ALVEY MAN-MACHINE INTERFACE STRATEGY
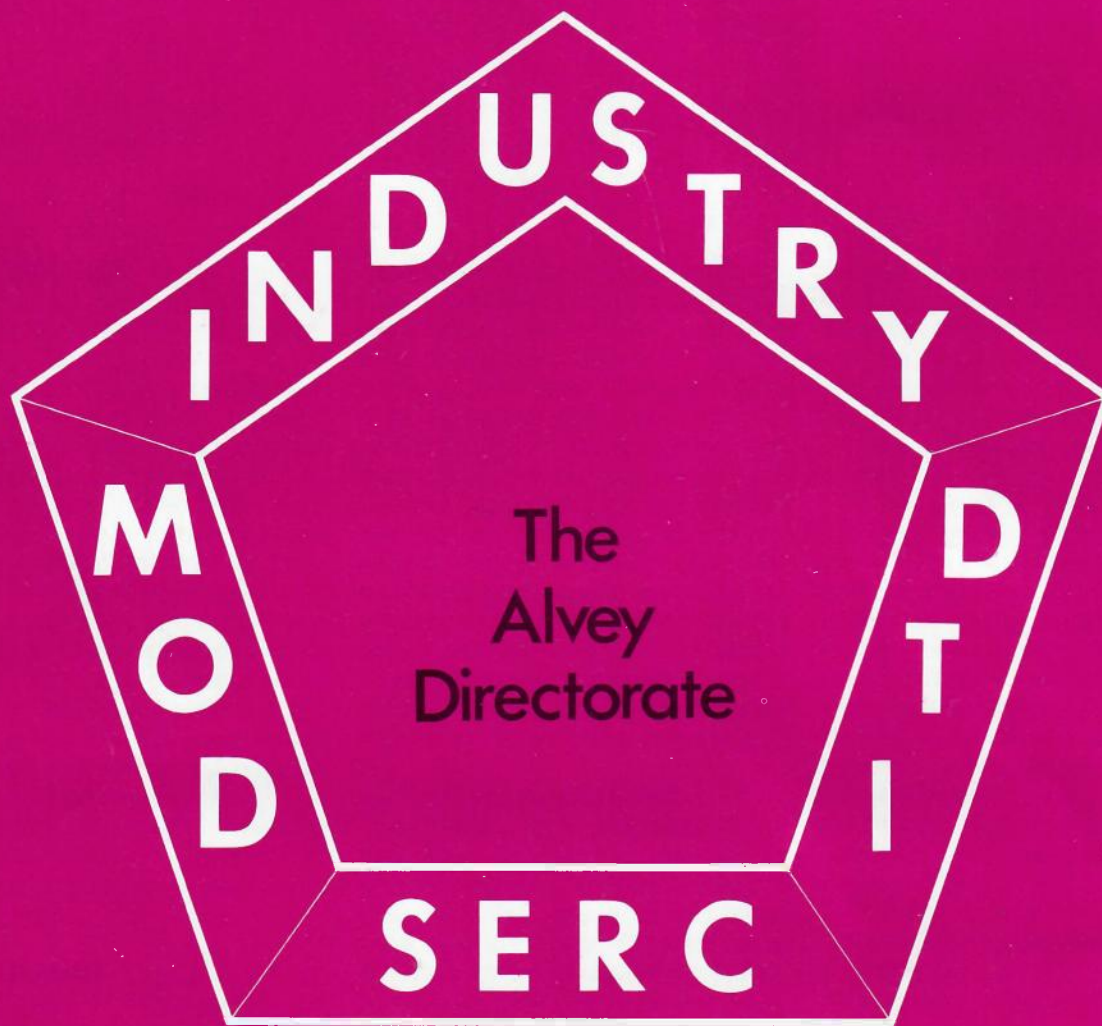
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The Alvey Directorate

ALVEY MMI STRATEGY

1. INTRODUCTION

This document presents the Alvey strategy for MMI research and development. It lays down a coordinated set of policies and actions designed to raise significantly the level of MMI research activity in the UK, and to improve correspondingly the quality of UK products through better MMI technology and design. It follows in broad terms the proposals of the Alvey Committee, on whose recommendation MMI was selected as one of the four main Alvey areas. These proposals have been developed into a more detailed programme identifying a number of key activities. However, this is a rapidly developing field and we aim to keep this strategy under constant review.

The strategy is based on the following statements regarding the definition of MMI and its importance to Information Technology (IT).

1.1 What is MMI?

The direct use of computers is fast becoming commonplace in society. In working and domestic environments many people now operate computer-based systems interactively, across a user interface designed to make the power and flexibility of the computer readily accessible to them.

This is the context of MMI—a context of widespread man-machine interaction made possible by the development of man-machine interfaces. The term "MMI" must necessarily encompass both terms. Research and development into MMI leads both to a better understanding of man-machine interaction and to the construction of better man-machine interfaces.

MMI work thus covers a multi-disciplinary field. It brings together researchers from many areas, including psychology, mathematics, organisational theory, electronics and computer science. Unlike other IT research topics it is exclusively concerned with the human user. It is also concerned with the technologies that support the user interface; these include image analysis and speech processing, collectively termed Pattern Analysis; which increasingly contribute to the design of advanced interactive systems. Thus the field of MMI is, in the Alvey context, a broad one covering a number of generic research topics and contributing to a number of applications and markets.

1.2 The Importance of MMI

The inclusion of MMI as a major area of the Alvey Programme reflects its growing importance. This derives not only from the spread of interactive products in to the hands of novice users, but also from these products' increasingly complex and powerful user interfaces. New technologies for interaction, such as high-performance display workstations and speech-processing techniques, are demanding fresh approaches to user interface design, placing a premium on innovation and on the use of objective design methods.

To be successful in the IT marketplace, UK industry must demonstrate an innovative approach to MMI. It needs to keep pace with other countries, notably the US, where innovative user interfaces have contributed to success in markets such as office automation, personal computers and micro-processor-controlled consumer goods. It needs to consider future needs for intelligent interfaces employing pattern-analysis techniques, and for interfaces to IKBS products. By making its own advances in MMI, in close association with the Alvey IKBS programme, UK industry will be able to play a leading role in these markets, rather than merely copying American and Japanese designs.

At the same time, UK industry needs stronger, more objective design methods for MMI. These will help meet an increasing demand for quality of interaction. MMI design quality is already a matter of concern to overseas manufacturers—witness IBM's policy of applying "usability plans" to its product development. UK manufacturers will need to take similar steps to maintain competitiveness, relying increasingly on the MMI R&D community in developing the necessary design capability.

1.3 The Need for an MMI Programme

A programme of MMI research and development is needed to ensure that UK products maintain competitiveness in the IT marketplace. The level of MMI R&D must be upgraded to bring it level with work in other countries and better mechanisms must be set up for exploiting the results of MMI research. At the same time the UK must seize opportunities to take the lead in key areas through sharply focused research programmes.

The need to raise levels of R&D is particularly serious in user interface design. Here the UK has lost ground over the last decade to the US, where research centres such as Xerox PARC have made great strides in user interface innovation and design methods. The UK now lacks expertise in many of

the key areas, and its R & D centres work in comparative isolation from each other and from the product divisions they are intended to serve. There is a danger that, without a vigorous programme of R & D, the UK will fail to maintain its share of the growing international market for interactive products.

A recent Alvey-sponsored survey of 110 of the major IT companies in the UK in both defence and non-defence work identified about 650 researchers in the Alvey related MMI areas. The survey was based on a classification of research work which enabled a separation of those working on Pattern Analysis and Displays, from those working on the Human Interface. This latter category included human factors, hardware and software interface aspects, environmental aspects and design methods. Of the 650 research workers 70% were working on the Human Interface, 17% on Pattern Analysis, and 9% on Displays. 35 of the companies have no research staff working on MMI, and a further 30 had groups of between 1 and 5. Only 4 companies had identifiable (named) groups working on some parts of Human Interface research, in the rest the workers were scattered throughout the organisation. A substantial amount of MMI work is conducted in government and industrial defence laboratories. Whilst intended for specific applications in the defence area, the generic problems underlying these activities are of wider significance and relevant to commercial activities.

In Academia there are various bodies including SERC, MRC and SSRC which fund work in their own particular area. There are few opportunities to mount multidisciplinary projects and no mechanisms to achieve cross-fertilisation or avoid duplication. An MMI programme can bring a much needed degree of coordination.

An MMI programme is often a key component of any large-scale initiative to integrate emerging technologies, e.g., VLSI, IKBS and Software Engineering. Programmes such as Alvey, ESPRIT and the Japanese 5th Generation are now addressing the problem of combining a number of advanced information technologies in a single product. MMI will play a vital role in making these products usable; an aggressive programme of R & D is needed to ensure that advanced IT meets expectations.

2. THE MMI PROGRAMME

2.1 The Objectives of the Programme
The objectives of the Alvey MMI Programme reflect the importance of MMI and the present state of MMI R & D in the UK. They are twofold:
(1) To raise the level of UK user interface design, in terms of innovation and design methodology, so that industry can compete effectively in world markets.
(2) To improve UK capabilities in pattern analysis, to make possible the use of advanced speech and image techniques in the user interface.

These objectives point to a broad R & D programme in MMI, with activities in user interface design and human factors, combined with research into advanced interactive devices and a strong programme in pattern analysis. To bring cohesion to the MMI community, investment is needed in the R & D infrastructure.

2.2 The MMI R&D Programme

2.2.1 Introduction
The programme will cover the major research topics contributing to MMI: user interface design, human factors, input-output devices and pattern analysis. It will necessarily be selective in order to achieve adequate depth of coverage and hence some areas are deliberately ignored. In general, research will be selected on a priority basis; in certain cases the programme will focus on specific research activities of high potential benefit to industry. This is especially true of input-output devices, where effort will be concentrated on developing large-area flat-panel displays for use in high-volume products.

2.2.2 Human Interface
The MMI strategy includes a broadly-based programme of R & D into Human Factors and User Interface Design; the term Human Interface is adopted as a heading for this arm of the strategy. The prime objective of raising the level of UK user interface design will be achieved through work in three inter-linked areas: User Interface Design, Human Factors and Design Methodology. To be effective, this work will require the active participation of researchers, designers and users. A major objective, therefore, is to bring together people working in these areas and link their work more closely to the needs of industry.

(a) User Interface Design. The MMI team will encourage the design, implementation, testing and documentation of innovative user interfaces. This is expected to be a dynamic area of R & D, with developments in technology giving rise to new ideas for interactive applications and techniques. The key areas of work will be:
— Interactive techniques with emphasis on developing ways of using new workstation architectures and input devices.
— Interface to IKBS, both for the end user and for the interface between the expert and the knowledge base.
— Exemplar projects, i.e. projects exploring and demonstrating the use of MMI in specific applications.
— Integration methods for combining together two or more applications (domain independence) or interactive capabilities (multi-media interaction).
— Technology evaluation including analysis of alternative hardware and software architectures for interactive systems.

(b) Human Factors. The MMI team will have the advantage of working with a number of active Human Factors research groups. These groups have research expertise in most of the key problem areas of Human Factors, namely:
— Cognitive processes of the individual IT user, with particular reference to the perceptual, problem-solving and decision-making processes involved in using interactive IT systems.
— Evaluation techniques for objective measurement of human-computer performance.
— Usability characteristics and determinants such as training, environment, hardware and software design and user support.
— Person-to-person interaction via IT, e.g. voice messaging systems.
— Organisational consequences of IT: tools and techniques for facilitating and evaluating the use of IT by groups of users.

Present coverage of these topics is uneven with the majority of effort going into experiments in usability, very little attention being paid to organisational research. The MMI team will attempt to achieve increased activity in neglected areas through a positive programme of research funding. At the same time it will strengthen industry's ties with academic research through the formation of consortia and through the general market-oriented approach.

(c) Design Methodology. The MMI team will encourage a build-up of R & D in this important but neglected area. Work will be sponsored in five topics:

—Use of models in MMI design including users' models, models of application environments, system architecture models, etc.
—Design tools and techniques for simulation, prototyping and evaluation.
—Design guidelines and procedures for hardware and software construction and for the application of human factors research.
—The design process. Investigating methods of improving the MMI design process (including user involvement).
—Design case studies and worked examples.

The overall objective of this work is to advance the discipline of user interface design, thus raising the quality of UK interactive products. The severe shortage of relevant expertise will undoubtedly hamper progress; there will be a need to capitalise on closely-related work in Human Factors and User Interface Design, and to encourage workers in these two areas to consider the contributions of their work to Design Methodology. Meanwhile an active programme of workshops and Alvey funded design projects will help raise the general level of expertise.

2.2.3 Displays

The R & D programme in displays will focus primarily on developing flat-panel displays meeting industry's requirements for high-volume interactive products. Key requirements are likely to include low cost, large area (at least A4 size) and high resolution range. Interactive properties will be important, and the programme will therefore include investigation of integrated input methods such as touch-sensitivity.

Large-scale investment will be needed to exploit the results of R & D in this area. Projects will be sponsored in a small number of industrial organisations possessing the necessary expertise and resources. Work in this area has benefited from support by the Electronics Applications (LA) Division of DTI, and will therefore continue under a joint Alvey-LA programme.

In addition to its mainstream flat-panel display R & D, the programme will sponsor smaller-scale research projects of an innovative or speculative nature, in areas of exceptional promise. This is reflected in the scale of Alvey funding for displays (see Sect. 3.4).

2.2.4 Pattern Analysis

The field of pattern analysis, covering the domains of speech and image processing, is highly relevant to MMI. It provides technologies for translation between human-oriented representations of data (text, pictures, speech, etc.) and machine-oriented representations, thus offering new approaches to human-computer interaction.

Pattern analysis research is relevant to a large number of markets and applications. Projects will be expected to show relevance to specific applications (e.g. automatic component inspection systems), not only to demonstrate potential benefit to industry, but also to ensure that the fundamental technologies on which they are based can support applications work. The research programme will, therefore, concentrate on the fundamental aspects, with an accompanying programme of application exemplars to demonstrate the applicability and validity of the research.

The Alvey programme in Pattern Analysis will be organised around the two major topics of image and speech processing:

(a) Image Processing includes research into the following generic problem areas:
—Image enhancement which requires the modelling of imaging and noise processes;
—Motion analysis which aims to determine automatically the parameters of motion;
—Image parametrisation—obtaining characterisations of the local shape of grey-level surfaces;
—Multi sensor fusion—the fusion of images received from multiple sensors;
—Optimisation of hierarchy design— the automatic optimisation of the processes required in image processing systems.

(b) Speech processing:
—Speech recognition: pattern matching by template extraction, integration of statistical models into speech recognition systems.
—Speech synthesis, e.g. methods of text-to-speech conversion, achievement of intonation patterns, speech transformation algorithms to reflect age, sex or style of delivery.

The task of assigning priorities to these activities has been undertaken by Research Planning Workshop (see 3.2), the reports of which will be widely available. It is expected that, in addition to these two categories of activity, some projects will be identified that are domain independent, i.e. relevant to both speech and image analysis.

2.3 The Market Orientation

The planning and coordinating of R & D in this area will recognise the application-specific nature of much MMI work. MMI deals directly with the user, and must therefore take account of the user's application for the IT system. The Alvey initiative is, however, concerned with the underlying technologies within IT, and the MMI programme will reflect this.

The market orientation of MMI provides researchers with a focus for their work and a means of validating its applicability by the use of exemplars. Tools and methods should be general-purpose, and this will be a criterion in the assessment of such research.

The market orientation is reflected in the approach to be taken in planning and funding MMI R & D in these areas, which are likely to include:

Office Systems
Automated Manufacture
Computer Aided Design
Command, Control and
  Communication
  (including Process Control)
Software Engineering
Computer-based Training.

The MMI team will prepare Announcements of Opportunity delineating the major market areas critically dependent upon MMI. Applicants for research funding will be expected to indicate the market areas to which their work relates. The assessment criteria for project approval will include the following:

Awareness of specific applications and products, within identifiable market sectors, whose sales in the UK and abroad would be enhanced by the research.
Existence of established disciplines supporting the proposed work: applicants should be experienced in such fields and should be aware of related work by other researchers.
Allowance for, and awareness of, reasonable risk levels such that results can be achieved over five years.
Statements of other research in related fields, on whose success the proposed work depends.
Statements on how the results of the proposed work will be presented and how these results will be transferred into industrial use.

2.4 Relationship of the MMI Strategy to Other Activities

2.4.1 Alvey

The MMI programme occupies a special position in relation to the Alvey Programme as a whole, where it has the essential role of representing the needs of the user in advanced IT projects.

(1) **Large-scale demonstrators.** The MMI programme is likely to make particularly strong contributions to Large-scale Demonstrator projects. This is the case for two reasons. First, all the Demonstrators will involve interactive technology, and hence will require consideration of MMI; moreover the MMI programme can make useful contributions to these projects at every stage. Second, Demonstrator projects will have strong Alvey influence and will therefore provide an opportunity to apply MMI methods and to learn from the results. The projects can produce valuable design histories, forming the basis for user-interface design case studies. The MMI team will take steps to ensure that there is the closest liaison with the Demonstrator Programme.

(2) **VLSI and CAD.** The MMI programme can work effectively with the VLSI programme especially in the development of designs and technologies for CAD workstations and interactive software. A second important area of collaboration lies in signal processing architectures; the VLSI programme's research into this topic will be of crucial importance to the Pattern Analysis programme.

(3) **Software Engineering.** The Integrated Project Support Environments planned under the Software Engineering programme will require advanced user interfaces. They will depend on the contribution of results from the MMI programme, particularly research into User Interface Design topics such as window managers.

(4) **IKBS.** The relationship between the MMI and IKBS areas is likely to be especially close. As more advanced IKBS applications are planned their need for MMI input on the user interface will increase. At the same time, collaboration between the MMI and IKBS areas can strengthen each area's work in cognitive research.

2.4.2 ESPRIT

The relationship of the Alvey MMI strategy to the EEC's ESPRIT programme is of prime importance. Given the limited resources for IT and especially the shortage of qualified R & D personnel, all possible steps must be taken to avoid unnecessary duplication.

The two most relevant parts of ESPRIT are Office Automation and Advanced Information Processing, and here the Alvey MMI Directorate will work to encourage UK participation in those ESPRIT projects where Europe has the stronger expertise or where there is a gain from influencing a European standard.

3. PROGRAMME IMPLEMENTATION AND MANAGEMENT

3.1 Introduction

Implementation of the MMI Strategy will involve two separate ongoing activities, the one concerned directly with promotion and funding of R & D, the other with providing support to R & D workers and to the IT community in general.

3.2 Research Planning Workshops

The MMI team has now held a set of Research Planning Workshops to complete the details of the MMI strategy. These have produced a better definition of the state of each area and have identified topics deserving funding.

Workshops will also be organised in each of the major application areas to delineate the application and identify its research needs. The selection of workshop topics will be based on predefined criteria for choosing applications.

The outcome from each of the workshops will be incorporated into an amalgamation of research requirements presented in Announcements of Opportunity; they will also help in the production of more detailed financial estimates.

3.3 R & D Support

3.3.1 Introduction

MMI Infrastructure facilities are required to provide a better focus for the research programme, to accelerate the provision of basic MMI tools and techniques, and to ensure coordination within the other Alvey areas. While MMI research may concentrate primarily in a small number of centres, a substantial range of MMI work will nevertheless be undertaken in a wide variety of institutions. Therefore the Alvey MMI programme will provide a number of levels of support, each commensurate with the recipient's degree of involvement with the MMI programme.

3.3.2 Computing and Networking Facilities

The importance of computing facilities to MMI R & D is recognised. There are special requirements for equipment in MMI, especially in areas such as usability research and pattern analysis. While endeavouring to meet these special requirements the MMI team will encourage standardisation in hardware and software, to minimise the duplication of hardware interfaces and software tools, and to promote the interchange of applications and ideas among members of the MMI community.

This is seen as a complex support issue, and MMI Directorate will take positive steps to determine the best course of action.

The MMI programme will depend on the availability of a nationwide network to support electronic mail, file transfer, remote logic and demand printing. This will be a further important element in establishing a coherent MMI community, and will be supported by Alvey Net.

3.3.3 R & D Technical Centres

All aspects of MMI work involve a high degree of multi-disciplinary activity. To ensure that MMI research groups are large enough to function effectively, the MMI programme will encourage the establishment of a small number of well-supported centres to act as focal points for MMI research, particularly for work on the Human Interface. Typically these centres will be built around established expertise and capabilities and be multi-disciplinary in nature. However, individual centres may well specialise in particular aspects of MMI work. Their on-going research will enable the centres to provide a range of services covering state-of-the-art help and advice in MMI. These will be particularly valuable to small firms lacking any in-house MMI expertise. It is envisaged that Alvey would support only the research activities of these centres, including the necessary facilities and infrastructure, and that the services rendered by the Centres would be available on a commercial basis.

An important function of these centres will be to help the dissemination of knowledge and experience. They will therefore be encouraged to collaborate closely with each other. They should be well equipped, e.g. with video facilities, to permit documentation of research work. They will be encouraged to take an active role in standardisation issues, both in this country and overseas.

3.3.4 MMI Training

The MMI team will encourage the setting up of MMI training measures, both for new students and for workers already in related fields. Attention will be given to the further training and development of postgraduate research workers and designers in industry. The team will encourage the PhD programmes offered by universities and polytechnics, by adopting funding strategies that enable centres of excellence to build up in the key areas of MMI R & D.

The MMI team takes note of the valuable work of the NEC working party, and of its useful recommendations regarding education and training in MMI published in its report, "Human Factors and Information Technology".

3.3.5 Dissemination of Knowledge

The MMI programme, in addition to organising and funding R & D will provide a wider service to the industrial and academic MMI community, through a coordinated programme of services and education, including the R & D Centres mentioned in 3.3.3). These activities will help diminish the isolation that presently affects the work of MMI centres in the UK. Recognising the potentially heavy cost of supporting these activities, the MMI team will take all possible steps to involve other bodies, such as professional institutions and governmental departments, so as to minimise overlap with existing activities and to ensure that the programme is efficiently administered. Supported activities will include:

—Awareness programmes, modelled after the successful programmes organised under the Microprocessor Awareness Programme though much smaller in scale.
—MMI workshops and meetings, including design workshops, general scientific meetings, collaborative meetings with workers in other Alvey areas, and annual plenary MMI progress meetings.
—UK Who's Who in MMI.
—MMI Mailshot including a regular quarterly newsletter.
—Database of papers and references.
—Audiovisual library with particular focus on video material presenting the results of MMI research.
—Design guidance, a longer-term activity devoted to the preparation of handbooks and instructional material.

3.3.6 Consortia and Staffing

The MMI team will encourage the formation of R & D consortia where necessary to ensure competence in project teams. This will occur particularly with highly complex technical projects, with large projects requiring more effort and more disciplines than one group can provide, and with projects involving geographically isolated groups— phenomena that are particularly common within the MMI field. In addition to helping form consortia, the MMI team will encourage collaboration between the different sectors of the MMI community, giving priority to proposals that include specific measures to achieve collaboration.

To help solve the severe shortage of qualified personnel the MMI team will encourage the active recruiting of MMI experts from non-R & D work in the UK and from other countries. It will adopt a policy of preferential support for groups that demonstrate an ability to attract and retain first-class staff. This will be done on the understanding that a vigorous and sharply-focused attack is needed in order to bring results in the MMI area. The MMI team will also support the formation of new, high-calibre R & D teams in areas such as user-interface design and design methodologies. Groups who have been working in closely allied areas, such as distributed computing, computer graphics or interactive applications, may find that they can make a contribution to the MMI programme; they will be encouraged to submit proposals, and to join the MMI community.

3.4 Costs

The table below represents the provisional assignment of Alvey funds to the parts of the MMI programme. The sum included under the contingency heading will be directed towards particular parts of the programme in the light of future developments of the strategy, and the strength of proposals received in particular areas.

Table 1: Alvey Funding

Human Interface	9.0
Pattern Analysis	12.4
Displays	1.3
Contingency	4.7
Infrastructure*	4.4
Totals	£31.8 M

*Includes the estimated cost of the activities in Section 3, a major part being the cost of capital equipment for the major R & D technical centres.

4. ACKNOWLEDGEMENTS