphasise the exploitation aspects and need to develop products.

- The taking out of patents is a measure of success.

. The academic laboratories emphasise the more fundemental long term research aspects.

- The publication of research papers and presentation of papers at conferences is a measure of success.

Within the MEL programme (and also ESPRIT) both types of research environment have an important role to play which is complementary.

. One important benefit from the MEL programme has been an increased level of understanding between industry and academia.

It was stated very forcibly by several organisations that a limit should be placed upon the number of participants in the projects:

. Unless there are very good reasons to the contrary, it is suggested that the number of participants be limited to 4 or 5.

  - Such a reason might be the development of standards.

4.3 THE MANUFACTURER/USER APPROACH

Within the MEL programme every effort was made to involve users as well as suppliers.

. New CAD design tools are usually only useful if developed in close collaboration with users.

. The characteristics of new manufacturing equipment are dictated by the requirements of new processes developed by the users.

. The involvement of users and manufacturers in every project enhances the probability that the results will lead to implementation.

To ensure the maximum involvement of the users and hence their impact on the project it is strongly recommended that user-manufacturer interaction should be well defined from the beginning and that the user should be treated as a partner from the commencement of the project.

. It is totally insufficient to reduce the role of the user to the evaluation of the product and use of the results after the development has been completed.

. In this partner role it is necessary to provide the user with some financial incentive to participate actively in the programme.

4.4 COMMUNITY CONTRIBUTION

Although the Commission is funding up to 50% of the cost of a project and while this is acceptable to industry it may be too low for academic contractors.

- In return for its 50% contribution, industry may be able to obtain commercial returns from the exploitation of the technologies developed.

- In the case of academia there is no opportunity of obtaining a commercial return to offset the 50% investment made.

To overcome this problem it has been suggested and is recommended that the Commission should stimulate industry to carry part of the other 50% of the academic laboratories.

- In projects in which the academic laboratories are clearly making a significant contribution this should not represent too great a problem.

Commenting on future collaborative programmes in microelectronics many respondents requested significantly higher levels of funding.

4.5 PROJECT MANAGEMENT AND REPORTING

The success of projects depends to a large extent on the definition of objectives and management of the project.

- This management task becomes more severe as the number of project participants increases.

It is strongly recommended that projects involving a large number of partners and contractors should have a professional full-time manager and that professional project management techniques should be used.

- As stated previously it is considered important that the management techniques used should be such as to ensure that every contractor and subcontractor feels involved in the total project and is aware of its role in relation to the other participants.

  - In addition progress of the project should be monitored against pre-specified milestones and project expenditure.

4.6 FURTHER WORK

In view of the existence of ESPRIT and the sanction that has now been given to proceed with the second phase there seems to be no need for a continuation of the MEL programme as a separate initiative..

. Within the draft work programme for the second phase of ESPRIT (Brussels 22 July 1987) there are research and development projects concerned with:

- An Integrated Design and Production System for high density integrated circuits (IDPS).
- European CAD integrated project (ECIP)
- VLSI Valuation and Test.
- Manufacturing equipment.

. Some of these projects represent continuation of the work started in the MEL programme and then carried out partially in the first phase of ESPRIT.

The second phase of ESPRIT is a necessary but not sufficient means of supporting R and D in the areas of CAD for VLSI and manufacturing and test equipment for the production of VLSI.

. The second phase of ESPRIT should build upon what has been achieved in the MEL programme and in the first phase of ESPRIT.

In addition there may be a need to consider the provision of further support to ensure commercial exploitation of the results achieved.

SUBJECTS COVERED BY THE CAVE WORKSHOPS

Workshop 1	-	Simulation and Modelling
	-	CAD systems
	-	Testing
	-	Layout
	-	Design methodologies
Workshop 2	-	VLSI design workstations
	-	MOS modelling
	-	Auto layout
Workshop 3	-	Specification languages
	-	Expert systems for VLSI CAD
	-	Multilevel simulation
	-	Silicon compilation
Workshop 4	-	Tools for testability
	-	Interfacing process, device and circuit emulation
	-	Design management and databases
	-	Floor planning
Workskhop 5	-	Parameterized and soft cells
	-	Use of A.I. languages in CAD
	-	High level design and synthesis
	-	self-test strategies
Workshop 6	-	Mixed mode simulation
	-	Automatic place and route
	-	Distributed CAD
	-	Automatic test pattern generation
Workshop 7	-	Trends in CAD for VLSI
	-	Process optimisation
	-	Benchmarking of CAD tools
	-	Use of expert systems in CAD for VLSI
Workshop 8	-	Tools for analogue design
	-	Open architecture for CAD systems
	-	Design of testable systems
	-	Application specific computers
Workshop 9	-	Logic synthesis
	-	ASIC design styles
	-	Commercialisation of the results of CAD research
	-	Design of high speed circuits and interconnect

EXHIBIT 1

ANNEXS

Annex 1: List of Projects included in the MEL Programme

Project No.	No. of Participants	Area	Title	Funding (MECU)
MR-01-IMG	6	CAD	CERES (cascade environment for the realisation of electronic systems)	4.2
MR-02-RAL	5	CAD	Three dimensional semiconductor device simulation including transient and thermal behaviour	1.8
MR-03-KUL	6	CAD	Mixed-Mode behavioural verification system for MOS VLSI design	0.6
MR-04-CVT	28	CAD	CVT (CAD for VLSI for Telecommunications)	12.0
MR-05-SIE	4	EQUIP	VLSI Tester 764/780	6.7
MR-06-STL	5	CAD	VLSI verification and compilation	0.7
MR-07-CRK	4	CAD	Two and three dimensional numerical modelling of MOS devices	0.4
MR-08-PHL	5	EQUIP	High resolution Electron Beam Lithography	2.2
MR-09-DFT	7	CAD	The cooperative development of a hierarchical VLSI design system	2.3
MR-10-MOV	3	EQUIP	Development and evaluation of manufacturing equipment for the production of low cost, high reliability packages suitable for hermetic protection of integrated circuits of high pin count.	0.9
MR-11-ASM	4	EQUIP	Development of a refractory metal deposition process and related equipment.	1.2
MR-12-ELT	3	EQUIP	MINSTREL, the development of a production orientated plasma/ reactive ion etching system for all major processes	1.1
MR-13-BUL	6	CAD	A CAD system for VLSI testing	2.3
MR-14EKC	4	EQUIP	Static and dynamic burn-in system	1.8
MR-15-CAM	5	EQUIP	Electron beam testing equipment for VLSI	1.0
Total	95		Total	39.2

ANNEX 2

PROJECT STATUS REPORTS

PROJECT NO: MR-01-1MG

TITLE: CERES (Cascade environment for the realisation of electronic systems)

PARTICIPANTS: IMAG/MICADO*, TMC, SGS-ATES, RTC, Philips

CEC SUPPORT: 4.172 M ECU

START DATE: 02-1983 **COMPLETION DATE:** 11-1985

OBJECTIVES: To develop an integrated CAD system for VLSI circuits comprising: mixed mode simulation, fault modelling and simulation, test data generation, logic compilation, silicon compilation, graphic editing, electrical modelling.

STATUS: Completed 11-1985

PATENTS: 1

PUBLICATIONS: 6

PAPERS: 20

SEMINARS: 0

EXPLOITATION: Follow on projects on fault simulation and simulation acceleration.
Exploitation spin-offs in Mullard, Innovative Silicon Technology and Micado.
Philips use CERES cascade simulator in their chip design system and obtain reduced design times, flexibility and use by non-software experts.

PROJECT NO: MR-02-RAL

TITLE: Three dimensional semiconductor device simulation including transient and thermal behaviour.

PARTICIPANTS: Rutherford Appleton Laboratory*, GEC, University College Swansea, Philips, Trinity College Dublin

CEC SUPPORT: 1.774 M ECU

START DATE: 04-1983 **COMPLETION DATE:** 04-1986
Duration 36 months

OBJECTIVES: To develop robust and efficient algorithms to simulate static or transient behaviour of silicon devices.

STATUS: Project Completed 04-1986

PATENTS: 0

PUBLICATIONS: 21

PAPERS: 0

SEMINARS: 0

EXPLOITATION: The 2D algorithms developed will be made available to European industry. ESCAPADE developed as an algorithm test bed.
Follow on projects in ESPRIT (962 and 1062).

PROJECT NO: MR-03-KUL

TITLE: Mixed mode behavioural verification system for MOS VLSI design

PARTICIPANTS: ESAT Laboratory, Katholick University Leuven*, University de Languedoc, Philips, Siemens, Silvar Lisco, Bell Telephone

CEC SUPPORT: 0.587 M ECU

START DATE: 01-1983 **COMPLETION DATE:** 12-1985

OBJECTIVES: The development of a prototype system for the verification of behavioural correctness and testability of MOS VLSI design.

STATUS: Project completed in 12-1985

PATENTS: 0

PUBLICATIONS: 5

PAPERS: 3

SEMINARS: 3

EXPLOITATION:

(i) Some of the software developed is incorporated in the CAD systems of industrial partners.
(ii) Some of the software developed has been commercialised by Silvar Lisco.
(iii) Some of the software developed is being incorporated in ESPRIT projects 97 and 1058.
(iv) Large effort required to engineer the prototypes into an end-product.

PROJECT NO: MR-04-CVT

TITLE: CVT (CAD for VLSI for Telecommunications)

PARTICIPANTS: CNET*, CSELT*, FI/DBP*, CII-HB, CIT-Alcatel, CENG-LETI, IMAG, INRIA, Thomson/EFCIS, SGS-ATES, Italtel, Olivetti, AEG-Telefunken, SEL, Universities of Bologna, Genoa, Milano, Torino, Aachen, Bremen, Darmstadt, Dortmund, Kaiserslautern, Karlsruhe, GMD and the Fraunhofer Institute

CEC SUPPORT: 12 M ECU

START DATE: 02-1983 **COMPLETION DATE:** 05-1986

OBJECTIVES: To implement a CAD system to be used by telecommunications system designers which is simple to use, fast and sure and will provide silicon implementations automatically from high level descriptions.

STATUS: Completed 05-1986

PATENTS: 2

PUBLICATIONS: 142

PAPERS: 12

SEMINARS: 3

EXPLOITATION:

(i) Internal use by participants (30 CVT users in Germany).
(ii) Exploitation by Periphere Computer Systeme GmbH.
(iii) DRC "Brutus".
(iv) Software House ANACAD set up to exploit design.
(v) Formation of ABAKOS user group by Kaiserslauten University - 35 participants involved in CAD software - book in preparation.
(vi) Opportunity to exploit CAD layout software tools.
(vii) ESPRIT project 802, 962E.
(viii) Automatic Module Generation to be exploited by IST.
(ix) CAD systems and tools by STET group.
(x) CNET system (Cossiopee) adapted for RACE.
(xi) Two additional start-up companies, APSIS and DOLPHIN.
(xii) CNET has improved design performance by factor of 5.

PROJECT NO: MR-05-SIE

TITLE: SI TESTER 764/780

PARTICIPANTS: Siemens*, EFCIS, Grundig, Italtel

CEC SUPPORT: 6.172 M ECU

START DATE: 01-1983 **COMPLETION DATE:** 01-1986

OBJECTIVES: To develop VLSI Testers SITEST 764 and 780
764 = 64 pins at 12 MHz
780 = 256 pins at 50 MHz

STATUS: 764 - Hardware and software development and integration completed 11-1985. 4 Prototypes operational.
780 - Development aborted.
770 - Development of intermediate tester aborted.
Project terminated 06-1986.

PATENTS: 2

PUBLICATIONS: 2

PAPERS: 0

SEMINARS: 0

EXPLOITATION: Siemens plan to design new tester (768) with 128 pins.
Plan to sell 200-300 systems (DM 130 M) over 5 years.
But severe competition from 4 US companies.

PROJECT NO: MR-06-STL

TITLE: VLSI Verification and Compilation

PARTICIPANTS: STL*, SEL, BT, GEC, CNET

CEC SUPPORT: 0.677 M ECU

START DATE: 01-1983 **COMPLETION DATE:** 06-1986

OBJECTIVES: To develop computer aids to reduce time taken to produce correct and compact custom VLSI and verify VLSI design.

STATUS: Completed 08-1986

PATENTS: 0

PUBLICATIONS: 12

PAPERS: 5

SEMINARS: 4

EXPLOITATION: In-house use by partners.
Dissemination through CAVE Workshops
Further development in ESPRIT project 490 (Panglass) and Alvey Project (Behavioural Languages for VLSI).

PROJECT NO: MR-07-CRK

TITLE: 2D and 3D Numerical Modelling of MOS Devices

PARTICIPANTS: University College Cork*, Queens University Belfast, Analog Devices, GEC

CEC SUPPORT: 0.366 M ECU

START DATE: 02-1984 **COMPLETION DATE:** 02-1987

OBJECTIVES: The development of a hierarchical range of programmes for numerical analysis of 2D and 3D MOS devices.

STATUS: Completed 06-1987.
Concluded that approach based on combination of finite differences and finite elements was preferable.

PATENTS: 0

PUBLICATIONS: 7

PAPERS: 6

SEMINARS: 4

EXPLOITATION: Internal exploitation.
Modelling system has speed advantages.
Related to ESPRIT 962 project.

PROJECT NO: MR-08-PHL

TITLE: High Resolution Electron Beam Lithography

PARTICIPANTS: Philips*, University of Delft, Bell Telephone, Siemens, Fraunhofer Institute

CEC SUPPORT: 2.224 M ECUS

START DATE: 11-1983 **COMPLETION DATE:** 11-1986

OBJECTIVES: To develop high resolution E-beam lithography and its application to direct writing of sub-micron patterns and x-ray mask preparation.

STATUS: Will be completed at end of 1987.
Equipment enhancements supplied to users.
Tests by users.
Technology for EB direct writing structures for x-ray masks was developed and implemented.

PATENTS: 0

PUBLICATIONS: 25

PAPERS: 5

SEMINARS: 0

EXPLOITATION: Enhanced equipment able to achieve 60 nm resolution introduced by Philips incorporating design, automation and software enhancements. The EBPG - IV. Will compete in worldwide markets and anticipate sales of 20 units worldwide over 3 years (45 M ECU) but competition.
Competitive product.
Application to GaAs ICS.
Application of E-beam fabrication of x-ray masks.
Exploitation by MIETEC.
High resolution instrumentation system - higher accuracy, lower cost.

PROJECT NO: MR-09-DFT

TITLE: The Co-operative Development of a Hierarchical and Multilevel VLSI Design System

PARTICIPANTS: University of Delft*, T.H. Twente, ICS, T.H. Eindhoven, B.T., P.C.S. Munich, I.C.N. Enschede

CEC SUPPORT: 2.26 M ECU

START DATE: 12-1983 **COMPLETION DATE:** 12-1985

OBJECTIVES: To design, develop and produce in prototype form an integrated system for CAD design.

STATUS: Completed 12-1985.
Prototype ICD sytem demonstrated has some unique selling points, e.g. total environment open system.

PATENTS: 1

PUBLICATIONS: 53

PAPERS: 89

SEMINARS: 33

EXPLOITATION: Design system used in-house by participants and commercialised by ICD Co. (ICS).
Work extending in ESPRIT project 991.
PCS exploiting technology in their CADMUS workstations.

USPs - Design efficiency and integrated management.
Design of mixed analogue/digital systems.
Design Book produced and published.

PROJECT NO: MR-10-MOV

TITLE: "Development and evaluation of manufacturing equipment for the production of low cost high reliability packages suitable for hermetic protection of integrated circuits of high pin count."

PARTICIPANTS: M.O. Valve Co.*, University College Cork, MOSTEK, CII-H.B.

CEC SUPPORT: 0.942 M ECU

START DATE: 01-1984 **COMPLETION DATE:** 01-1987

OBJECTIVES: Establish package specification, develop and commission equipment for its manufacture and demonstrate large scale production.

STATUS: Chip for testing packaging developed.
Package specification, design and manufacturing process defined.
Prototypes manufactured for assessment having 200 pins and suitable for Si and GaAs use.
Fired ceramics used to give dimensional accuracy and stability plus low tooling costs.
Will be completed in 1988.

PATENTS: 3

PUBLICATIONS: 1

PAPERS: 4

SEMINARS: 0

EXPLOITATION: Led to ESPRIT project 830 and ALVEY project 050 on high performance packaging.
Up to £3 M of sales forecast over 5 years.
Possible exploitation of chip for testing packaging.

PROJECT NO: MR-11-ASM

TITLE: Development of a refractory metal deposition process and related equipment.

PARTICIPANTS: ASM Europe*, Matra-Harris Semiconductors, INSA, Plessey Research

CEC SUPPORT: 1.169 M ECU

START DATE: 12-1983 **COMPLETION DATE:** 06-1987

OBJECTIVES: Development of equipment for chemical vapour deposition (CVD) of refractory metals (e.g. tungsten).
Phase I - Tungsten CVD and Plasma enhanced CVD.
Phase II - Enhanced CVD.

STATUS: Prototypes (Mark I) for low pressure CVD delivered to users for evaluation.
Plasma enhanced version of Mark I delivered to user for evaluation.
INSA withdrew from project

Will be completed at end of 1987.

PATENTS: 3

PUBLICATIONS: 0

PAPERS: 7

SEMINARS: 0

EXPLOITATION: Results will be utilised in ESPRIT project 554.
Complimentary work will be undertaken in ESPRIT project 1125.
Process developed will be exploited by Plessey in their one micron CMOS fabrication of ASICS
(£10 M of sales over 5 years).
Equipment (CVD Reactor) will be marketed by ASM (10 M Fl sales over 5 years) - cost competitive product.
Process developed will be used by MHS for production of ASICS and memory VLSI.

PROJECT NO: MR-12-ELT

TITLE: "MINSTREL, the development of a production oriented plasma/reactive ion etching system for all major processes".

PARTICIPANTS: Electrotech Research*, Siemens, Thomson/Eurotechnique

CEC SUPPORT: 1.14 M ECU

START DATE: 11-1983 **COMPLETION DATE:** 06-1986

OBJECTIVES: The development, supply and testing of single chamber and four chamber equipment prototypes for the fabrication of current and future VLSI devices having 1 micron line resolution.

STATUS: Single chamber and four chamber prototypes delivered to users.
Four chamber system non-optimal for needs of Electrotechnique and validity of multichamber system for high throughputs is not proven.
Completed 06-1986.

PATENTS: 0

PUBLICATIONS: 3

PAPERS: 3

SEMINARS: 0

EXPLOITATION: Experience gained on etching mechanisms and sub-micron technology.
Technologies will be exploited in OMEGA range of etchers (Eurotechnique) - Forecast Sales - £32 M over 5 years.
Production of advanced MOS ICS with sub-micron design rules will be achieved with 2 chamber configuration.

PROJECT NO: MR-13-BUL

TITLE: "A CAD system for VLSI testing".

PARTICIPANTS: C11-HB*, GEC, Plessey, Universities of Aachen, Duisburg LAMM

CEC SUPPORT: 2.279 M ECU

START DATE: 02-1984 **COMPLETION DATE:** 02-1987

OBJECTIVES: To upgrade present test methods and CAD tools to cope with the needs of VLSI of late 1980's.
Phase A - Analysis and Specification.
Phase B - Development and Integration.

STATUS: Completed 08-1987.

PATENTS: 3

PUBLICATIONS: 27

PAPERS: 13

SEMINARS: 15

EXPLOITATION: Internal use by participants for advanced ASICS.
Commercial exploitation by start-up companies.
USP - Multilevel tools for test generator.
Led to participation in ALVEY projects (CAD 088, 018, 042).
MTPG Software will be exploited commercially.
Test processor will be exploited.
Start-up company formed (GSD) to exploit results.
Start-up company formed (ARCARD) to exploit results.

PROJECT NO: MR-14-EKC

TITLE: "Static and dynamic burn-in systems"

PARTICIPANTS: Elektronik Centralen*, BT, SGS-ATES, Matra-Harris

CEC SUPPORT: 1.841 M ECU

START DATE: 12-1983 **COMPLETION DATE:** 01-1987

OBJECTIVES: To develop and manufacture a general purpose dynamic burn-in/test system for complex ICS.

STATUS: Will be completed in 1988.
Prototypes delivered to users during 1986 but overall project delayed by 1 year.

PATENTS: 1

PUBLICATIONS: 0

PAPERS: 0

SEMINARS: 0

EXPLOITATION: Commercial exploitation by Scantest Systems A/S of Denmark under licence from Electronik Centralen.

PROJECT NO: MR-15-CAM

TITLE: "Electron beam testing equipment for VLSI".

PARTICIPANTS: Cambridge Instruments*, SGS-ATES, CSELT, SEL, Siemens

CEC SUPPORT: 0.966 M ECU

START DATE: 12-1983 **COMPLETION DATE:** 12-1986

OBJECTIVES: The development and manufacture of an electron beam system for the testing and evaluation of advanced VLSI.
Phase 1 - Development
Phase 2 - Enhancement
Phase 3 - Upgrading and Automation

STATUS: Three prototypes delivered after delays (1.5 years late). Will be completed at end of 1987.

PATENTS: 0

PUBLICATIONS: 1

PAPERS: 0

SEMINARS: 40

EXPLOITATION: Will be commercially exploited by Cambridge Instruments - second generation equipment (projected sales of £6 M over 5 years).
Equipment developed is being used in ESPRIT projects 271 and 241.
Equipment has several USPs (Unique Selling Points).

Annex 3: Overview of the responses to the questionnaire

Questionnaires and Visits

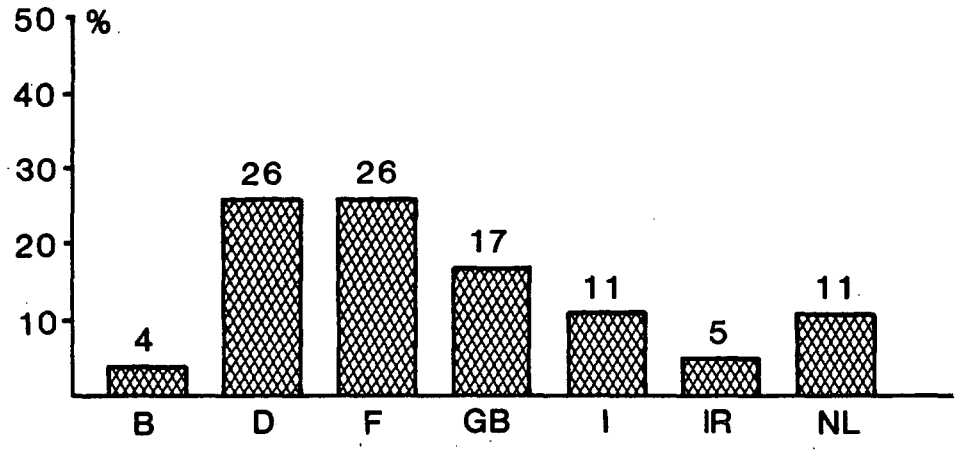
Project	Questionnaires				Interviews
	Answers/Letters		%		Total
MR-01-IMG	6	7	85.7		2
MR-02-RAL	5	5	100		2
MR-03-KUL	2	5	40		1
MR-04-CVT	23	29	79.3		4
MR-05-SIE	3	4	75		1
MR-06-STL	3	5	60		1
MR-07-CRK	3	4	75		1
MR-08-PHL	4	5	80		2
MR-09-DFT	5	6	83.3		2
MR-10-MOV	3	3	100		2
MR-11-ASM	3	4	75		2
MR-12-ELT	3	3	100		3
MR-13-BUL	4	6	66.7		1
MR-14-EKC	4	4	100		3
MR-15-CAM	5	5	100		4
	76	**95**	**80%**		**31**
Mail	46	95	48.4%		
Direct	30	95	31.6%	**RETURNS**	
TOTAL	**76**	**95**	**80.0%**		

A N N E X 4

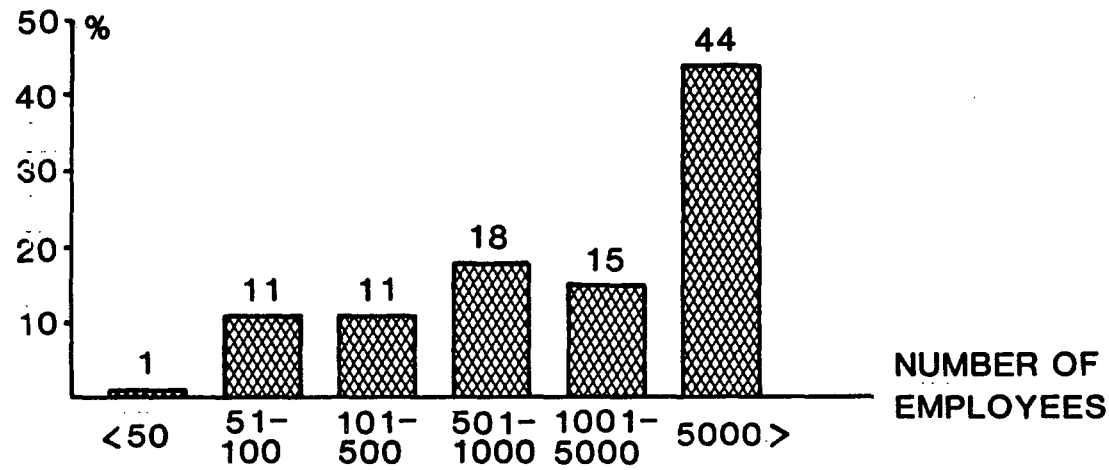
SUMMARY OF QUESTIONNAIRE RESPONSES

SUMMARY OF QUESTIONNAIRE RESPONSES

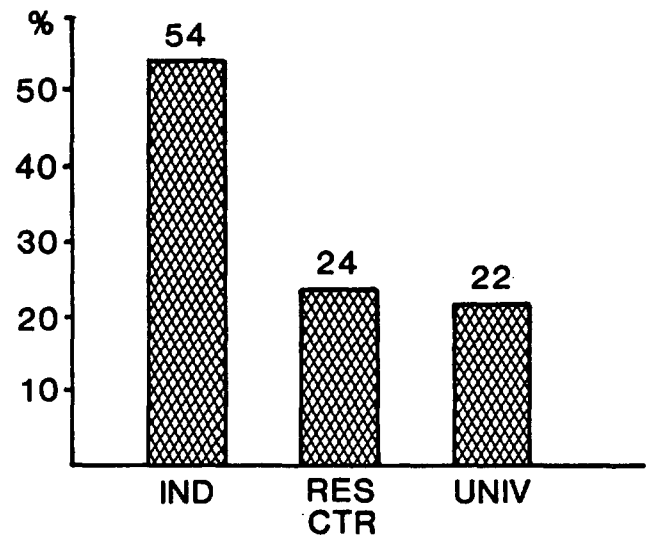
A2 DISTRIBUTION BY COUNTRY



A3 DISTRIBUTION BY SIZE OF ORGANISATION

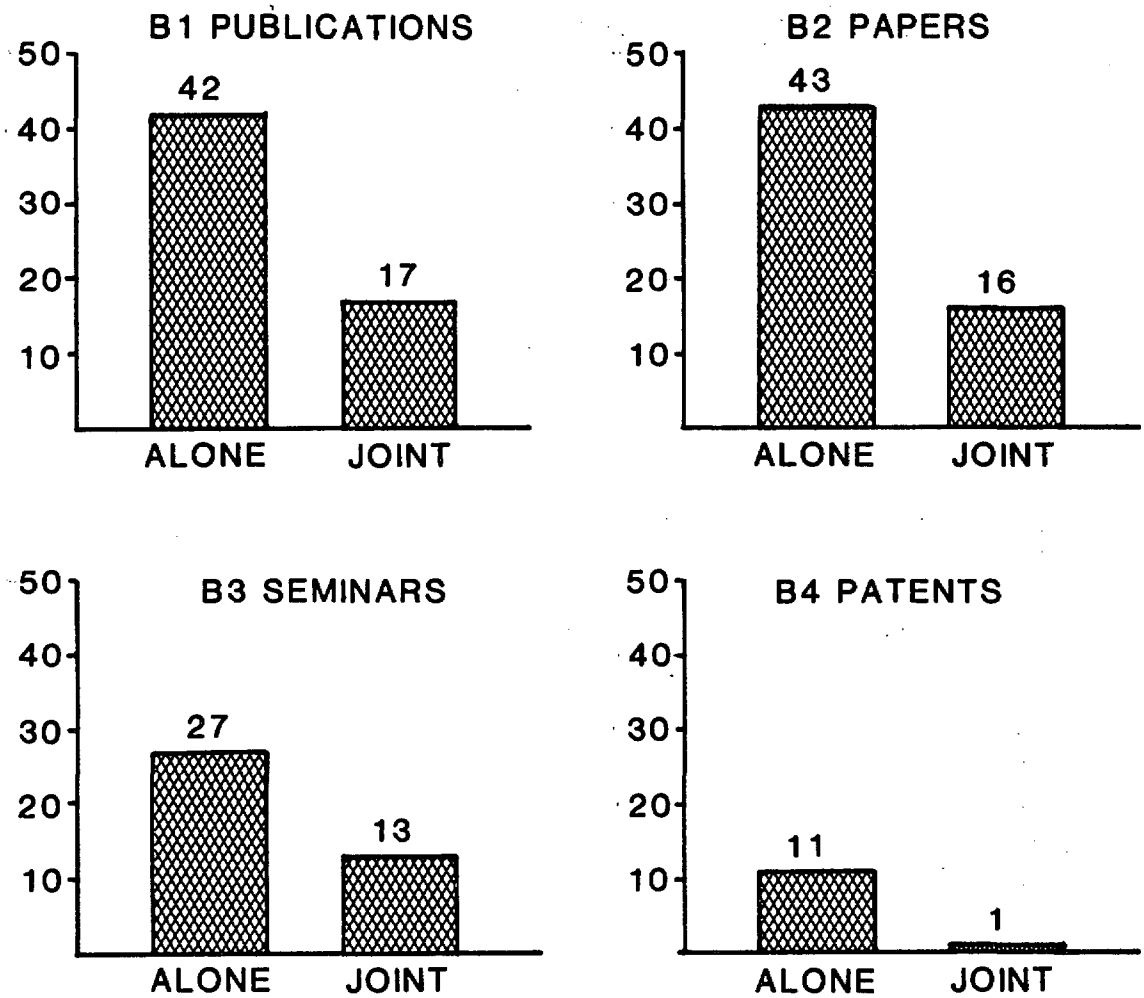


A4 DISTRIBUTION BY TYPE OF ORGANISATION



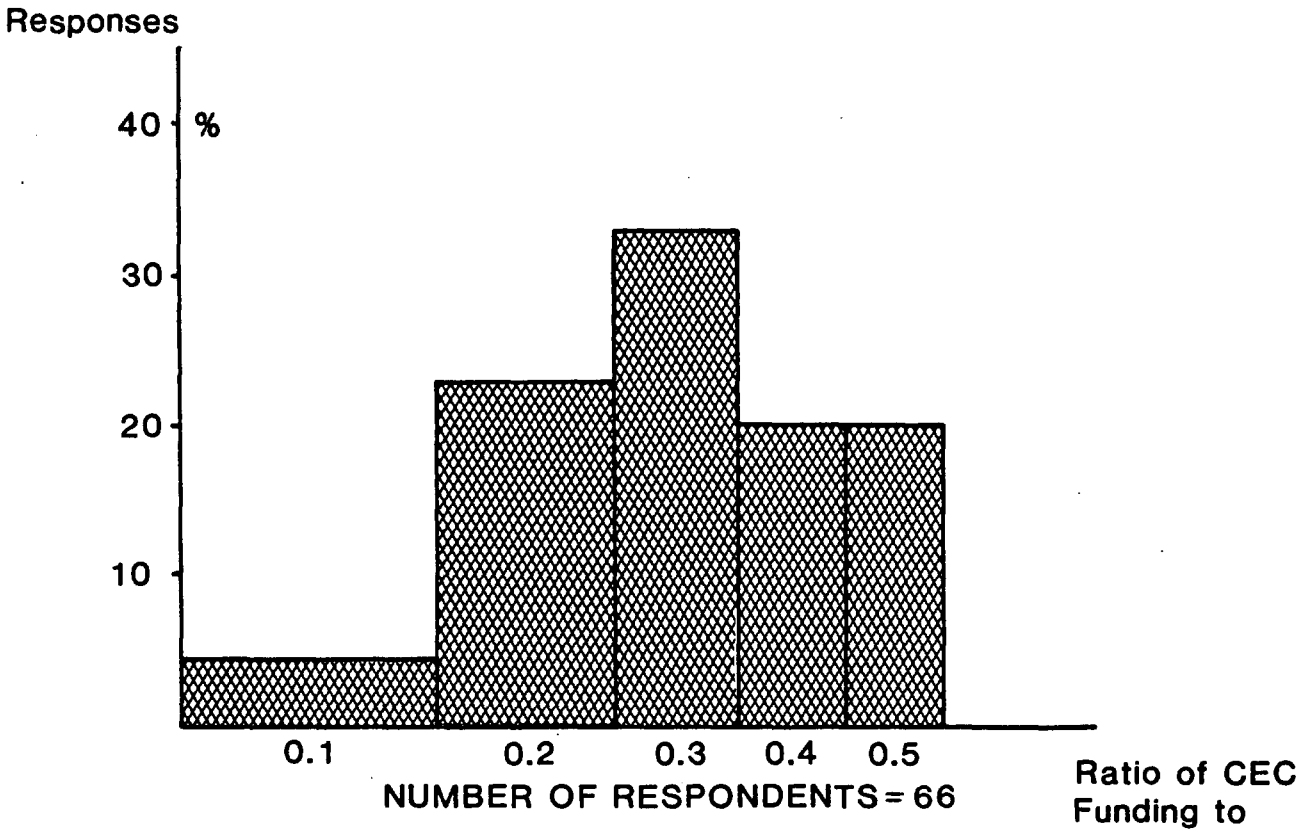
NUMBER OF RESPONDENTS=76

B PUBLICATIONS/PAPERS/SEMINARS/PATENTS STEMMING FROM THE MEL PROGRAMME



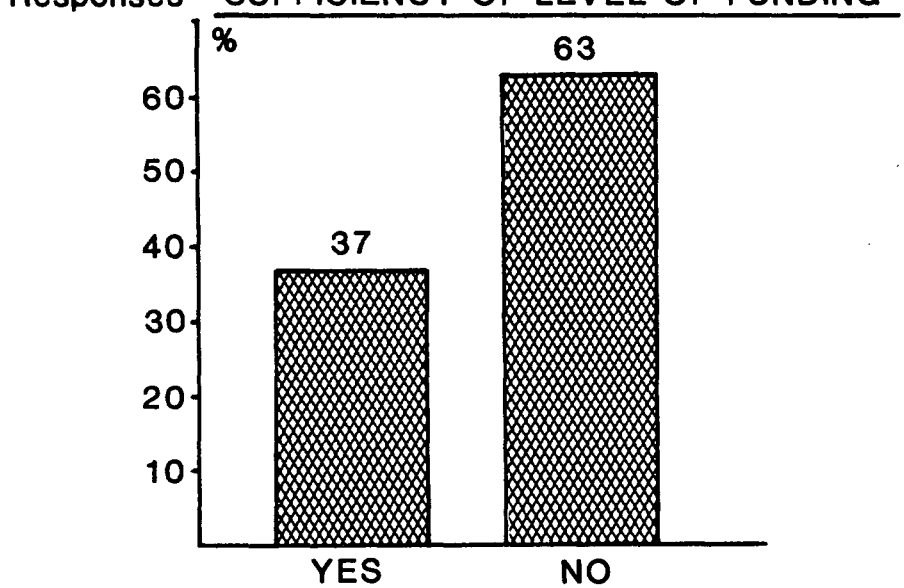
NUMBER OF RESPONDENTS = 76

B11 PROJECT FUNDING LEVELS



NUMBER OF RESPONDENTS = 66

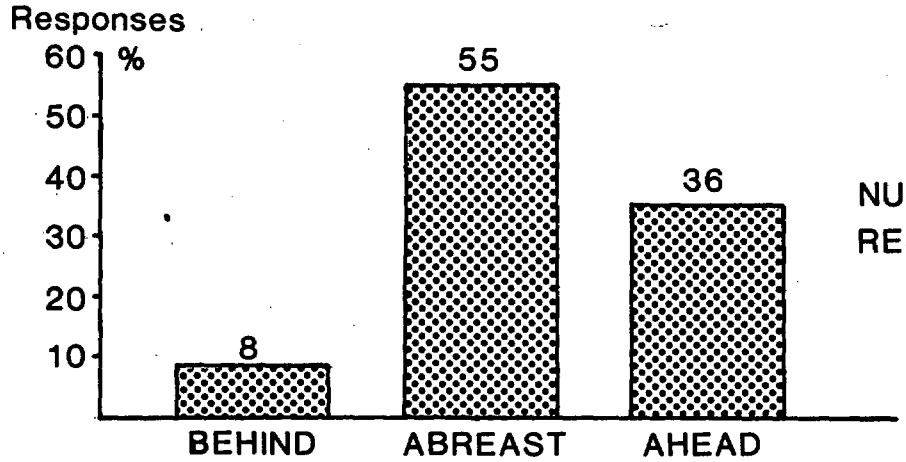
SUFFICIENCY OF LEVEL OF FUNDING



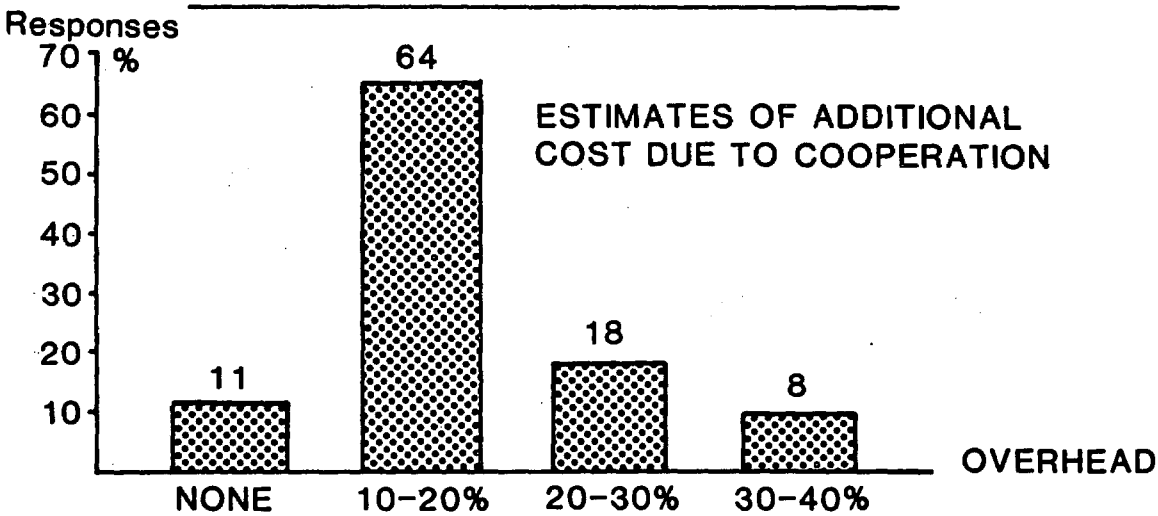
NUMBER OF RESPONDENTS = 69

C COMPETITIVE ENVIRONMENT

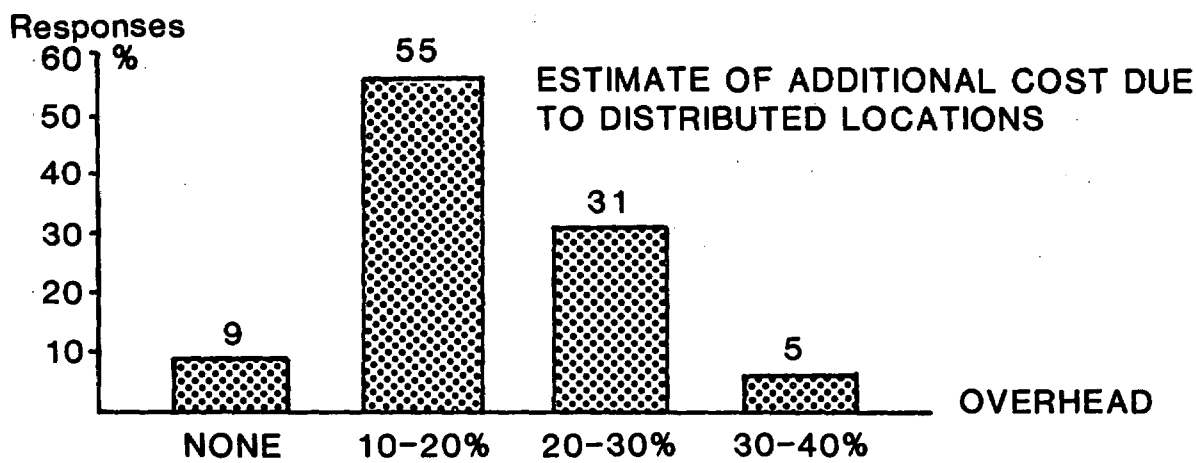
COMPARATIVE STATUS OF THE TECHNOLOGY



D TRANSNATIONAL COOPERATION

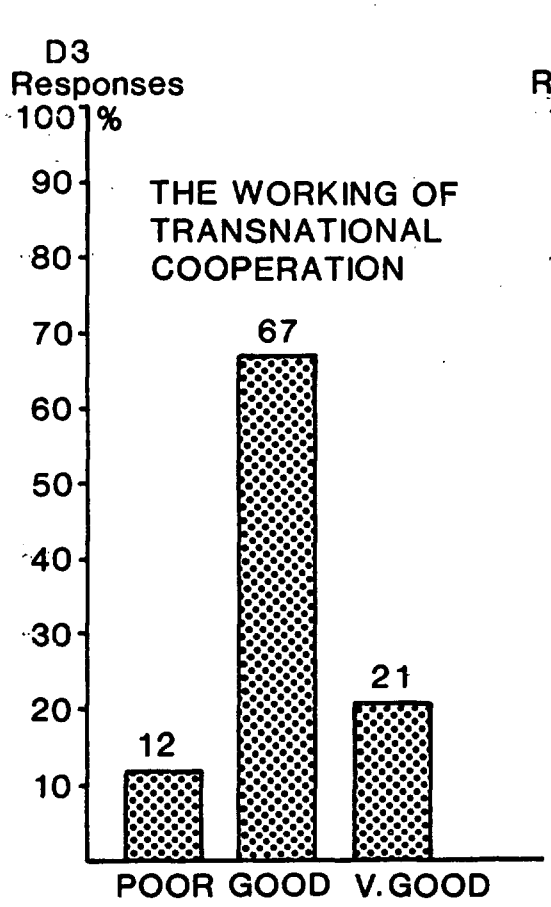


NUMBER OF RESPONDENTS=73

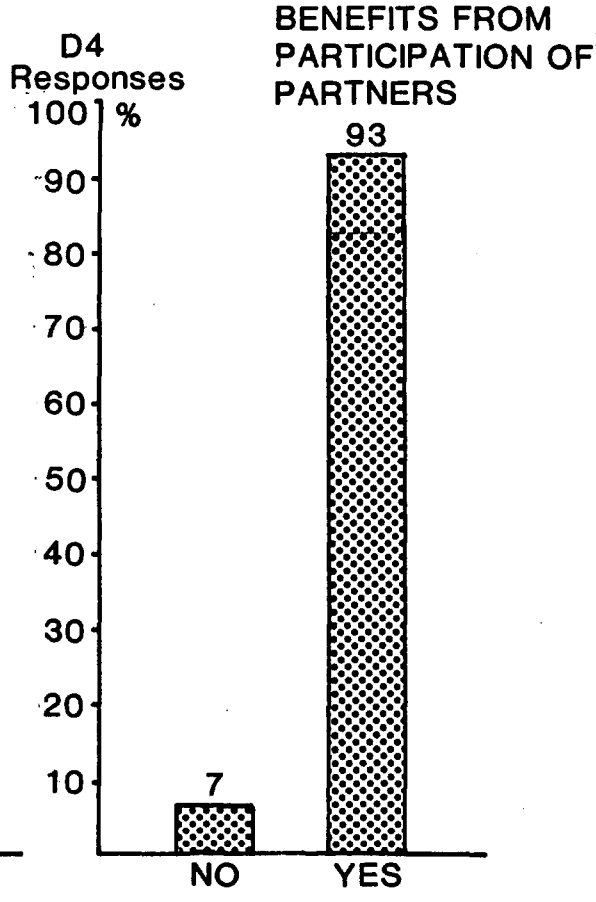


NUMBER OF RESPONDENTS=71

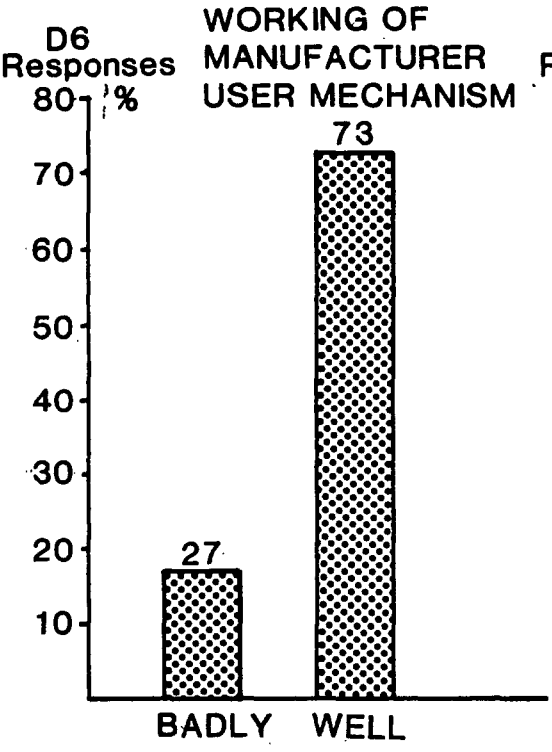
D TRANSNATIONAL COOPERATION (CONT'D)



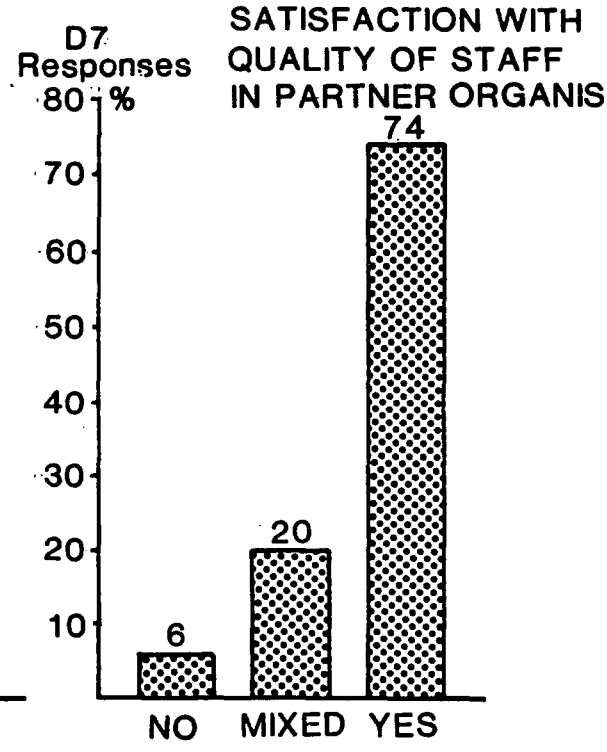
NUMBER OF RESPONDENTS = 74



NUMBER OF RESPONDENTS = 72



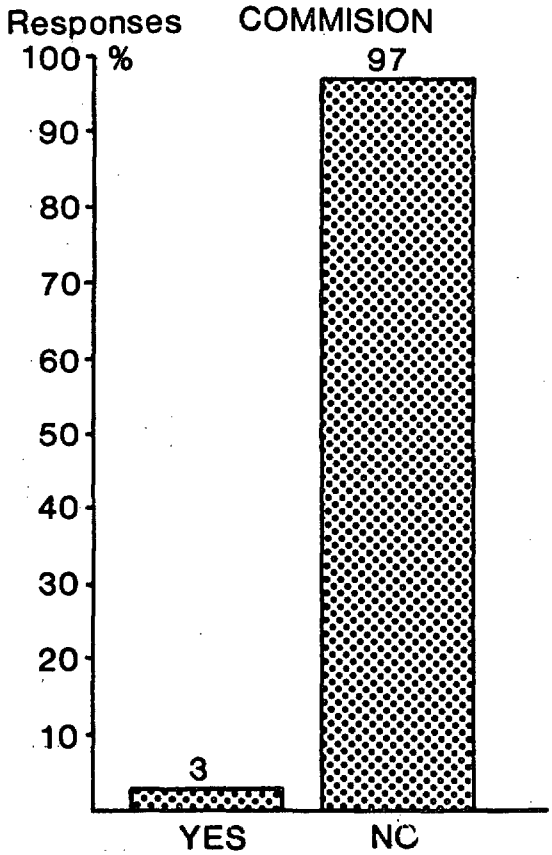
NUMBER OF RESPONDENTS = 49



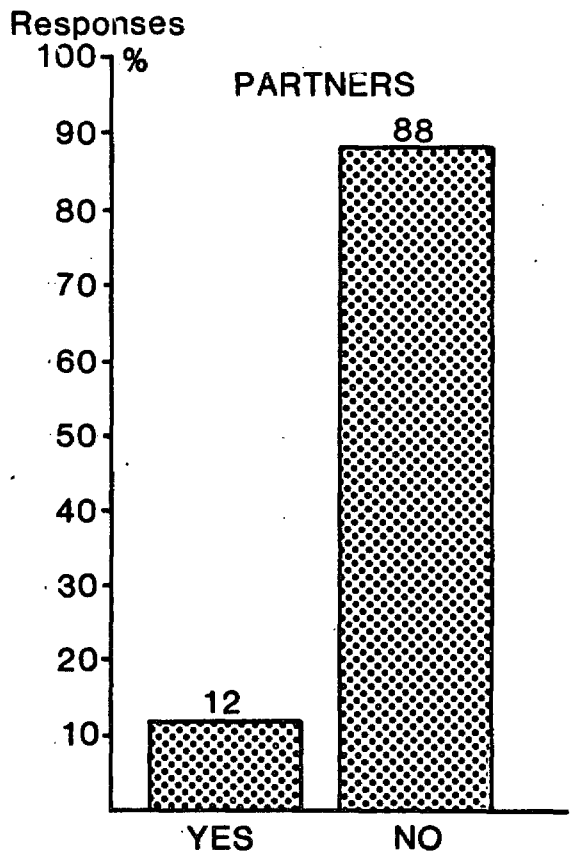
NUMBER OF RESPONDENTS = 68

E INDUSTRIAL PROPERTY RIGHTS

POSIBBLE PROBLEMS WITH PARTNERS OR THE COMMISSION ON INDUSRIAL PROPERTY RIGHTS



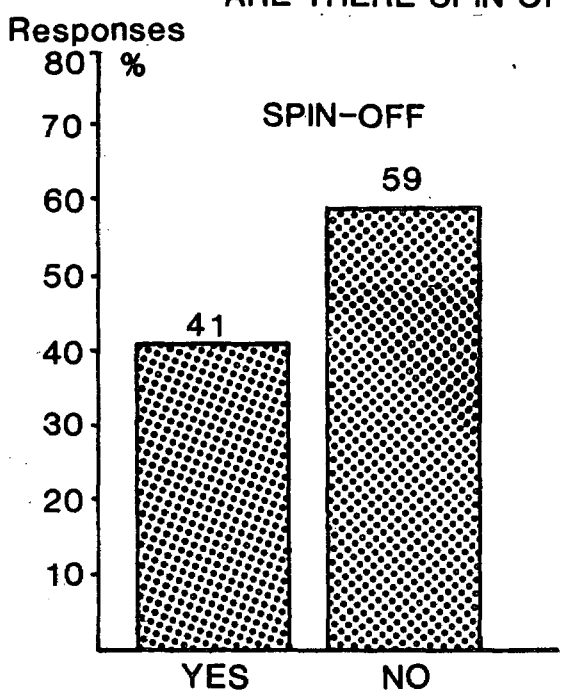
NUMBER OF RESPONDENTS = 71



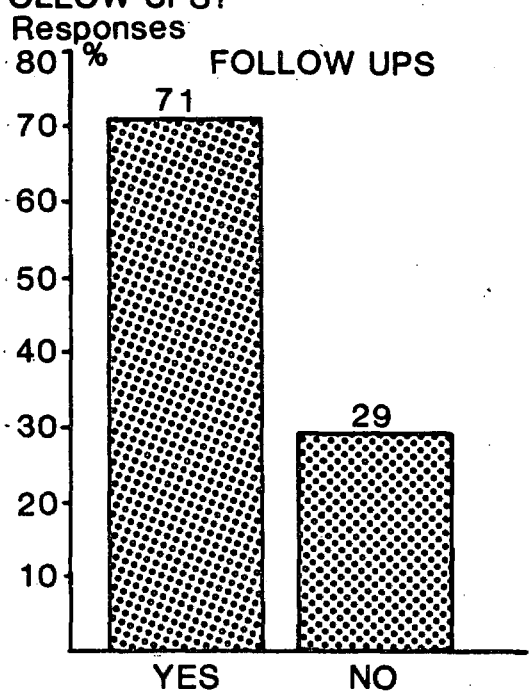
NUMBER OF RESPONDENTS =73

F OTHER ISSUES

ARE THERE SPIN OFFS/FOLLOW UPS?

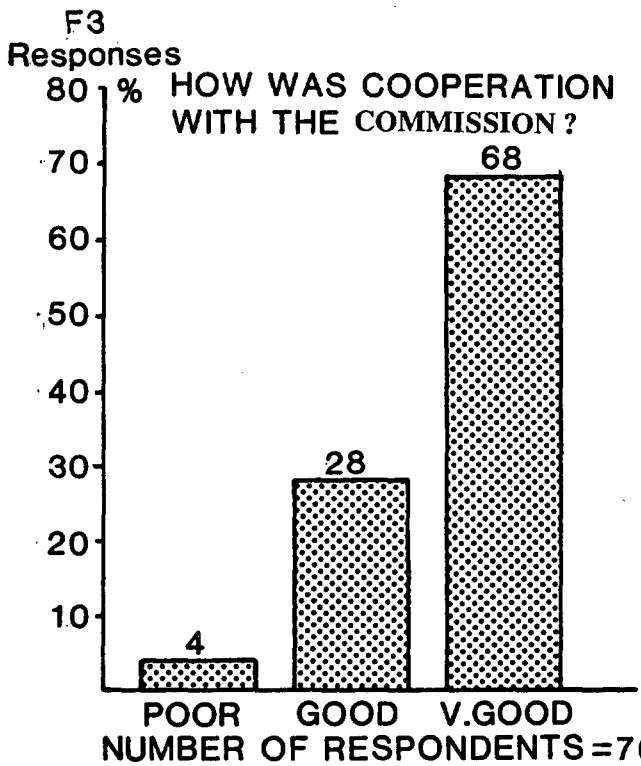


NUMBER OF RESPONDENTS = 73

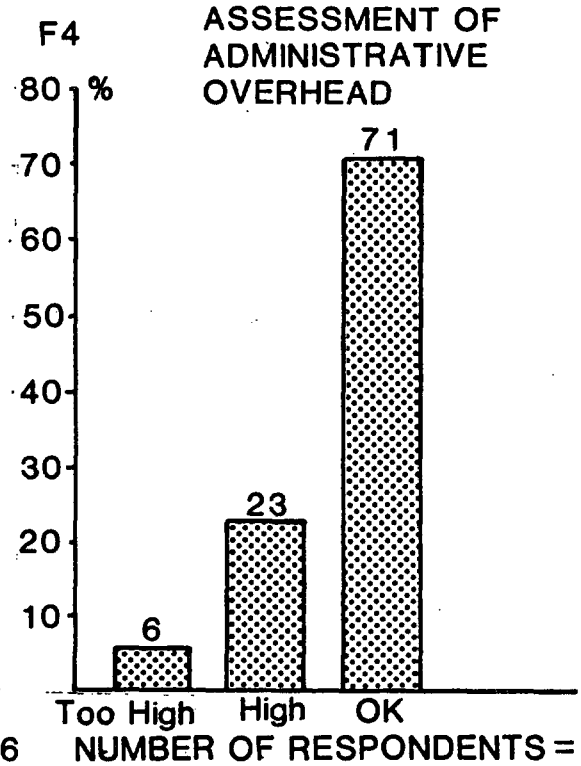


NUMBER OF RESPONDENTS = 73

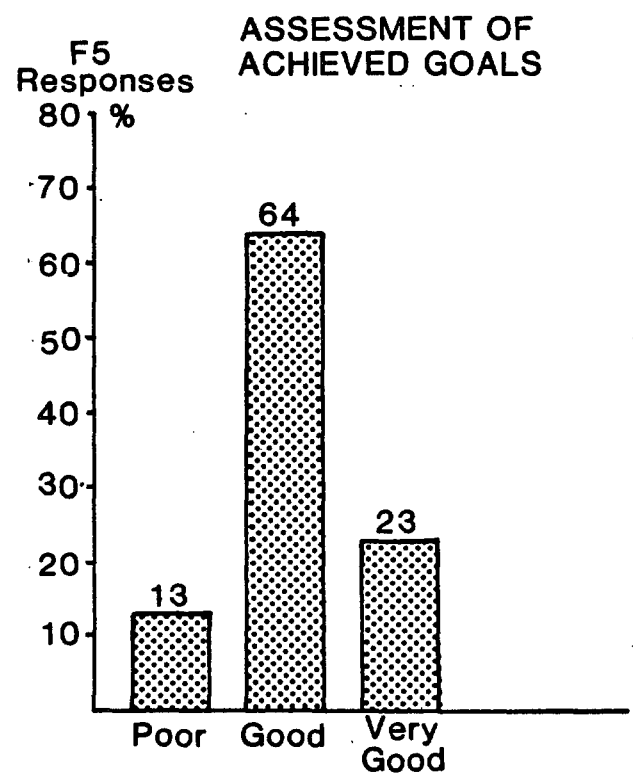
OTHERS ISSUES (CONT'D)



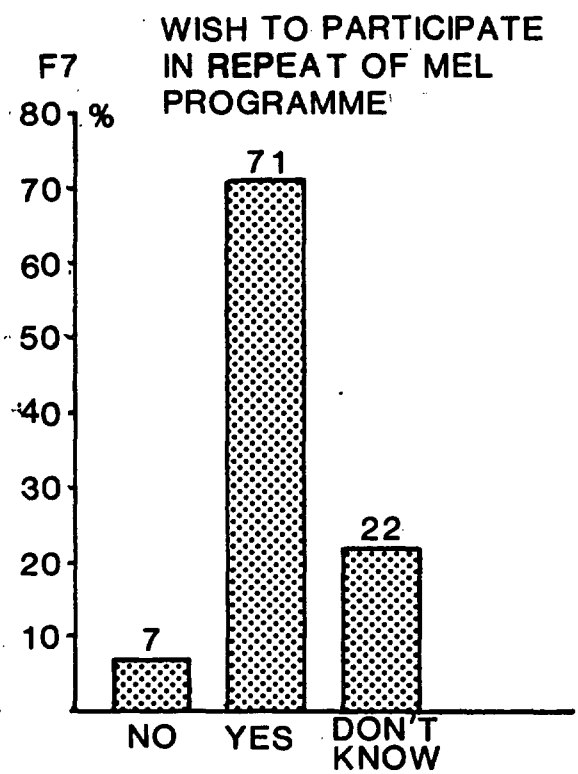
NUMBER OF RESPONDENTS = 76



NUMBER OF RESPONDENTS = 72



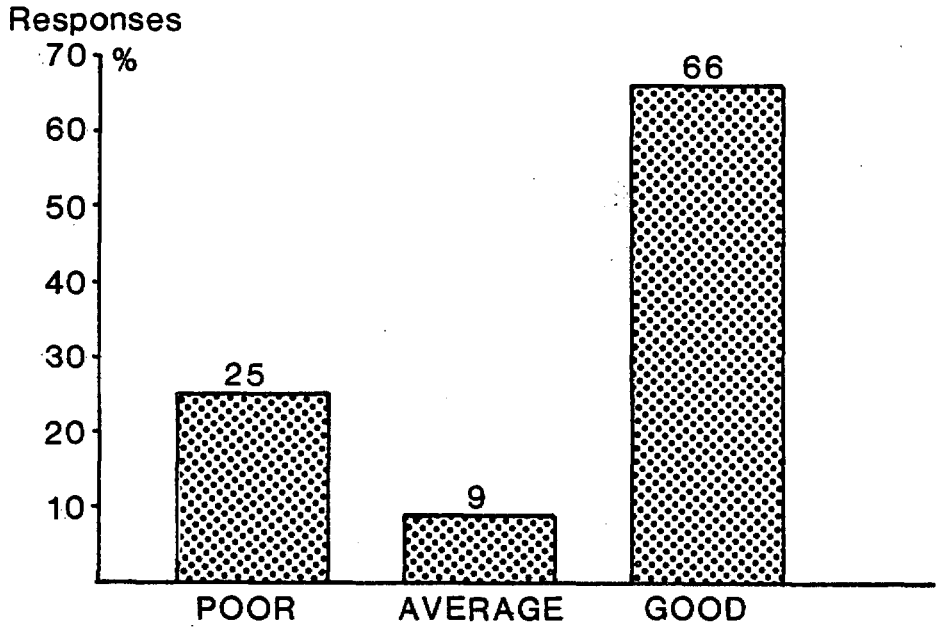
NUMBER OF RESPONDENTS = 75



NUMBER OF RESPONDENTS = 75

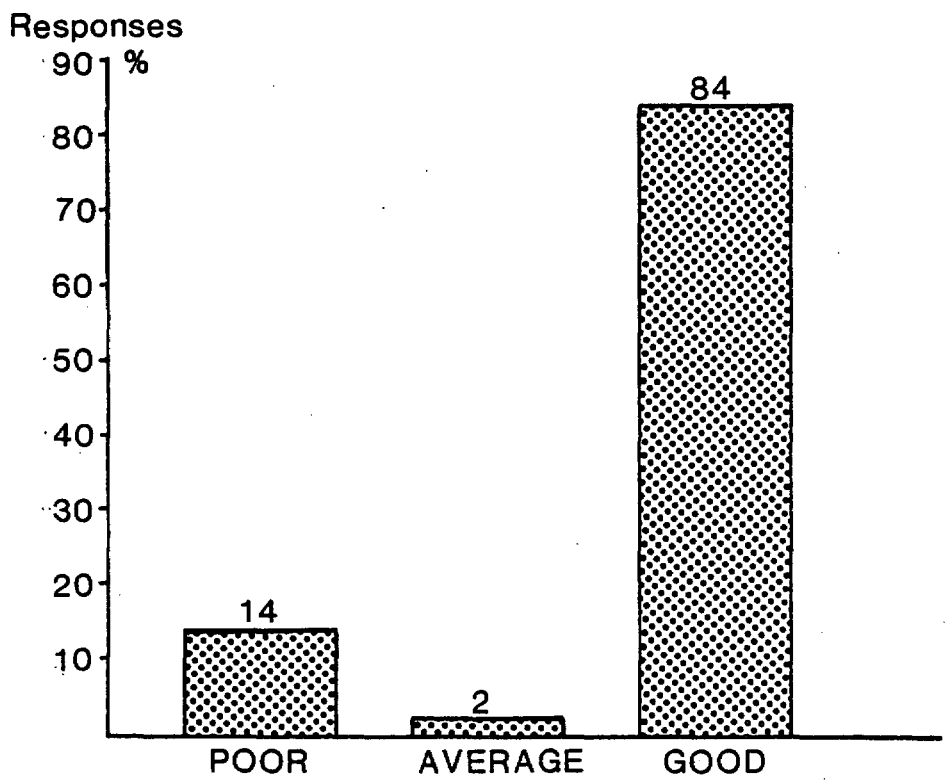
OTHER ISSUES (CONT'D)

F16 ASSESSMENT OF TENDERING PROCEDURES



NUMBER OF RESPONDENTS = 73

F17 ASSESSMENT OF USE OF EXTERNAL ADVISORS



NUMBER OF RESPONDENTS = 43