ARTIFICIAL INTELLIGENCE
EUROPEAN MARKET OPPORTUNITIES

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Artificial Intelligence - European Market Opportunities

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EUROPEAN MARKET OPPORTUNITIES

ABSTRACT

During the last four or five years, artificial intelligence has steadily moved from the universities and research establishments to the commercial suppliers and users of information technology. It is now seen by many (but certainly not all) as one of the key technologies of the immediate future, offering a whole new range of gains in terms of service, efficiency, and competitive edge to its users and new market opportunities to its suppliers and support service industries.

In Europe, A.I. has been specifically identified at government and EEC levels as a key technical priority, it has received considerable attention from the media, and it has a core of committed users and practitioners. Despite that, A.I. is not well understood by the wide computer user community, and some potentially damaging misconceptions exist.

In this report, INPUT puts A.I. into perspective by describing the technology and its applications and by offering an analysis of the current market conditions and likely future directions. Forecasts for the period 1986-1991 are included for the four major European country markets of France, Italy, the United Kingdon, and West Germany.

This report contains 167 pages, including 40 exhibits.

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I INTRODUCTION

I INTRODUCTION

A. OBJECTIVES AND SCOPE

- Artificial intelligence (A.I.) is regarded by many as one of the key technologies of the immediate future and, therefore, as an area that offers significant business opportunities to a range of companies in the computer industry.

- At present the A.I. market is small and immature and there is a generally low level of awareness among computer users of what A.I. is and how it can be applied to commercial and organisational needs.

- INPUT's objectives in conducting this research programme and producing this report have been to:

  - Provide an overview of A.I., the technologies associated with it (in particular software), and the potential applications for it.

  - Identify key issues in terms of user attitudes, technical developments, and marketing strategy.

- Although A.I. can be treated in a technical and specialised manner, the report does not cover technical details in-depth, and interested readers are referred to the relevant publications and product specifications.

B. METHODOLOGY

- Field research for this report was obtained from an interview programme that was carried out during June and July 1986.

- Interviews were conducted with both users and vendors.

  - In total, some 127 user interviews were conducted by telephone in France, the U.K., and West Germany.

  - Additionally, 52 vendors were contacted in order to gauge levels of interest and product and marketing activity in the A.I. area. Vendors were interviewed in France, Italy, the U.K., and West Germany.

- Definitions of terms used in this report are included in Appendix A.

- A complete analysis of the interview sample is provided in Appendix B.

- The questionnaires used as the basis of these interviews are included as Appendices C and D.

- For convenience of comparison between markets, local currencies have been converted to U.S. dollars. U.S. dollar conversion rate assumptions over the five-year forecast period (1986-1991) are given in Exhibit VIII-1. These conversion rate assumptions should not be interpreted as forecasts of exchange rates.

- Definitions of terms used in this report are included in Appendix A.

- Enquiries and comments are invited by INPUT regarding this report and any related topics of interest.

- INPUT expresses its thanks to all those individuals and companies that participated in the research programme upon which this report is based.

C. REPORT STRUCTURE

- The remaining chapters of this report are structured in the following way:

  - Chapter II is an Executive Overview providing a summary of the contents of the entire report.

  - Chapter III provides a background description of A.I. including some definitions, historical background, a view of some modern A.I. initiatives, and the characteristics that distinguish A.I. systems.

  - Chapter IV describes software and hardware products that are associated with A.I.

  - Chapter V examines user perspectives on A.I., both positive and negative.

  - Chapter VI provides an analysis of vendor issues including vendor commitment to this emerging market and the levels of product and service provision.

  - Chapter VII includes an analysis of potential obstacles to market growth, key technical developments, and vendor marketing issues.

  - Chapter VIII contains INPUT's market analysis and forecast for the period from 1986 through 1991.

- Chapter IX provides a number of selected vendor profiles of companies already active in the European A.I. marketplace.

- The Appendices contain a list of definitions of terms, an analysis of the research sample, and the questionnaires used for field research.

II EXECUTIVE OVERVIEW

II EXECUTIVE OVERVIEW

- This section summarises the content of the report in a prepared presentation format.

- The Executive Overview can be used to quickly acquire a strategic overview of A.I. and its market.

- The key points of the entire report are summarised in Exhibits II-1 through II-8. On the left-hand page facing each exhibit is a script explaining its contents.

A. THE SCOPE OF A.I.

- Artificial intelligence is something of a blanket term that encompasses a number of technical and theoretical areas such as:

  - Game playing and complex problem solving, sometimes involving the application of heuristic methods. Research in this area is relevant to problem representation, planning applications, and operations research.

  - Mechanical theorem proving based generally on the techniques of mathematics and formal logic. A.I. has some interesting applications in circuit design, software engineering, machine learning, and the use of computer systems to assist the tasks of design and specification.

  - Pattern recognition and 'intelligent' response to stimuli such as speech, images, and signals. Most current applications are defence and security, but the technology is likely to be applied to design tasks, human-to-computer interfaces, and advanced office systems.

  - Natural language recognition is a highly complex area which is unlikely to be fully understood in the foreseeable future. However, even partially developed language models can be usefully applied, particularly to the areas of processing large text banks, machine translation, and natural language interfaces to information systems.

  - 'Expert', 'knowledge-based', and 'diagnostic' systems, typically incorporating specialised human knowledge of a problem domain. Enormous potential in decision support, planning, education and training, operations support, and problem diagnosis. A.I. is currently the subject of great interest from major financial and industrial organisations.

EXHIBIT II-1

INPUT®

THE SCOPE OF A.I.

- Complex Problem Solving with Heuristics
- Mechanical Theorem Proving
- Pattern Recognition and Response
- Natural Language Recognition
- Expert and Knowledge-Based Systems

B. A.I. - AN EMERGING MARKET

- Currently, the A.I. market is small and immature and has reached nothing like its full potential. However, there are strong indications that it is taken very seriously by influential institutions.

- A.I. has been identified as a key technology by the U.K. government, the EEC, the government of Japan, and the U.S. government via DARPA (Defense and Advanced Research Projects Authority). A great deal of research and development in A.I. is government sponsored in one way or another.

- Computer industry majors such as IBM, DEC, and Xerox have invested in A.I. Clearly, they expect customer demand to develop in the immediate future. In addition, many of the major software houses in Europe and the U.S. are already well on the way to offering a range of products and services in the A.I. area.

- A.I. already has a growing customer base in defense, aerospace, major manufacturing corporations in the automotive and electronics industries, and the petrochemical majors.

- The powerful financial institutions are beginning to assess A.I. in terms of its relevance to areas such as investment and underwriting. Some financial services organisations are already users of expert systems.

- Either A.I. has a serious commercial future or all of these organisations have got it wrong and wasted a lot of money.

INPUT®

A.I. - AN EMERGING MARKET

- Emergent High-Potential Market
- Key Technology/Government Bodies Awareness
- A.I. User Base
  - Defence
  - Aerospace
  - Manufacturing
  - Petrochemicals
  - Universities/Research
- Financial/Service Industry Assessment

C. MARKET OPPORTUNITIES

- Historically, the emphasis has been placed on the software tools suitable for A.I. development--languages like LISP and PROLOG, expert system shells, and integrated software environments.

- With the predicted market expansion, the emphasis will change to focus on end-user requirements and demand will widen to embrace service activities such as consultancy and development services as well as products.

- As applications become better understood, end-user systems will be packaged for a range of commercial activities.

- Integrated systems for specific applications areas are likely to emerge; there are several available now in the U.S.

- Natural language processing is likely to be utilised as an enhancement to software products such as data base systems, expert system generators, and packaged expert systems. Some products developed in the U.S. already offer this feature.

- The potential market for end-user-oriented products and services is much greater than that for the development tools, which will remain the province of specialist technical staff.

EXHIBIT II-3

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MARKET OPPORTUNITIES

- Development Products - Languages and Generators
- Application Packages
- Natural Language Systems
- Integrated Systems
- Consultancy and Training
- System Development Services

D. $800 MILLION MARKET BY 1991

- INPUT estimates that the market for A.I. software products and services will exceed $800 million by 1991 in the four country markets of France, Italy, the U.K., and West Germany.

- Currently, INPUT has assessed these markets at nearly $80 million for calendar year 1986.

EXHIBIT II-4

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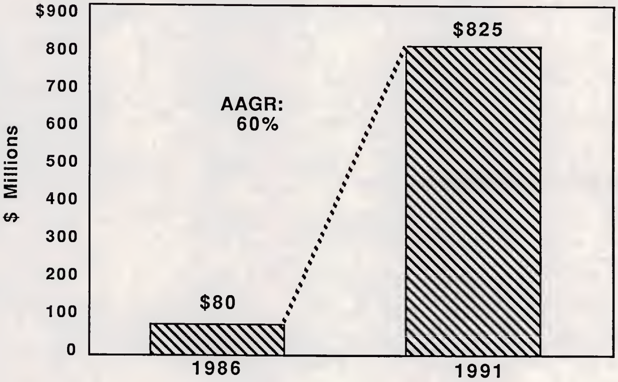
$800 MILLION MARKET BY 1991



E. NEGATIVE PERCEPTIONS OF A.I.

- Negative perceptions of A.I. on the part of computer users can be addressed by appropriate marketing initiatives stressing:

    - That A.I. is relevant to commercial applications.

    - Promotion of awareness of the technology.

    - Potential for integration with other DP systems.

    - The accessibility and strength of the technology.

- Many computer users fail to identify worthwhile applications for A.I. within their organisations. In part this is a consequence of lack of awareness of the technology and of the often obscure way in which the A.I. industry has communicated with users.

- As an indication of this, a high proportion of users feel that they do not know enough about the technology to judge its value.

- A number of users feel that the successful implementation of more standard computer systems represents a higher priority.

- Many users believe that the technology is still immature and not yet ready for serious use.

- A common perception of A.I. is that it is too technically demanding to be used for commercial applications.

EXHIBIT II-5

INPUT®

NEGATIVE PERCEPTIONS OF A.I.

- No Serious Applications
- Lack of Knowledge and Understanding
- Conventional Systems Are a Higher Priority
- The Technology Is Immature and Inaccessible

F. MARKET DRIVING FORCES

- User and vendor perceptions of the forces driving the emerging A.I. market are:

  - Improvement in the computing function by the provision of better programming tools and 'expert' interfaces to existing applications such as data bases and information systems, modelling and simulation, and CAD.

  - The need to approach problems which are not susceptible to conventional computing techniques, typically those requiring some form of knowledge representation.

  - Using expert systems in areas like diagnostics, operations support, and training to disseminate some of the expertise of human specialists.

  - Extending the role of computers in decision support via expert systems and improved interfaces to existing decision support systems.

EXHIBIT II-6

INPUT®

MARKET DRIVING FORCES

- Improvement of the DP Function
- Need to Solve New Problems
- Dissemination of Expertise through the Organisation
- New Options in Decision Support

G. KEY TECHNICAL DEVELOPMENTS

- The key technical developments needed to widen the appeal and effectiveness of A.I. technology are already being addressed by existing vendors. They are:

  - Integration of A.I. with existing computer applications by linking A.I. development systems to corporate computers, providing interfaces to data base resources and integrating with existing programs and systems.

  - Provision of applications portability from development environments to end-user systems such as PCs and microcomputer systems.

  - Improved flexibility of the software design and development processes (A.I. already scores very well in this area).

  - Better man/machine interfaces via natural language processing and speech recognition.

  - Continued development of essential system building techniques such as knowledge representation, production systems, and frame-based systems.

EXHIBIT II-7

INPUT®

KEY TECHNICAL ISSUES

- Integration of A.I. with Existing Technology
- Applications Portability
- Flexibility in Design and Programming
- Improved MMI
- Continued Development of Knowledge Engineering Techniques

H. KEY MARKETING ISSUES

- A summary of key marketing issues based mainly on vendor assessments of the current A.I. market includes:

  - Clear communication based on a vocabulary with which users are familiar and which targets A.I. at recognisable applications and commercial problems.

  - Marketing strategies with a strong educational component aimed at making management aware of the potential benefits of A.I.

  - A.I. technology has some potentially damaging image problems--that it is difficult to use, immature and unstable, and can only be used in a highly specialised context. In fact, A.I. technology is typically user friendly, resilient, well tested, and can be applied to a variety of tasks.

- The signs are that A.I. is moving from an emphasis on development tools to an emphasis on end-user applications. The marketing of products and specialist services is likely to be targetted at specific niche market opportunities.

EXHIBIT II-8

INPUT®

KEY MARKETING ISSUES

- Avoiding the Abstract Approach Based on Jargon
- Improving Management Awareness
- Communicating the Strengths of the Technology
- Identifying Clear Niche Opportunities

III WHAT IS ARTIFICIAL INTELLIGENCE?

III WHAT IS ARTIFICIAL INTELLIGENCE?

- For centuries humans have been fascinated by the idea of machines that could emulate and surpass man's own functions. Many attempts have been made both to describe and to build such machines.

- In the age of micro-electronics and software engineering, many believe that we are at the beginning of an era when the boundaries of machine intelligence will be extended in a dramatic way.

- A number of misconceptions exist about A.I., and the majority of computer users have only a vague idea of what it is and how it can be applied.

- Even researchers and experienced practitioners sometimes disagree about precise definitions and descriptions.

- This chapter contains:

  - Some definitions and descriptions of A.I.

  - A brief history of its development.

  - Some modern initiatives that have promoted A.I.

  - Some common fallacies about A.I.

- An overview of what comprises A.I.

- The characteristics that distinguish A.I. systems.

A. HISTORY AND DEFINITIONS

1. DESCRIBING A.I.

- The term 'artificial intelligence' was coined by the American researcher John McCarthy to describe an amalgam of activities that were concerned with the machine simulation of human cognitive and investigative functions.

- Unwittingly, McCarthy may have done a disservice because the term that he coined has some quite emotive interpretations and embraces a wide range of technologies, each of which can be described adequately without resorting to the blanket phrase 'artificial intelligence'. However, there is no denying that the phrase does have a ring to it and usually produces a response from people, even if that response is sometimes a hostile one.

- A number of definitions have been put forward, but the ones that have been found to be generally acceptable have the common theme that there is an association between A.I. and the ways in which human beings perform intellectual tasks.

- An interesting definition of A.I. is provided by Elaine Rich of the University of Texas:

  - 'Artificial intelligence concerns the attempt to have machine systems carry out tasks at which, currently, humans are better'.

- Rich's definition contains a neat insight into the way in which new technologies are perceived. In effect, she is saying that a field of research ceases to be A.I. as soon as it is fully understood and implemented.

- Professor Campbell of London University suggests that the distinguishing feature of an A.I. system lies in its use of heuristic reasoning. Heuristic methods are used constantly by humans to cope with problems. In general terms, a heuristic method is one which is known to work well under certain circumstances but which cannot be fully formalised (unlike an algorithm, for example). The Greek root of the word is colloquially equivalent to 'proceeding by discovery'.

- A.I. recognises the immense complexity of even apparently simple human activities. A variety of every day tasks would never be performed at all if it were necessary to analyse every contributory factor that could possibly affect them. In the real world humans simply ignore many factors which experience tells them are of marginal importance (they employ a range of heuristics) and concentrate their efforts upon obtaining satisfactory results. Most A.I. systems operate on a similar basis, and they are implemented in the knowledge that they must cope with incomplete and in some cases imperfect information.

- A more pragmatic definition is offered by the sales director of a British software house specialising in the A.I. market:

  - 'Artificial intelligence is whatever our customers think it is'.

- We offer a generalised definition of A.I. as follows:

  - 'Artificial intelligence is the attempt to reproduce in a machine system some aspect of intelligent and well-motivated human behaviour'.

- A.I., then, is in general terms concerned with:

  - Reasoning and deduction.

  - Reaction to significant factors in a situation.

  - Applying knowledge and experience to problems.

  - Investigation and discovery.

  - Coping with uncertainty.

  - Deriving satisfactory rather than mathematically optimised results.

- Although any academic definition of A.I. should be independent of direct technical associations, in practical terms the enormous advances in both hardware and software technology have allowed A.I. to move from the seminar room and the research laboratory into the forefront of applied computing. As described later in this chapter, many of the techniques of A.I. have been understood for 20 years or more but the hardware and software necessary for their widespread implementation to be a practical proposition are largely products of the last five years or so.

2. HISTORICAL LANDMARKS

- A.I. is not, as many people believe, a new technology. It is only comparatively recently that it has received attention in any medium apart from specialised journals, but research and development work has proceeded for many years. Historical landmarks in the development of A.I. are illustrated in Exhibit III-1.

- As A.I. is launched as a major technology, its lengthy history can be seen as a very positive asset because:

EXHIBIT III-1

HISTORICAL LANDMARK

1980	A.I. Becomes an Industry
	R&D Work Continues
1970	PROLOG Language Developed, MYCIN
	The First Expert Systems Are Built
1960	LISP is Developed The First A.I. Systems for Digital Computers
	Theoretical Work Continues
1950	Turing Test for the Intelligent Machine
	Early Theoretical Work

- The software tools now being marketed have a solid R&D history which contributes to their performance and reliability.

- Many of the problem areas to which A.I. is now being applied have been studied for a number of years, and techniques to cope with them have been developed.

- There is a repository of people with relevant skills available to the industry.

- Until the beginning of the 1980s, A.I. was not generously funded, particularly in Europe. Few major companies actively researched in the field, although some of them sponsored university departments to do so. Therefore, the early history of A.I. is almost exclusively concerned with developments in academic and research sites.

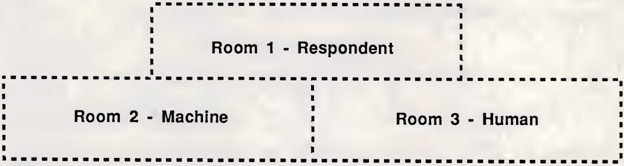
- The first theory associated with A.I. probably grew from operations research and tactical planning at the time of World War II. No mass-produced computer technology existed that could exploit this theory, but the association with problems involving uncertainty, requiring human judgment for their successful resolution, and recognising satisfactory rather than optimal results remains to this day.

- In 1950, mathematician Alan Turing proposed a theoretical test for an 'intelligent' machine system. The test is now universally known as 'the Turing test' and adaptations of it have been used to test expert systems in the fields of medicine, pure science, and agricultural science. In its pure form, as Turing proposed it, many researchers believe that the test is too severe for any machine system to ever pass. Exhibit III-2 shows how the Turing Test is operated.

- In the late 1950s and early 1960s researchers began to develop the first A.I.-type systems which could run on digital computers. Generally speaking, these

EXHIBIT III-2

THE TURING TEST



- Respondent receives communications from either Room 2 or Room 3. These are presented in identical format.

- Respondent asks questions, assesses responses.

- If respondent cannot identify which communications come from the machine system and which from the human, then the machine system passes the Turing Test.

were systems which could be categorised as theorem provers in formal logic and mathematics or as game playing systems. Although some dealt with apparently trivial matters (such as noughts and crosses), their contribution should not be undervalued because they laid the foundations for theory about problem representation and the mechanics of search for solutions which are so important in A.I. now.

- In 1959 John McCarthy (author of the term artificial intelligence) produced the prototype of the LISP language. LISP is an acronym for LISt Processing and has become generally known as 'the assembler language of A.I.'. LISP is referrred to again in Chapter V of this report.

- The first expert systems began to be built in the mid 1960s , almost always at academic and research sites in the U.S. One of the earliest and best known of these was the DENDRAL system developed at Stanford University about 1965. The famous MYCIN system was developed in 1972, also at Stanford University, and is still in use as a teaching system. In its generalised form, EMYCIN, the system gave birth to the first expert system generator.

- In 1972, the first interpreter for the PROLOG (PROgramming in LOGic) language was developed at Marseilles University by a team under Dr. Alain Colmerauer. Subsequent development of the language took place at Edinburgh University through the 1970s, and the standard syntax is now acknowledged to be the 'Edinburgh Syntax'. Along with LISP, PROLOG is generally recognised as a language particularly well suited to the programming of some (not all) A.I. applications. It is mentioned again in Chapter V, Section C of this report.

- Throughout the 1970s, artificial intelligence remained in the academic and research institutions, principally in the U.S. Two major computer companies in particular were associated with A.I.--the Xerox Corporation via its Palo Alto Research Centre (PARC) and DEC via its links with the academic computing community and the experimental expert system (later called XCON) which was developed in association with Carnegie-Mellon University.

In this period, the foundations were laid for the software tools and problem solving techniques that the A.I. industry now offers its users.

- The current upsurge of interest in A.I. and the enormous proportional increase in funding for it dates from about 1980. The main developments in this period are described in Section 3 of this chapter.

3. MODERN DEVELOPMENTS

- From 1980 onwards, A.I. has made the transition from a research discipline to a growing industry. A number of disparate factors have had a bearing on its subsequent direction (and as we mentioned before, by no means everybody sees A.I. as a major technology). In this section we describe developments at the national level that have focused attention on A.I.

- In 1980, the Japanese 5th Generation initiative was announced. In effect, the Japanese electronics complex stated that its strategy was not to challenge American domination of the established computer systems market but to develop a new computer industry built on what were identified as 5th generation system characteristics. These included:

    - Parallel processing hardware architectures that would, ultimately, eclipse the power of 'conventional' computer systems by many orders of magnitude.

    - Advanced software engineering and production technologies.

    - 'Intelligent knowledge-based systems' (artificial intelligence) that would extend system problem solving capabilities by an order of magnitude.

    - Advanced man/machine interface devices and software to enhance the accessibility of computer systems.

- Partly in response to the Japanese initiative (and the reaction to it in the U.S.) and partly because of a growing belief that information technology was central to the economic future of the U.K., the British government via the then Minister for Information Technology, Kenneth Baker, commissioned a committee under the chairmanship of Sir John Alvey (British Telecom) to report on the British situation.

- The Alvey Committee contained representatives from the computer industry, leading academic institutions, and major users of information technology. In summary, the committee identified four key areas which it considered vital to the continuing growth of the U.K. industry:

  - Advanced software engineering, to address the problems of software development, reliability, mass production, and portability.

  - VLSI (very large scale integration), to address the issue of competitive hardware performance and cost.

  - MMI (man/machine interface), to address the problem of human access to advanced computing facilities.

  - IKBS (intelligent knowledge based systems), the application of artificial intelligence to the systems of the future.

- These were collectively designated 'the enabling technologies' and it can be seen that a strong affinity exists with the objectives of the Japanese 5th Generation initiative.

- Following the publication of the Alvey Report (September 1981), a government backed program was announced with an initial funding of about 450 million pounds. In summary, the objectives of the program were to bring a quite radical new perspective to advanced computing in the U.K.:

- To create a three way collaboration between the commercial sector, the academic and research sector, and the government to optimise IT development.

- To improve education, training, and awareness of new technologies.

- To promote higher standards of production and service.

- To provide 'pump-priming' finance for start-up enterprises, collaborative R&D projects, and demonstrator projects (much of this funding went directly to A.I. projects).

• The EEC entered the arena in 1982 via the ESPRIT program. In many ways its objectives are not dissimilar to those of the Alvey program, but ESPRIT demands that all funded projects should demonstrate the involvement of partners from more than one EEC country. Its philosophy is, of course, that singly no EEC country can offer the financial resources and technological base to challenge the U.S. and Japan but that collectively they can. Like the Alvey program, ESPRIT has identified A.I. as an essential technology and has funded it accordingly.

• The Alvey and ESPRIT programs have been running for several years and can generally be regarded as successful. As far as A.I. alone is concerned, they have:

  - Given it credibility with industry.

  - Focussed media attention on it.

  - Provided vital start-up finance.

- Contributed considerably to knowledge of A.I. and how to apply it successfully.

- Brought together academic research and industry.

4. A.I. - FALLACIES AND FACTS

- Fallacy: A.I. is accessible only to Ph.D level academics.

- Fact: There are areas of A.I. research (natural language models, for example) that require specialist theoretical knowledge. Similarly, there are areas such as image recognition which require high level engineering skills for their implementation. However, what A.I. is and how it can be applied are accessible to any intelligent person who takes the trouble to learn something about it.

- Fallacy: A.I. is useful in pure research but it has no relevance to commercial and industrial matters.

- Fact: A high proportion of A.I. research is sponsored by commercial concerns and is focused upon either developing marketable products or upon solving problems which cannot be addressed by standard computing techniques.

- Fallacy: A.I. attempts to create computerised versions of the human thought process.

- Fact: A.I. acknowledges that the human cognitive process is not fully understood and is unlikely to be so in the foreseeable future. Humans cope well with an imperfect and imprecise understanding of their environment and the ways in which they themselves function within it. A.I. focuses upon narrow areas of human capability and attempts only to simulate those aspects of behaviour which can be adequately described and which have proved to be effective. It does not set itself the futile objective of 'modelling the human mind'.

- Fallacy: A.I. concerns itself only with "toy" problems which can be solved under controlled and artificial circumstances.

- Fact: Many A.I. applications and development projects are concerned with high-risk situations in the real world. A.I systems currently assist humans in areas such as:

    - Fault diagnosis in complex and expensive plants.

    - Agricultural crop regulation and health.

    - Financial investment.

    - Long-term product development projects.

- Fallacy: A.I. is isolated from the established areas of computing.

- Fact: A.I. systems draw heavily upon many established problem solving techniques and computer-based facilities. For instance they may:

    - Utilise statistical analysis packages to provide evidence for conclusions.

    - Interface to data base systems in order to access hard data relevant to their task performance.

    - Interface to operations research and simulation models in order to solve planning and logistics problems.

    - Access and interpret the outputs from financial models and packages.

- Far from being isolated, the future of A.I. depends heavily upon the ability to integrate it with existing computer resources.

- Fallacy: A.I. is very expensive.

- Fact: A.I. technology is subject to exactly the same price constraints as any other computer-based product group. There are expensive, specialised products designed to cope with large and difficult problems, and there are low-cost, microcomputer-based products which are designed to deal with less complex applications.

- Fallacy: A.I. is too technically specialised to be accessible to ordinary programmers and users.

- Fact: One of the outstanding features of A.I. languages and development software is the high degree of assistance provided for programmers, designers, and end users.

B. A.I. - SCOPE AND APPLICATIONS

- A.I. encompasses several different fields but the common thread is, as suggested earlier, that they all attempt to reproduce some aspects of human reasoning capability.

- A common characteristic of all successful A.I. systems is that they are restricted to a narrow domain of activity. In other words, they are not set on the impossible objective of reproducing a wide range of human reasoning skills but are concentrated on highly specific targets. Thus, there are no medical systems which attempt to reproduce the knowledge of a general practitioner but there are systems which attempt to make generally available the knowledge of specialists in a highly specific field of medicine.

- Given that important characteristic, the keys to the success of A.I. systems can be deduced:

  - They do not have lapses of memory and overlook important factors in a problem.

  - They can collect a range of material relevant to their domain from a number of human experts and retain it all.

  - They do not die or retire taking their knowledge with them.

  - They do not get tired or bored with a problem.

  - They do not allow emotional factors to influence their judgment.

  - They do not panic in situations where their reaction to a situation is of vital importance.

  - They can react many orders of magnitude more quickly than a human to new or changing circumstances (particularly relevant to real time response systems such as guidance systems and plant diagnostic systems).

  - They are capable of interfacing quickly to data base systems which contain data relevant to their task performance.

- We now mention the areas comprising A.I. with a brief indication of their application.

- Although these are separated in the interests of giving an overall view of the field, in practice, an A.I. system may contain components drawn from several of these areas.

I. GAME PLAYING AND PROBLEM SOLVING

- This is one of the oldest areas of A.I. research and was originally applied to problems which represented a particular type of human skill.

- Many of the original problems were 'toy' ones--noughts and crosses, the towers of Hanoi, the truth teller puzzle, and so on. However, the elements of these types of problems can be applied to a wide range of serious activities because they require:

  - The development of an effective strategy often involving some form of heuristic.

  - A means of representing the problem to a computer system.

  - A criterion for evaluating the effectiveness of any solution(s) produced.

- This area of knowledge is fundamental to A.I., and the ideas associated with problem representation and solution strategy underpin what is frequently referred to as 'knowledge engineering' (the technology of transferring human skills to a computer system).

- The problem solving strategies of 'game playing' are used in the development of expert systems and some of them appear as paradigms in expert system generator 'shells' as pre-programmed solution techniques.

- The technology can be applied to large-scale planning applications and to some areas of operations research, computer modelling, and computer simulation.

2. MACHINE THEOREM PROVING

- At one level, this area of A.I. is the preserve of academic researchers in specialist areas, particularly some branches of mathematics and formal logic.

- It is concerned with the formal proof of theorems from a set of axioms and other theorems.

- Like much of A.I., theorem proving has a pure academic dimension which does not prevent its useful application to more immediate real world problems like:

  - Logic circuit design.

  - Machine learning (highly relevant to the performance of A.I. application systems).

  - Proving the validity of design and specification decisions in software engineering and complex product design.

- Currently, this technology has not achieved its potential at either the theoretical or the application level.

3. PATTERN RECOGNITION

- Pattern recognition is concerned with the recognition of, and reaction to, stimuli such as noise (speech included), visual images, and signal streams of various types.

- Problems in this area generally have an engineering component (how to present the stimulus to the system) as well as an A.I. component (what is the system to make of the stimulus?).

- Currently, this technology is the subject of very serious investment, most of it emanating from the defence and aerospace sectors.

- Although most applications are confined to the defence sector, the technology has enormous potential in the commercial sector.

- Reasons why it has not already impacted include:

    - The very high investment levels associated with the technology have effectively confined it to national governments and multinational corporations.

    - Because of the specific nature of development projects (more often than not covered by some aspect of national security legislation), almost no marketable products have emerged.

- However, the technology has so much to offer that those conditions and restrictions will inevitably change. Currently, R&D projects are under way to apply pattern recognition to:

    - Civil aviation and shipping.

    - Telecommunications.

    - Security systems.

    - Robotics and automated production technology.

    - Petrochemical and mineral exploration.

    - The automated office.

    - Advanced human/computer interfaces.

- Some would suggest that the whole field of pattern recognition is not really A.I. at all but is the application of advanced engineering techniques. This view is reasonable enough, but the area has been presented as part of A.I. because of the existence of a group of research and development projects that seek not only to have machine systems take in features of their environment (such as images, sound, and other signals) but also to react to those features in an intelligent manner.

4. NATURAL LANGUAGE RECOGNITION

- This is concerned with the extraction of meaning from language.

- Although the outer reaches of the field are highly complex and specialised, language models can still be usefully applied.

- Natural language recognition is a good illustration of both the potential and current limits of A.I. technology.

- On the one hand, the idea of machine systems that can extract meaning from, and react intelligently to, natural language (either spoken or written) opens the door to a range of valuable applications.

- On the other hand, language is such a complex medium that limitations are imposed on the range and sophistication of the language with which a machine system can be realistically expected to cope. The notion of a machine system with which one could carry on a dialogue exactly as if it were an intelligent human being (as specified by the Turing Test) is clearly not attainable in the foreseeable future.

- The focus, therefore, is upon language models which although incomplete and imperfect are nonetheless both useful and computable. Applications include:

- Natural language interfaces to data bases and information retrieval systems which represent a move forward from fourth generation languages but which still have restrictions upon the range of language which they permit.

- Some aspects of machine translation of text from one language to another.

- Machine scanning of large banks of text to search, extract, and summarise.

5. EXPERT AND KNOWLEDGE-BASED SYSTEMS

- These represent the best known area of A.I. and have enormous potential in all areas of commerce and industry.

- Expert systems attempt to represent the knowledge and reasoning processes of human experts.

- In order to do so, they draw upon the knowledge representation and solution techniques previously discussed.

- Once again, expert systems have necessary limitations, and the successful ones share the characteristic that the domain of knowledge to which they are applied is both narrow and well-defined (that is not to say, though, that it has to be complete and comprehensively defined).

- In the most general terms, expert systems are applied to tasks which are the prerogative of skilled humans:

    - Diagnostic tasks.

    - Consultative and advisory tasks.

- Support of low-skilled operatives.

- Decision support.

- Prescribing recommended actions.

- Education and training.

- Expert systems typically share the characteristic that they are capable of both retracing and 'explaining' the reasoning behind their conclusions. Thus, they should be capable of answering such questions as:

    - 'Why do you advise me to take that course of action?'

    - 'Why have you diagnosed that condition?'

    - 'Give reasons for your recommendation'.

- Expert systems can be applied to most areas of activity which require specialist knowledge and expertise, and it is impossible to list all the individual application areas--there are far too many. A list of examples of known current applications would include:

    - Geological analysis.

    - Numerous specialist areas of medicine.

    - Commodity broking.

    - Computer-aided learning in mathematics.

    - Fire risk assessment.

- Lubricant mixing.

- Vehicle fault diagnosis.

- Operations support for insurance broking staff.

- Production line maintenance (automotive parts industry).

- Oil rig maintenance and fault diagnosis.

- Spectrograph analysis.

- Diagnosis of crop diseases.

• INPUT believes that the potential for expert systems is almost limitless and that they will ultimately embrace a range of tasks from the comparatively mundane, advising on the correct way to fill in a claim form perhaps, to the complex and specialised, for example, assisting a financial consultant to assess investment values.

• The scope and applications of A.I. systems are illustrated in Exhibit III-3.

• Over the next decade we expect expert systems to become as commonplace as data processing systems now are.

6. GENERAL CHARACTERISTICS OF A.I. SYSTEMS

• Although A.I. systems can span a wide range of applications, it is possible to identify some common characteristics that are associated with them. That is not to say that every A.I. system has all of these, but every A.I. system will have some of them.

EXHIBIT III-3

A.I. - SCOPE AND APPLICATIONS

Game Playing/ Problem Solving	Knowledge Engineering
	Planning
	Operations Research
Machine Theorem Proving	Circuit Design
	Machine Learning
	Design and Specification
Pattern Recognition	Weapon Systems, Aerospace, Exploration
	Telecomms, Security, Robotics
	MMI, Office Technology
Natural Language Recognition	5th Generation Enquiry Languages
	Machine Translation
	Text Scanning
Expert and Knowledge-Based Systems	Diagnostic Systems
	Consultative/Advisory/Support Systems
	Training and Educational Systems

- The characteristics of A.I. systems are illustrated in Exhibit III-4.

- The scope of the report does not permit a rigorous technical analysis of these, and interested readers are referred to specialist texts on the subject.

- It should be noted in connection with this that the production of systems incorporating these characteristics is made considerably easier by the availability of appropriate software tools.

- A.I. systems do not simply access data values, they also manipulate symbols which represent:

  - Real world objects.

  - Relationships between objects.

  - Characteristics of objects.

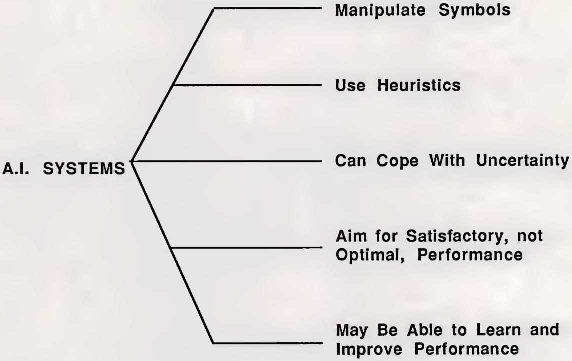
- The use of symbols offers a much richer design and programming environment and also allows problems to be represented in a medium which is much closer to the way that humans themselves see the world. The two languages most closely associated with A.I., LISP and PROLOG, as well as specialist A.I. tools and generators offer this symbolic capability.

- A.I. systems do not rely on decision paths which are exclusively controlled by algorithms; they also employ heuristics. This allows A.I. systems to consider problems which, because of the magnitude of the search space, are not computable if an exhaustive formal method is used.

- A.I. systems can cope with imprecision, incompleteness, and uncertainty. Thus, they can be usefully applied to problem areas which cannot be fully and formally specified. Coping with uncertainty is a key issue in A.I., essentially, there are two groups of techniques:

EXHIBIT III-4

CHARACTERISTICS OF A.I. SYSTEMS



- Mathematical representations such as 'fuzzy logic'.

- Heuristic certainty factors defined by human experts, such as those used in MYCIN, where degrees of certainty are represented by integer values or other symbols.

- Because of the nature of the problems with which they cope, A.I. systems are generally concerned with producing satisfactory rather than optimal performance. Once again, this reflects the way in which most human tasks are carried out; indeed, in the case of many human activities there is no formal measure of optimal performance.

- Most A.I. systems incorporate a production subsystem. This is a set of rules which regulate the behaviour of objects in the system and which can incorporate heuristics and certainty factors.

- A feature that some claim to be a defining characteristic of an A.I. systems is the ability of that system to 'learn' and expand its own capabilities. Certainly, some A.I. systems do incorporate a learning subsystem, but INPUT believes that at the current state of the art this is too severe a condition to be definitive.

7. WHO IS USING THE TECHNOLOGY?

- The scope of what we have identified as A.I. is wide and its applications range from relatively simple diagnostic and operations support systems to complex engineering products such as guidance systems and speech processing systems.

- The common thread that joins all these is that in some way the A.I. system emulates a human reasoning process whether it is to make an 'intelligent' reaction to a set of environmental stimuli as in the case of a guidance system or to make a reasoned deduction from a set of premises or evidence as in the case of a diagnostic system.

- Exhibit III-5 gives the current break down of A.I. users based on analysis of the claimed customer bases of a cross-section of vendors.

- The next chapter reviews hardware and software products associated with A.I.

EXHIBIT III-5

MAJOR USER GROUPS

SECTOR	ESTIMATED CONTRIBUTION
Military and Aerospace	35-45%
Manufacturing Majors	15-20%
Petrochemical Majors	10-15%
Financial Services Sector	5-10%
Academic and Research	5-10%
Software Houses	5-10%
Mainstream Industries	<5%
Service Industry Sector	<5%

IV A.I. SOFTWARE AND HARDWARE PRODUCTS

IV A.I. SOFTWARE AND HARDWARE PRODUCTS

- In this chapter, the software and hardware products associated with A.I. are described.

- An overview of A.I. software product groups is given in Exhibit IV-1.

- The scope of the report does not permit a detailed technical analysis and the interested reader is referred to specialist publications and technical manuals accompanying specific products.

A. THE LANGUAGES OF A.I.

- Although A.I. applications can be, and are, developed in other languages, LISP (LISt Processing) and PROLOG (PROgramming in LOGic) are the languages most closely associated with A.I.

- LISP has been in use for more than 25 years now and is often known as 'the assembler language of artificial intelligence'. One good reason for referring to it as such is that, as well as being an excellent and powerful programming language in its own right, LISP has been used as the host language for higher level software tools--KEE from Intellicorp and LOOPS from Xerox PARC being two among many examples.

EXHIBIT IV-1

OVERVIEW OF A.I. SOFTWARE PRODUCT GROUPS

- Language Implementations (LISP, PROLOG)
- Expert System Generators
- Integrated Programming Environments
- Run-Time Support Environments
- Packaged Applications
- Natural Language Systems

- LISP is essentially a simple and 'open' language, consisting of a limited number of 'core' functions and an execution loop. However, on that foundation , most of the high-quality LISP 'dialects' have built a range of system functions to carry out processes ranging from specialist computation through to graphics management.

- Although it supports standard procedural operations, (for example, 'If...' 'Then...' and 'Do... command sequences), the suitability of LISP for A.I. development work lies in its ability to manipulate a range of symbolic structures as well as normal data types. The fundamental symbolic structure is the list which can be used to represent a wide variety of real world objects and relationships.

- Complex LISP programs are built in the form of a hierarchy of functions, and the nature of the language permits one function to serve as an argument to another. Thus, for example, one might build a program as follows:

    - Define a top level function which is called to run the program.

    - Define a function (called by the first) to select an appropriate rule set.

    - Define a mathematical or statistical function (called, say, by the second function) to carry out some specialist operation.

    - Define a graphics function (called by the first function) to output results to the user.

- LISP systems fall into one of two main categories:

    - Where the language forms the base for an 'engine' type system such as the Symbolics, Xerox 1185, TI Explorer, or the LMI lambda. With these systems the LISP primitives are micro-coded and, typically, any higher level development tools are built from the LISP language also. LISP

execution times are, as one might expect, fast. Systems of this kind do not have conventional operating systems, and the range of functions normally associated with the operating system are also provided by the LISP environment.

- Where a LISP implementation is run on a host system just like any other language with no special facilities for it. In this type of system LISP is just another programming language (still a very good one though) and its performance and environmental features will not equal that of a specialised LISP engine system.

- Whichever type of LISP implementation is used, it is sure to be characterised by a range of 'programmer friendly' features including on-line 'help' facilities, comprehensive trace and debugging tools, incremental interpretation/compilation (i.e., one part of a program can be compiled and tested without the rest), and a completely interactive development environment.

- A most important development in terms of LISP, and one that any potential user of the language should note, has been the recent initiative to standardise the language syntax and facilities under the banner of 'Common LISP'.

- Common LISP was originally defined in the book of the same name written by Dr. Guy Steele, but the concept has been embraced by all of the major LISP product suppliers and, perhaps more importantly still, by DARPA (Defense and Advanced Research Projects Agency) in the U.S. and by the Alvey and ESPRIT programs in Europe.

- One objective of Common LISP is to provide portability for software tools and applications systems written in LISP.

- The main rival to LISP in the affections of the A.I. community is the PROLOG language, originally developed at the University of Marseilles by a team headed by Dr. Alain Colmerauer. Subsequently, PROLOG was adopted at

Edinburgh University where a high level of expertise in Logic Programming was built up through the 1970s.

- Like LISP, PROLOG is an apparently simple language that, used correctly, represents a very powerful programming tool. It is based on a subset of formal logic and has an elementary 'inference engine' as part of the language implementation.

- The representation of knowledge and data in a Prolog program is very different from how it is handled in a standard language. For a start, there is no formal separation of data and procedures, as far as Prolog is concerned the program and its knowledge base are one and the same thing and the distinction between data and procedure is purely at design level--the program simply consists of a series of (hopefully true) statements.

- The association with formal logic has presented PROLOG with a simple representation medium, predicate calculus, with which it is easy to program statements in a way not very far removed from language. For instance, the statement, 'the operating system for VAX hardware is VMS' can be 'translated' into predicate calculus representation (and thereby into a usable PROLOG statement) as operating system (VAX-VMS).

- This characteristic justifies the assertion that of all the widely used computer languages, PROLOG has the most highly developed 'declarative' capability, that is that program statements are notably close to the way in which humans would verbally 'declare' the same statement.

- PROLOG also has an inference mechanism; that is, that the truth of new statements can be 'inferred' from the presence of other statements in the program. This feature makes much of the process of procedural programming redundant in PROLOG--a logical specification of a problem is the program.

- Like LISP, any reputable implementation of PROLOG is sure to be 'programmer friendly'; it will offer completely interactive development, on-line tracing and debugging, error recovery procedures, and interactive interpretation/compilation. Most of the better versions of the language will include simple provision for the interfacing of programs written in other languages to a PROLOG program.

- Also in common with LISP, PROLOG programs can manipulate a range of symbolic structures including lists.

- PROLOG is particularly well suited for rapid prototyping, data modelling, and the formulation of sets of rules which use inference to reach conclusions. It is also an excellent language for the writing of natural language systems and some types of expert systems - notably those that use a backward chaining solution strategy.

- The 'state of the art' as regards PROLOG is not as advanced as in the case of LISP. There are currently no PROLOG engine systems although it is well known that Japan has the production of such systems as one of its 5th Generation program priorities (in Japan, PROLOG has been assigned the role of A.I. assembler language). One reason why such a concept is appealing is that the characteristics of PROLOG are likely to make it a particularly suitable language for parallel processing environments.

- At the time of writing there are numerous versions of PROLOG available for a range of machines and operating systems ranging from PCs to mainframes. One word of caution in respect to these is that there are syntactic variations, in some cases of major proportions. All the signs indicate that any future standardisation of the language along the lines of Common LISP is likely to be based upon the Edinburgh University syntax, as defined in the standard text by Clocksin and Mellish.

- Devotees of the Smalltalk language would certainly resent the suggestion that LISP and PROLOG are the main A.I. languages. Smalltalk was originally developed at Xerox PARC and is a high level object-oriented programming language.

- Smalltalk is steadily becoming more popular in Europe, and implementations of it are available for a range of host machines and operating systems.

- POP11 is another language which is suitable for A.I. programming. It was developed at Sussex University and forms the basis of the well known POPLOG programming environment where it is integrated with PROLOG and Common LISP.

B. EXPERT SYSTEM GENERATORS

- This category represents a large, and growing, group of products. The objectives of these software systems, often referred to as 'shells', are to preprogram many of the functions that expert system developers will need.

- Good calibre generators, then, can be expected to offer their users predefined ways in which to:

  - Represent knowledge about an application area.

  - Formulate production rules.

  - Generate a solution strategy.

- In order to achieve this degree of standardisation and preprogrammed functions, generators of necessity lose the openness and freedom of choice that a pure language gives. Against that, of course, they save substantial amounts of development and testing time.

- There is no doubt that, assuming predictions for the use of expert systems are realistic, the future for good class system generators is very promising indeed. In general terms, the attributes that should be looked for in a generator are:

  - Versatile knowledge representation.

  - A choice of search and solution methods.

  - The ability to cope with imprecision and uncertainty.

  - Preprogrammed interfaces to the host operating system.

  - Preprogrammed interfaces to other types of software such as graphics, mathematical functions, and data bases.

  - Support for porting applications to end-user delivery systems (notably PC systems).

C. INTEGRATED PROGRAMMING ENVIRONMENTS

- These are neither languages nor generators although they are frequently erroneously categorised as the latter.

- Unlike expert system generators, software of this type, well known examples being products such as KEE, ART, and KNOWLEDGECRAFT, neither commits the user to any particular design strategy nor is its use strictly confined to A.I.

- These types of systems--more often than not based upon LISP--consist of a collection of integrated software tools and programming paradigms underpinned by a general problem solving strategy.

- Typically, products of this kind are both sophisticated and expensive.

- Typically again, they require a powerful hardware system to run effectively because the high level of programming and design support that they offer is expensive in terms of CPU requirements.

- Because the fundamental problem solving strategy differs between, say, KEE and ART, these software environments can be difficult to describe succinctly. However, all the tools in the class certainly exhibit these characteristics:

    - They offer a very high degree of programmer support and feedback; facilities such as error tracing and recovery are exemplary.

    - They provide excellent user interfaces, notably via the use of graphics.

    - They provide a high level syntax for program statements.

- Products of this kind are targetted at users who wish to tackle complex applications which are not susceptible to standard programming techniques.

- A serious issue in relation to this class of software tools is that of applications portability. It may be economically feasible to develop a complex application using an expensive tool running on a powerful processor. However, where substantial numbers of end users are involved the cost-effectiveness may diminish sharply if the same environment is required to run finished applications. Run time support systems to allow applications to be run on smaller machines are therefore important.

D. RUN-TIME SUPPORT ENVIRONMENTS

- One of the software licensing issues that has faced the A.I. industry over the last few years has been the legitimate concern of users and potential users to ensure that once they have decided to enter the A.I. arena, they can distribute the benefits of doing so through their organisations in a cost-effective manner.

- Because of the complexity it usually contains, A.I. development software is typically costly. Clearly, it is unlikely to be an economically viable proposition to place a powerful hardware system and an expensive software development tool on the desk of every end user of, say, a commercial expert system.

- This problem has been addressed by many suppliers by the provision of run-time support software. Applications can therefore be developed on one system which is licensed for a full development product, but they can then be run on other systems which are licensed only for run-time support software.

- Relevant issues are:

  - The proportional cost of run-time software to development software; INPUT suggests that this ratio is likely to stabilise around 1 in 10 with high-volume licensing discounted.

  - Run-time support software should not necessarily be confined to host machines which also support the full development software.

E. PACKAGED APPLICATION SYSTEMS

- At the time of writing, there are very few packaged A.I. applications. One of the best known is an American product which bundles hardware and an expert system in an integrated package targetted at the financial services market.

- A leading accountancy/management consultancy firm told INPUT that an expert resource management system is available to U.S. customers via its New York office. The service is sold on the same basis as the company's range of financial modelling software, i.e., on a subscriber dial-up arrangement. The service is shortly to be offered to U.K. customers.

- INPUT believes that the pattern of development of A.I. application packages will follow a similar pattern to that of package development in other areas of computing but that, due partly to the likely demand and partly to the current level of expertise in package development, the process will be considerably accelerated.

- INPUT suggests that the whole area of packaged applications represents a most attractive range of opportunities in the immediate future given, and it is an important proviso, that applications are chosen that are well understood, closely bounded in terms of their scope, and common to a large proportion of companies in a given vertical market area. Many of the packages that are produced and marketed over the next few years will be quite modest in scope--for example, interpretation of a category of legislation--and will be targetted at the PC end-user market.

- We confidently predict that in two years a range of packaged applications will be available in the standard forms:

  - Integrated systems incorporating hardware and applications software.

- Software packages that can run on a variety of host machines, particularly PCs.

- Subscriber dial-up services.

• Some areas of A.I. are not likely to be susceptible to packaging in the immediate future, but INPUT predicts that the widespread packaging of simple expert system applications is only a matter of time, sooner rather than much later.

F. NATURAL LANGUAGE SYSTEMS

• Potentially, natural language systems have much to offer in terms of improving the means of communication between man and machine.

• They also have great potential in automating the slow and labour-intensive group of tasks concerned with the storing of large banks of text and the operations performed on that text, i.e., indexing, summarising, extracting, condensing, and so on.

• A third role that is claimed for systems in this general category is within the now enormous industry concerned with translation of written material into a variety of languages. The EEC is currently sponsoring an experimental project in the area of machine translation.

• Natural language processing does, however, have limitations placed upon it at present, principally the inescapable facts that language is highly complex and idiosyncratic, that concepts expressed in one language typically do not map to identical verbal constructs in other languages, and that, sophisticated and as advanced as modern linguistic science is, it cannot provide theoretically complete and computable models of language.

- However, by setting the standard that a machine system should understand everything communicated to it, one falls into the same trap as if one expects A.I. to provide a complete model of the human thought process--neither one is remotely practicable.

- As in other areas of A.I., the key to approaching natural language is to concentrate on the attainable, not the impossible, and to settle for systems which, although limited in human terms, are operational within a narrow domain and are based on a language model which although incomplete is still effective.

- If such a perspective is adopted, then it is possible to identify some obvious application areas which are, in fact, currently in use, particularly in the U.S.:

    - Fifth generation data base enquiry languages.

    - Natural language interfaces to expert systems.

- A data base enquiry application fulfills the requirements for effective natural language processing very well. Firstly, a data base has natural limits on the scope and type of words and operations that are relevant to it. Secondly, the system is likely to operate in an environment where highly idiosyncratic or ambiguous word sequences are uncommon.

- An expert system has similar characteristics so far as natural language is concerned in that it is (if operable) certain to be domain specific and therefore limit the size of the vocabulary relevant to it, and that only a limited number of verbal constructs will relate to its activities.

- In the U.S., natural language processing has already made its mark on the A.I. industry, the best known product being the famous 'Intellect' system from the Artificial Intelligence Corporation, a product supported by no less an organisation than IBM.

- The applications group concerned with processing text banks is also a field with great possibilities. INPUT can vouch for the fact that at least one major U.K.-based information agency is currently running a pilot project to investigate the potential of this type of application, although the organisation has asked not to be named in our report.

- In the U.S., Cognitive Systems Incorporated has developed a system for the Coast Guard that processes unformatted telexes, extracts the relevant information, and updates a shipping information data base.

- On the translation front much research remains to be done. Certainly any serious successes in this area have obvious cost and time-saving benefits. INPUT believes that some serious progress is now being made in the particular area of translating technical material.

- In summary, our evaluation of natural language systems is positive; market research shows conclusively that users are very favourably inclined to this technology and their perceptions of what it can do for them. Progress on three fronts should be:

    - Availability of natural enquiry languages for data base and information processing products, including expert system generators.

    - Some specialist 'one-off' systems developed for users with large text banks.

    - Continuing research in translation.

G. HARDWARE

- There is no 'A.I. hardware' as such. Like any other area of computing, A.I. is defined by its application area and characteristics not by the language in which it is written or the host system on which it runs.

- The emergence of A.I. has, however, coincided with that of workstations, and the majority of workstation suppliers have aggressively promoted their products to the A.I. community.

- Workstations place the power of a conventional minicomputer system in the hands of a single user. Partly for that reason, they are particularly suitable for A.I. development work because the facilities that A.I. development systems offer their users tend to be expensive in terms of hardware resources.

- In addition to their power, workstations also typically offer a rich programming environment with windowing, core graphics, and programming trace and recovery features. These features are highly attractive to developers of complex software, A.I. included.

- Whether workstations also represent a cost-effective medium for the delivery of end-user systems is a different issue. As INPUT sees it, there are several factors to consider:

    - The complexity of the application.

    - The importance of the application.

    - The number of end users.

- Added to that there is also the consideration that in terms of price, performance, and facilities, workstations and personal computers are steadily

converging. A price range that was until recently occupied exclusively by PCs is now beginning to admit products from workstation suppliers. Conversely, the new generation of PCs is adopting design features that were until recently regarded as being exclusive to workstations; for example, windowing, core graphics, large RAM, networking standards, and high volume fixed disks.

- One exception to the debate is the group of products that were described in Section A of this chapter as 'LISP engines'. These occupy a particular niche in the market and have certainly dominated the A.I. market in the U.S. At present, and probably always, LISP-based development projects are far better suited to these hardware environments than to any others. No general purpose system running LISP as a language can match their performance and programming facilities.

- A.I. software is available for several different types of host systems:

  - General purpose workstations such as the SUN and Apollo systems.

  - LISP workstations such as the Symbolics 3600, Xerox 1180 range, and Texas Instruments Explorer.

  - PCs - typically IBM compatibles.

  - Advanced minicomputer systems such as the Digital VAX range.

- Key hardware issues at the moment include:

  - Open systems, i.e., does the hardware recognise standard communication protocols?

  - Applications portability, i.e., can applications developed on a workstation be ported to PCs and/or minicomputer systems?

  - Operating systems, i.e., does the future lie with UNIX?

V USER PERSPECTIVES

V USER PERSPECTIVES

A. NEGATIVE ATTITUDES TOWARDS A.I.

- Exhibit V-1 summarises the responses of surveyed users in terms of their response to the basic question, 'Does your organisation use or have an interest in using A.I.?' The main categories of reasons given for negative replies are summarised.

- The contribution from French users distorts the overall picture somewhat--only 4 of 45 French users displayed any serious interest in A.I. In the U.K. and Germany, more than half the users sampled had a positive attitude to A.I.

- Another feature of the French sample is that a quarter of the negative respondents had no coherent reason for their attitude, offering what seems to INPUT to be, coming from professional managers, the rather lame statement, 'We are just not interested'. No U.K. or German respondent offered complete disinterest as a reason; all put forward reasonable justifications for their attitudes.

- Overall, the commonest reason for rejecting A.I. at this stage is the perceived lack of applications for it. In connection with that, it is interesting to note that a high proportion of respondents (over a third) gave the secondary reason that they did not know enough about the technology; that statistic does not appear in Exhibit V-1 where only primary reasons are shown.

EXHIBIT V-1

NEGATIVE RESPONSES TO A.I.

ATTITUDE	PERCENT OF RESPONDENTS*			
	FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
Not Using/Considering AI	90%	40%	50%	60%
REASONS FOR NEGATIVE ATTITUDE				
There Are No Suitable Applications	30%	50%	45%	40%
We Do Not Know Enough About It	15%	35%	30%	25%
DP Systems Are a Greater Priority	10%	15%	10%	10%
The Technology Is Immature	20%	0%	5%	10%
A.I. Is Technically too Difficult	5%	0%	10%	5%
We Are Just Not Interested	25%	0%	0%	10%

* Rounded to the Nearest 5%

- Insufficient understanding is the next most common reason for negative attitudes, and INPUT suggests that a strong connection exists between that and the perceived absence of useful applications for A.I. Computer industry history supports the view that as soon as managers and technical professionals acquire a comfortable understanding of a new technology, they begin to see ways in which to use it. (Cynics might argue that once a solution is understood people go in search of a problem for it.)

- A proportion of respondents gave the very reasonable response that other types of systems are a greater organisational priority--a point that is difficult to refute. Certainly the A.I. community frequently overlooks the fact that many organisations are still in the process of learning to use computer systems effectively for any group of applications. INPUT is slightly surprised that more respondents did not cite this reason because in informal exchanges with computer users, one frequently hears remarks like, 'We can't even get our stock control system working properly and these people are trying to sell us artificial intelligence'.

- The final pair of reasons concern the technology itself are that either it is not yet ready for serious use or it is too difficult to use. Both these problems can be addressed by providing a better understanding of A.I.

- In summary, the reasons given for the attitudes of 80% of negative respondents can be addressed by providing a better understanding of the technology and its applications.

- The latter point is further supported by the responses to a question concerning management awareness of A.I. overall:

    - Only about 5% of respondents described management awareness as 'good' or better.

- Only 15% described it as even 'limited'.

- Some 30% described it as 'low'.

- Half the respondents described it as 'nil' or nonexistent.

- Despite the high proportion of negative responses to A.I. at the moment, the survey of future attitudes to it are rather more positive. A summary appears in Exhibit V-2, and it can be seen that 40% of the negative respondents expected to further their interest during the next few years, about a quarter regarded A.I. as a long-term interest, and the remainder saw no prospect for it within their organisations.

- A very clear message emerges for vendors and would-be vendors of A.I. products and services:

  - Promotion of awareness of what A.I. is and what it can do must be a major component of marketing and sales initiatives.

  - A.I. has to be connected with applications to which the management of commercial organisations can relate and for which they see a cost benefit or competitive advantage--abstract treatments of A.I. are likely to be ineffectual. If this appears to be stating the obvious, we apologise but justify it on the grounds that it is better to state the obvious than to omit the important.

B. POSITIVE ATTITUDES TOWARDS A.I.

- In this section we survey the information provided by those users who demonstrated a positive attitude towards A.I. To recap, these comprise:

EXHIBIT V-2

FUTURE PLANS OF NEGATIVE RESPONDENTS

PLANS	PERCENT OF RESPONDENTS*			
	FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
Further Interest in Less than 2 Years	10%	15%	0%	10%
Further Interest in 2-4 Years	20%	5%	10%	15%
We Will Keep A.I. Under Review	5%	20%	20%	15%
No Action Inside 5 Years	35%	5%	30%	25%
No Action Ever	10%	5%	5%	10%
Do Not Know	20%	50%	35%	25%

* Rounded to the Nearest 5%

- Approximately 60% of those surveyed in the U.K.

- Approximately 50% of those surveyed in Germany.

- Only 10% of those surveyed in France.

- Exhibit V-3 summarises the stage of involvement that users have so far reached with A.I. The fact that so many are at only a preliminary stage but are nonetheless displaying a degree of commitment to A.I augurs well for the immediate business potential of products and services.

- That point is further supported by the evidence supplied by Exhibit V-4. Leaving aside those organisations already using some form of A.I. system--all of which, incidentally, confidently predicted further system developments--the majority of those at preliminary or development stages expected to be significantly further advanced in terms of using A.I. within two years.

- As one might expect, the proportion of those that expected to be no further along in two years was very low. It would be legitimate to ask why they initiated an interest in A.I. in the first place if no progress was expected in two years.

- Of the remainder, the picture is generally positive, and in this context a 'don't know' reply need not necessarily be construed as negative. As the survey indicated, even users with a generally positive attitude towards A.I. still acknowledge that the general level of awareness remains weak. In some cases a neutral 'don't know' response is a recognition that the technology is not well understood and confident predictions cannot be made.

- In terms of management awareness, the positive group of users fairly predictably demonstrated a somewhat higher level than their negative respondent counterparts, but it is still low to barely adequate on average.

EXHIBIT V-3

CURRENT STAGE OF A.I. DEVELOPMENT

DEVELOPMENT STAGE	PERCENT OF RESPONDENTS*			
	FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
Preliminary or Evaluation Stage	75%	90%	70%	80%
Development Phase	25%	10%	10%	10%
Systems in Place	0	0%	20%	10%

* Rounded to the Nearest 5%

EXHIBIT V-4

STAGE OF A.I. DEVELOPMENT IN TWO YEARS

DEVELOPMENT STAGE	PERCENT OF RESPONDENTS*			
	FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
A.I. Systems in Place	30%	55%	35%	45%
Significant Further Development	70%	30%	40%	40%
No Further Progress	0%	0%	10%	5%
Do Not Know/Cannot Predict Accurately	0%	15%	15%	10%

* Rounded to the Nearest 5%

- Overall, 60% described management awareness of A.I. as 'low' or 'limited'.

- Overall, 20% described it as 'good' or 'adequate'.

- Overall, 20% described it as 'high' or 'acute'.

- Predictably enough, those users with A.I. systems in place or under development correlated well with 'good' or 'high' awareness ratings.

C. PRODUCT ANALYSIS

- Of those users who demonstrated a positive attitude towards A.I., data on products acquired or planned for acquisition is summarised in Exhibit V-5.

- It can be seen that of the products currently in place, the majority are expert system generators.

- The product analysis is consistent with the picture presented in the last section wherein the majority of interested users are still at the preliminary or evaluation stage.

- The proportion of users planning to buy A.I. products but still uncommitted to a particular product type suggests a substantial market potential for software products but emphasises once more the prevalent feeling among users that they are not yet sure enough of their ground to move more positively. The latter point introduces the potential for support and consultancy services which are discussed later in the report and which INPUT identifies as a significant area of opportunity.

EXHIBIT V-5

ACQUISITION OF A.I. PRODUCTS

PRODUCT CATEGORY	PERCENT OF RESPONDENTS							
	FRANCE		UNITED KINGDOM		GERMANY		TOTAL	
	Have Product	Intend to Acquire	Have Product	Intend to Acquire	Have Product	Intend to Acquire	Have Product	Intend to Acquire
Expert System Generator	50%	0%	35%	5%	5%	5%	20%	5%
PROLOG	0%	25%	5%	0%	5%	0%	5%	<5
LISP	0%	0%	0%	0%	0%	0%	0%	0%
Programming Environment (KEE)	0%	0%	0%	0%	0%	5%	0%	<5
Turnkey System	0%	0%	0%	0%	5%	5%	<5	<5
Intend to Buy - No Product Yet Decided	N/A	100%	N/A	45%	N/A	60%	N/A	55%

D. OTHER PRODUCTS AND SERVICES

- In addition to the standard groups of A.I. software products described in Chapter III (i.e., expert system generators, programming languages, etc.), a survey was made of the relevance of other products and services. The information produced is summarised in Exhibit V-6.

- All of the product/service areas highlighted are at an elementary level in terms of current availability but in the case of each one, user attitudes are substantially positive.

- Assessment of the information concerning these products and services must be made with the premise that the A.I. market is very much in its formative period. As we have seen, the level of interest in A.I. among users is healthy but the level of understanding is relatively low. Similarly, on the supplier side a number of companies are beginning to prepare the ground for the provision of new products and services but as yet have only an embryo market to sell into.

- In the case of the four product/service areas here, the following remarks are relevant:

    - System development services are currently inhibited by two factors: first, is the shortage of appropriately skilled staff; second, is the problem of selling a development service to a user community who is still largely at the preliminary evaluation stage.

    - Consultancy is a somewhat different issue because it has both 'educational' and strategic functions, and INPUT expects it to have a key role to play in the formative period of the A.I. market (and after). Once again there is a shortage of staff at the appropriate level.

EXHIBIT V-6

USER ATTITUDES TOWARDS OTHER PRODUCTS AND SERVICES

PLANS	PERCENT OF RESPONDENTS*			
	FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
SYSTEMS DEVELOPMENT SERVICES ARE:				
Essential	25%	20%	15%	20%
Important	25%	15%	45%	30%
Useful	0%	45%	15%	25%
No Interest	25%	<5%	25%	15%
Do Not Know	25%	20%	0%	10%
CONSULTANCY IS:				
Essential	50%	10%	10%	10%
Important	0%	15%	45%	30%
Useful	0%	40%	15%	25%
No Interest	50%	25%	20%	25%
Do Not Know	0%	10%	10%	10%
END USER APP'N PACKAGES ARE:				
Essential	50%	10%	45%	30%
Important	25%	20%	30%	25%
Useful	0%	60%	10%	30%
No Interest	25%	0%	<5%	5%
Do Not Know	0%	10%	10%	10%
NATURAL LANGUAGE SYSTEMS ARE:				
Essential	25%	10%	35%	25%
Important	25%	35%	35%	35%
Useful	0%	10%	15%	10%
No Interest	50%	20%	15%	20%
Do Not Know	0%	25%	0%	10%

* Rounded to the Nearest 5%

- Packaged applications were discussed in the previous chapter. Almost by definition, packaging is only possible when, first, an application area is thoroughly understood and, second, when a steady demand from a particular user group is identified.

- INPUT suggests that at the present time few applications fully meet the first condition and almost no user groups meet the second. That is not to say that packaged software has no future. We are confident that it has a very large market but believe that the real action will commence in two years or so.

  - Natural language systems are difficult to place in their correct context vis-a-vis market opportunities. On the one hand it is easy to see why the majority of users find the idea of natural language communication with systems attractive, but on the other one wonders whether users, and suppliers, too, for that matter, appreciate the theoretical problems that arise. In addition to that, little hard evidence exists about the real ergonomic advantages of natural language interfaces. INPUT tentatively predicts that natural language products, some of which exist already, will form a part of the A.I. product range in two guises, first as high level enquiry (and possibly task specification) languages connected to data base and information retrieval software, and second as specialist applications targeted at users who have large banks of stored text.

- None of the previous comments are intended to be negative; quite the reverse, INPUT believes that all the areas highlighted (with the possible exception of natural language) are certain to develop into major profit makers over the next five years. We see the role of natural language systems somewhat differently, that is not as a product group in their own right but as an attractive addition to other product types such as data bases, expert system shells, and probably packaged expert systems.

E. USERS' PERCEPTIONS OF A.I. APPLICATIONS

- Exhibit V-7 summarises users' evaluation of A.I. tools and techniques as an extension of the role of computing in general terms, i.e., using A.I. to develop new programming techniques and using A.I. systems to optimise the use of existing computer systems by adding 'user friendly' front ends, explanatory subsystems, and tutorial subsystems.

- Exhibit V-8 summarises users' evaluations of five general categories of A.I. applications. All of these are functional areas relevant to the operations of any commercial concern. These fall mainly in the area of A.I. that has been characterised as expert systems.

- In addition to those applications, three other groups of applications were surveyed--manufacturing operations, equipment maintenance, and specialist technical. Because these are not relevant to the whole of the user sample, no table is provided but, in summary, the evaluation of interested users was favourable to those application areas.

- It is important to note that the applications were put to users by the market research team; in other words, they were not applications suggested by users themselves and to interpret them as such gives a misleading impression of the level of awareness among users.

- The survey in this category simply confirms that the most often cited examples of the application of A.I.--extending the range of programming and system design; various types of expert systems in support, diagnostic, and educational contexts; and supporting technical and manufacturing functions--really do appeal to users once they are presented to them.

- Exhibit V-9 shows the league table of user priorities in terms of how they view the organistional impact of A.I.

EXHIBIT V-7

EVALUATION OF A.I. AS AN EXTENSION OF DP

PLANS	PERCENT OF RESPONDENTS*			
	FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
EXTENSION OF PROGRAMMING				
High Interest	25%	35%	50%	40%
Some Interest	25%	50%	25%	40%
Low Interest	25%	15%	20%	15%
Do Not Know	25%	0%	5%	5%
EXTENSION TO DP SYSTEMS				
High Interest	50%	65%	60%	60%
Some Interest	25%	25%	20%	20%
Low Interest	0%	10%	10%	10%
Do Not Know	25%	0%	10%	10%

* Rounded to the Nearest 5%

EXHIBIT V-8

EXPERT SYSTEM APPLICATIONS

APPLICATION AREA	PERCENT OF RESPONDENTS*			
	FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
EDUCATION AND TRAINING:				
High Interest	25%	50%	40%	40%
Some Interest	0%	30%	40%	35%
Low Interest	50%	20%	15%	20%
Do Not Know	25%	0%	5%	5%
OPERATIONAL SUPPORT FOR LOW-LEVEL EMPLOYEES:				
High Interest	50%	35%	30%	35%
Some Interest	25%	30%	30%	30%
Low Interest	0%	15%	35%	25%
Do Not Know	25%	20%	5%	10%
INTELLIGENT OFFICE:				
High Interest	50%	35%	60%	50%
Some Interest	25%	25%	20%	20%
Low Interest	0%	40%	20%	25%
Do Not Know	25%	0%	0%	5%
SALES AND MARKETING SUPPORT:				
High Interest	25%	35%	40%	35%
Some Interest	0%	25%	40%	30%
Low Interest	0%	40%	15%	25%
Do Not Know	75%	0%	5%	10%
FINANCIAL APPLICATIONS:				
High Interest	50%	45%	25%	35%
Some Interest	25%	30%	25%	30%
Low Interest	0%	25%	45%	30%
Do Not Know	25%	0%	5%	5%

* Rounded to the Nearest 5%

EXHIBIT V-9

RANKING OF ORGANISATIONAL PRIORITIES

RANK	PLANS	PERCENT OF RESPONDENTS*			
		FRANCE	UNITED KINGDOM	WEST GERMANY	TOTAL
1	Improved DP Function	25%	35%	25%	30%
2	Disseminate Expertise	25%	25%	25%	25%
3	Management Support	25%	20%	20%	20%
4	Cost Reductions	0%	15%	20%	15%
5	Employee Productivity	25%	5%	5%	10%
6	Solve New Problems	0%	0%	5%	<5%

* Rounded to the Nearest 5%

VI VENDOR APPROACHES TO A.I.

VI VENDOR APPROACHES TO A.I.

A. DEGREE OF COMMITMENT

- As might be expected, the level of awareness of A.I. is a great deal higher among vendors than among users.

- Exhibit VI-I summarises the level of commitment among the sample of vendors to four easily identifiable areas of A.I.

- Vendor attitudes in Italy in particular, and to a lesser degree in Germany, are especially positive.

- Quite clearly, European vendors are taking A.I. seriously as a commercial proposition. The point is supported by direct experience of the U.K. market as well as by the INPUT survey.

- In addition to the vendors surveyed, major software houses such as Systems Designers, Logica, Software Sciences, Data Logic, and Pactel have all created A.I. and expert systems groups. Companies of their type have, collectively, an enormous customer base in defence, aerospace, manufacturing, petrochemicals, finance, and the service industry sector. The fact that software companies of the size and influence of those named have moved towards A.I. and are currently selling it into their customer bases does, of itself, provide a positive market force.

EXHIBIT VI-1

VENDOR COMMITMENT TO A.I.

AI DEVELOPMENT AREAS	PERCENT OF RESPONDENTS*				
	FRANCE	ITALY	UNITED KINGDOM	WEST GERMANY	TOTAL
EXPERT SYSTEMS					
Active	15%	100%	50%	60%	50%
Considering	80%	0%	45%	40%	45%
No Interest	5%	0%	5%	0%	5%
EXPERT SYSTEM GENERATORS					
Active	15%	65%	25%	25%	25%
Considering	35%	35%	30%	35%	35%
No Interest	50%	0%	45%	40%	40%
NATURAL LANGUAGE SYSTEMS					
Active	15%	25%	30%	20%	20%
Considering	55%	25%	45%	55%	45%
No Interest	30%	50%	25%	25%	35%
PROGRAMMING LANGUAGES					
Active	25%	75%	25%	60%	45%
Considering	60%	25%	50%	40%	45%
No Interest	15%	0%	25%	0%	10%

* Rounded to the Nearest 5%

- In addition to the major software houses, the big accounting/management consultancy companies such as Coopers and Lybrand, Arthur Andersen, and Peat Marwick and Mitchell (among a number of others) have also moved towards A.I. Their customer base and influence is similar to that of the major software houses, and INPUT suggests that their involvement with A.I. provides another significant pointer to the future growth of the market.

- Having made the previous couple of points, we are not about to be so naive as to suggest that these companies see A.I. as the be-all and end-all of their future prosperity and that they are preparing to abandon their established profitable activities in favour of it. Having discussed the position informally with representatives of most of the companies named and others, we suggest that the consensus view of A.I. on the part of the major software and consultancy firms is along these lines:

    - They believe that A.I. products, services, and applications have a serious commercial future.

    - They are currently receiving the 'right noises' from the major companies in their customer bases.

    - They believe that it is important to act early to move onto the learning curve associated with A.I.

    - They believe that A.I. can be naturally merged with the products and services they already offer.

B. PRODUCTS AND SERVICES

- Exhibit VI-2 summarises vendor activities and future plans relative to the range of A.I.-related products and services.

- The first category is taken to include language implementations, expert system generators, and integrated programming environments. In many cases these products are likely to be provided on a licensed dealership basis; that is, the vendors obtain a license to market and distribute a particular product from its originators.

- In respect of the second category, packaged applications, INPUT is somewhat sceptical that so many vendors claim to be active in the market area. We suspect that some respondents may have included expert system shells in this category rather than in the first. However, we can only report the results of surveys, and there is no doubt that packaged applications are destined to be a serious factor in the market even if their current availability is not, we suggest, as widespread as the vendor survey indicates.

- The third category, system development services, is one that we would expect the majority of vendors with an interest in A.I. to identify as an area of opportunity--obviously they do.

- The same remarks apply to the fourth category, consultancy services.

C. VENDORS' ASSESSMENT OF APPLICATION AREAS

- Exhibit VI-3 summarises the views of vendors on the ways in which A.I. can be applied. As with the corresponding user survey, the applications can be seen as falling into three main categories: improving the existing DP function by

EXHIBIT VI-2

VENDOR PRODUCTS AND SERVICES

AI DEVELOPMENT AREAS	PERCENT OF RESPONDENTS*				
	FRANCE	ITALY	UNITED KINGDOM	WEST GERMANY	TOTAL
SOFTWARE TOOLS					
Active	25%	65%	45%	60%	45%
Considering	50%	25%	45%	40%	40%
No Interest	25%	10%	10%	0%	15%
PACKAGED APPLICATIONS					
Active	15%	35%	45%	25%	30%
Considering	70%	0%	45%	35%	40%
No Interest	15%	65%	10%	40%	30%
SYSTEM DEVELOPMENT SERVICES					
Active	25%	90%	50%	50%	50%
Considering	40%	10%	45%	20%	30%
No Interest	35%	0%	5%	30%	20%
CONSULTANCY SERVICES					
Active	35%	100%	50%	60%	55%
Considering	50%	0%	30%	25%	30%
No Interest	15%	0%	20%	15%	15%

* Rounded to the Nearest 5%

EXHIBIT VI-3

VENDOR ASSESSMENT OF APPLICATION AREAS

APPLICATION AREAS	PERCENT OF RESPONDENTS*		
	HIGH	MEDIUM	LOW
Category 1: Improving the DP Function			
Programming	30%	50%	20%
System Front Ends	70%	10%	20%
Category 2: Expert System Applications			
Education and Training	20%	20%	60%
Operations Support	20%	30%	50%
Intelligent Office Systems	35%	45%	20%
Sales and Marketing	35%	20%	45%
Financial Systems	65%	10%	25%
Category 3: Manufacturing and Technical			
Manufacturing Systems	45%	10%	45%
Equipment Maintenance	40%	20%	40%
Specialist Technical	70%	20%	10%

providing improved or additional programming techniques and front-ending applications systems, standard expert system applications, and manufacturing and technical applications.

- Because there were no notable differences in perception from one European country to another, the figures are presented in overall percentage format.

- Those application areas usually associated with A.I. are, as one might expect, well regarded by vendors in much the same way as they are by users.

- Three general application areas for A.I. are particularly well regarded by vendors.

- Seventy percent of vendors see A.I. as a means of improving the performance of existing computer systems. In its broadest context this concept embraces:

    - The provision of intelligent, 'user friendly' interfaces to systems. In the case of some system types, complex financial models, for example, this idea would embrace the idea of another 'layer' of assistance provided by the computer, i.e., guidance on how to interpret system results.

    - The provision of expert 'help' facilities to replace the human expert in explaining system functions, user training, and guidance during system use.

    - Expert system design tools to facilitate the production of high calibre systems.

- Concern about the gulf between computer professionals, who by and large design and develop application systems, and the end users the systems serve has existed as long as the commercial computer industry. The problem has been approached in a whole variety of ways, but there is a perception that

with the advent of A.I. it may now be possible to not only implement the systems but at the same time to implement an intelligent adviser to cope with end-user problems in operation.

- Sixty-five percent of vendors see A.I. as a means of automating new types of financial systems. Again the potential range is wide and certainly embraces financial analysis, investment, loan risk, and underwriting. Potential customers include not only organisations in the financial services sector but also other types of industries who have the usual range of financial functions which require expert attention.

- Seventy percent of vendors see A.I. as a means of tackling specialist technical areas of knowledge. Obvious examples include medicine, scientific analysis, mineral exploration, aspects of engineering design and complex product mixing such as lubricant production. A belief in the suitability of the A.I. approach to such applications is undoubtedly supported by the large number of A.I. systems that are already operational in the area--certainly the first category of applications to produce working expert systems, e.g., DENDRAL, MYCIN, PROSPECTOR, and many others.

- By and large, INPUT believes that the above is a fair assessment of the current state of the art and that vendors have generally identified the key application areas correctly. Certainly, we have stressed throughout this report our belief that financial systems generally represent an enormous potential market for A.I.

D. VENDOR PERCEPTIONS OF USER PRIORITIES

- Exhibit VI-4 gives a league table of vendor assessments of the factors, in terms of user needs, driving the development of the A.I. market. Users were surveyed in a similar manner (see Exhibit V-10), although the question was put

EXHIBIT VI-4

VENDOR RATINGS OF USER PRIORITIES

USER PRIORITY	PERCENTAGE OF VENDORS RATING EACH FACTOR MOST IMPORTANT
Improved DP Function	30%
Solve New Problems	25%
Disseminate Expertise	20%
Management Support	15%
Cost Reduction	5%
Employee Productivity	5%

to them from a rather different standpoint, that is, from their own organisational priorities.

- Once again, there were no significant national differences and the figure presented are for all vendors in the four countries.

- Also once again, the opportunity to improve the computing function in general, by the provision of new programming and design techniques and the addition of better user facilities to systems, was rated highest by the vendors--just as it was by the user group surveyed.

- However, a great difference in perception between users and vendors can be seen in their rating of the ability of A.I. to tackle problems that could not previously be computed. Vendors rated this the second highest category with 25% of them nominating it as the most important; users placed it last in terms of organisational needs with less than 5% of them regarding it as a first priority.

- Using expert systems to disseminate the knowledge of experts and for new decision support applications were rated similarly by users and vendors (slightly higher by users).

- Perhaps surprisingly, neither users nor vendors saw cost savings as the primary motive for using A.I. That is not, of course, the same as saying that there are no cost benefits.

VII MARKET ISSUES

VII MARKET ISSUES

A. OBSTACLES TO MARKET GROWTH

- This section is based mainly on the results determined by the survey of users' and vendors' perceptions of those factors which inhibit the more widespread use of A.I.

- Comment and information from sources other than the market research survey is included whenever it is relevant.

1. VENDOR RATING OF OBSTACLES

- Exhibit VII-1 summarises vendors ratings of the seriousness of each of the nominated problem areas.

- No national differences of any significance were detected, and the figures are presented on an overall basis.

- The most serious obstacles, in the view of vendors, are:

    - Lack of experience and proven techniques (rated as a serious obstacle by 55% of vendors).

EXHIBIT VII-1

VENDOR PERCEPTION OF ISSUES INHIBITING MARKET GROWTH

INHIBITORS	PERCENT OF RESPONDENTS*			
	A Serious Obstacle	An Obstacle But Not Serious	No Obstacle at All	Do Not Know
Lack of Adequate and Appropriate Hardware	20%	30%	50%	0
Insufficient Accumulation of Experience/Techniques	55%	30%	15%	0
Shortage of Trained Knowledge Engineers	45%	35%	15%	5%
The Slowness of Knowledge Acquisition	40%	35%	15%	10%
Lack of Development Funds	30%	40%	30%	0
The Limited Scope of Expert Systems	25%	25%	50%	0
The Need for Customisation (Driving Demand for Generators)	20%	35%	40%	5%
Risk of Failure in Systems	15%	30%	50%	5%
Heavy Demand on Computer Resources for Complex Problems	20%	30%	40%	10%
Difficulty in Programming and Maintaining Systems	35%	20%	45%	0
The Need for Specific Hardware	20%	30%	50%	0

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- The shortage of knowledge engineers (rated as a serious obstacle by 45%).

- The slowness of knowledge acquisition (rated as a serious obstacle by 40%).

- All of those categories of problems are related in one way or another to the human factor's side of A.I., and INPUT believes that the vendors surveyed and other vendors approached for in-depth interviews whose views largely concurred have got it right.

- The first point to be made is that, despite the many 'show piece' applications, the level of experience in terms of actually managing, developing, and implementing A.I. systems, particularly commercially-oriented expert systems, is still low across the board.

- Added to that there is the problem that formal techniques to aid the design and implementation of A.I. systems are not currently available in any standard accepted form. In fact, one of the major ESPRIT-sponsored A.I. projects is the development of a systems methodology for expert systems.

- However, some of the larger software houses who are active in the A.I. market have addressed the problem by developing their own standards in the project management and development area.

- A senior manager with Systems Designers PLC told INPUT, 'We see the programming of an expert system as at most 25% of the problem - less if a good system generator is used. The serious challenge is the application of formal and effective procedures for specification, documentation, management, progress reporting, and acceptance testing'. (We stress that this was the manager's personal view, not an official company line, although we suspect that the two coincide quite closely.)

- The same manager also added this point which we regard as highly relevant, 'Big organisations in the commercial sector have learned from bitter experience to mistrust software companies who do not approach projects in a rigorous, formal, and properly organised manner; they are quite right to do so. Therefore, any company that wishes to do business with these firms in A.I. systems is going to have to approach them on that basis, too'.

- So far as knowledge engineering and knowledge acquisition are concerned these points can be made:

    - There is a shortage of knowledge engineers; indeed, if the truth be known there is nothing like universal agreement about what the formal qualifications are. Certainly, the cynical definition suggested a couple of years ago by the author of this report (as a spoof it should be said)--'a systems analyst who has attended a LISP course'--represents a highly inadequate job definition.

- As long as two years ago a senior executive of the Carnegie Group told the author of this report, 'Right now in the U.S., anyone who can demonstrate real knowledge engineering skills and experience can write their own ticket. We assess that there are less than a thousand available. It will be the same in Europe in three or four year's time'.

- INPUT believes that universal job definitions for knowledge engineers are irrelevant and that theorising over what one should or should not be formally trained in is the province of those university and business school departments whose valuable function it is to provide staff with appropriate theoretical backgrounds to the industry. Once in place, we believe that the role of the knowledge engineer will become both application-specific, i.e., they will specialise in vertical market areas like finance and manufacturing, and to some extent, product related, i.e., they will learn to utilise particular product types such as expert system generators to produce commercial systems. This pattern follows the development of the role of systems analysts in data

processing where, typically, a formal training at degree level is followed by career specialisation in financial systems, manufacturing systems, and so on.

- Knowledge acquisition is always going to be a problem, and it should come as no surprise to any industry professional that such is the case. Volumes of case histories, papers, books, and articles have been written on the human factor's problem of extracting accurate information from end users during the specification phase of DP systems. One can hardly expect this problem to be diminished when several extra layers of complexity are added to it in the case of extracting knowledge--some of it imprecise and incomplete--from a human expert.

- Having said that, just as tools and methods have been developed to diminish the problems of DP system design and specification, so will they be to cope with some of the problems of knowledge acquisition.

- The remainder of the potential obstacles have, quite rightly in INPUT's view, been accorded less importance. The technical features of A.I. are, we believe, much further developed and better understood than the human factor's side.

- A brief assessment of each is given in the order in which the factors appear in the table shown in Exhibit VII-1.

  - As shown earlier in Chapter VI, Section G, there is certainly no shortage of appropriate hardware upon which to develop A.I. systems. Workstations, including LISP engines, minicomputer systems like the VAX, and PCs such as IBM compatibles all have a wealth of A.I. software products available for them. The issues are more likely to concern delivery systems for end-user applications also discussed elsewhere in Section C.

- Lack of funding is seen as a serious obstacle by 30% of vendors. Funding is likely to be affected by the view of A.I. held by financial management in user organisations. They will be looking for evidence of cost-effectiveness and value before committing anything above exploratory budgets (typically small). Once again, this point reinforces the message to vendors that marketing initiatives that represent A.I. in the abstract or as 'something you should invest in because it is leading edge' are likely to be ineffectual. Applications and cost benefits need to be stressed.

- The limited scope of expert systems certainly should not be an inhibiting factor so long as the message is communicated that the success of the technology relies to a great extent on the fact that expert systems are limited and highly specific in scope. Parallels can easily be drawn with other areas of computing which are highly task-specific.

- Customising for vertical market areas; for example, producing not just expert system generators per se but expert system generators for, say, underwriting systems, is a likely market development for the near future. The availability of such products will depend largely on the same factors as affect packaged software development, that is the emergence of clear vertical markets and well understood application groups.

- Risk of systems failure in A.I. is really no different from the parallel risks in any area of computing. Appropriate security and fall back procedures are part of the management function for any type of computer system—A.I. systems are no different.

- Heavy demand on computing systems for complex problems. Once more the trade-off is the same as for any other type of system--do the system benefits justify a pro rata resource allocation. If so, then a complex system will justify its host machine.

- Difficulty in programming and maintaining systems. Two points here: first, the programming environments associated with A.I., whether they be languages like LISP and PROLOG, generators, or intergrated tools like KEE, are generally distinguished by their programmer friendly features. Given an appropriate level of training, programming should not be a problem. Having said that, the conceptual understanding required to use most A.I. programming tools is such that the low end of the programming staff spectrum are not likely to find it within their grasp.

- Maintaining systems is a somewhat different problem because it has management aspects to it. With many A.I.-type systems maintenance includes system growth and expansion; in other words, improving the 'knowledge' and performance of the system. This implies an ongoing development function which needs to be controlled and managed and requires the continuing involvement of users and knowledge engineers.

- The need for specific hardware mainly involves decisions either about the use of LISP engine systems or about the use of software which only runs on a limited range of machines. The first problem is being addressed by the suppliers of LISP systems who are universally moving towards open communications with other machine types and downward portability for applications. The second problem should be addressed in a similar manner.

2. USER RATINGS OF OBSTACLES

- Exhibit VII-2 summarises users' assessment of the same categories of potential obstacles as those presented to vendors.

- Users were, perhaps surprisingly, less aware of serious obstacles than the vendors. The highest rated serious obstacle--the same one identified by

EXHIBIT VII-2

USER PERCEPTION OF FACTORS INHIBITING MARKET GROWTH

INHIBITORS	PERCENT OF RESPONDENTS*			
	A Serious Obstacle	An Obstacle But Not Serious	No Obstacle at All	Do Not Know
Lack of Adequate and Appropriate Hardware	10%	10%	75%	5%
Insufficient Accumulation of Experience/Techniques	30%	20%	45%	5%
Shortage of Trained Knowledge Engineers	20%	35%	30%	15%
The Slowness of Knowledge Acquisition	10%	25%	40%	25%
Lack of Development Funds	10%	30%	50%	10%
The Limited Scope of Expert Systems	25%	40%	30%	5%
The Need for Customisation (Driving Demand for Generators)	15%	20%	60%	5%
Risk of Failure in Systems	25%	25%	45%	5%
Heavy Demand on Computer Resources for Complex Problems	5%	20%	35%	40%
Difficulty in Programming and Maintaining Systems	25%	20%	35%	20%
The need for Specific Hardware	10%	25%	65%	0

vendors, lack of experience and techniques--was only identified as serious by 30% of users, and 45% of them specified it as no obstacle at all.

- The limited scope of expert systems was cited as a serious obstacle by 25% of users but perhaps an ambiguity exists here and users were concerned not at the narrow domain which expert systems have to operate in but at the relatively small number of applications currently running.

- Comments on other areas of the vendor survey apply also to the user survey.

B. KEY TECHNICAL DEVELOPMENTS

- This section is based on the user and vendor responses to the part of the survey which asked them to rank some technical developments relevant to the spread of usage of A.I. systems.

- Additional comments obtained from in-depth interviews and contacts within the industry are included wherever they are relevant.

- Some of these developments have already been discussed in Chapter VI.

- Exhibits VII-3 and VII-4 summarise vendor and user perceptions, respectively. Once more, we would not expect significant national differences in this area, and overall figures are provided.

- It is immediately apparent that one of the key themes of this report, that A.I. has a limited future if it is developed in isolation from the rest of the computer industry, appears again in this part of the survey.

- Linking to corporate computer systems and interfacing to data bases and integrated environments all rate very highly with both users and vendors and

EXHIBIT VII-3

VENDOR RATINGS OF KEY DEVELOPMENTS

RANK	DEVELOPMENT AREA	PERCENT OF RESPONDENTS			
		Important Development	Useful Development	Not Important	Do Not Know
1	Linking A.I. to Data Bases	80%	15%	5%	0%
2	A Fully Integrated Environment	65%	15%	15%	5%
3	Linking Standalone Systems to Corporate Computers	55%	25%	20%	0%
4	Run-Time Systems for Applications Portability	50%	30%	20%	10%
5	Development of Rule-Based Systems	50%	20%	20%	5%
6	Improved Design Flexibility	40%	20%	35%	10%
7=	Formal Approaches to Coping with Uncertainty	35%	30%	25%	5%
7=	Development of Frame-Based Systems	35%	15%	30%	20%
	Improving the Ease of Programming in A.I. Languages	30%	25%	30%	15%
	Voice Input Systems	15%	25%	60%	0%

* Rounded to the Nearest 5%

EXHIBIT VII-4

USER RATINGS OF KEY DEVELOPMENTS

RANK	DEVELOPMENT AREA	PERCENT OF RESPONDENTS			
		Important Development	Useful Development	Not Important	Do Not Know
1	Linking A.I. to Data Bases	75%	5%	20%	0%
2=	Linking Standalone Systems to Corporate Computers	65%	15%	15%	5%
2=	Improved Natural Language	65%	15%	15%	5%
4=	Improving the Ease of Programming in A.I. Languages	60%	25%	15%	0%
4=	A Fully Integrated Environment	60%	25%	15%	0%
6	Formal Approaches to Coping with Uncertainty	45%	30%	25%	0%
7	Improved Design Flexibility	45%	25%	20%	10%
8	Development of Rule-Based Systems	45%	20%	5%	30%
9	Voice Input Systems	35%	20%	45%	0%
10	Development of Frame-Based Systems	20%	30%	10%	40%
11	Run-Time Systems for Applications Portability	10%	65%	20%	5%

* Rounded to the Nearest 5%

all are aspects of the theme of 'integration'. Quite clearly, A.I. is destined to be confined to specialist and research applications if a high degree of integration is not achieved, but vendors already active in the A.I. market have already realised that such is the case and have reacted accordingly.

- INPUT believes that more specialised technical issues--rule-based and frame-based systems for instance--will be naturally dealt with as the A.I. industry continues to evolve and become more commercially oriented. It is quite significant that a high percentage of users returned 'don't know' responses about these specialised system design features. Here the responsibility rests with vendors to make potential users aware of the advantages to be derived from these advanced system building techniques.

C. KEY MARKETING ISSUES

- In this section we address the perception of key marketing issues so far as vendors are concerned.

- Once again the basis for the section is the returns from vendors obtained by the market survey. Additional comments from other sources are included where relevant.

- Exhibit VII-5 summarises vendors views on marketing issues.

- An obvious problem to be addressed is that, perhaps because of its history, A.I. has a particularly esoteric vocabulary associated with it. Earlier sections of the report have touched upon the vagueness of some descriptions and definitions.

- The answer to this problem surely lies with the A.I. industry itself--learn to communicate the benefits of A.I. in language to which customers can relate

EXHIBIT VII-5

VENDOR PERCEPTIONS OF KEY MARKETING ISSUES

RANK	MARKETING ISSUE	PERCENT OF RESPONDENTS*	
		Respondents Rating Issue Most Important	Respondents Rating Issue Among 3 Most Important
1	Artificial Intelligence Jargon	25%	60%
2	Low Level of Management Awareness	15%	50%
3	Lack of Clear Vertical Markets	15%	45%
4	Scepticism of the Technology	15%	40%
5=	Product Limitations	10%	30%
5=	Lack of Customer Education and Training	10%	30%
7	Slow Rate of Take-up (Low Initial Profitability)	5%	20%
8	Costs (Including Maintenance)	5%	15%
9	Lack of Low-Entry Products	0	10%

and in terms of problems and applications which they can recognise. Companies already active in the A.I. market have successfully adopted this approach.

- Management awareness of A.I. has also been a recurrent theme in the report. It is undoubtedly connected to the previous point in that management awareness is unlikely to be enhanced by a presentation style that requires managers to learn a new and obscure vocabulary. Once again, marketing initiatives aimed at promoting management awareness must be presented in a manner that links A.I. to familiar organisational problems and cost benefits.

- The lack of vertical markets is an issue that will take time and constructive marketing to address. Some vertical market areas already exist but INPUT would certainly support the view that they are currently very general (e.g., finance, insurance, higher education) and difficult to analyse in terms of targeting products and services with any reasonable degree of certainty.

- Skepticism of the technology is a problem that springs from other issues already discussed. Components include:

  - Impenetrable jargon.

  - General lack of awareness.

  - Comparatively low number of existing cost-effective applications.

VIII MARKET OVERVIEW AND FORECAST

VIII MARKET OVERVIEW AND FORECAST

A. MARKET OVERVIEW

- This chapter contains INPUT's assessment of the current size of the A.I. market in the U.K., France, West Germany, and Italy.

- In addition to this analysis of the 1986 market, forecasts for market growth up to 1991 are made.

- INPUT predicts that the products that are currently identified as 'A.I. products' will be increasingly integrated with existing information technology. Thus, it is likely that during this five-year period a sharply differentiated market for A.I. will fragment.

- That is not to say that market opportunities in the area of A.I. will not exist; on the contrary, INPUT believes that they will but that vendors will need to be aware of new perspectives for the use of A.I.

- The forecasts made do not represent the upper bound of the potential of the market but are intended as a realistic assessment of future market potential.

B. MARKET FORECAST

1. FORECAST DEFINITION

- The market assessment and forecast growth that follow were developed from as assessment of current and projected activities within the market definition described below.

- The forecast covers the period 1986 to 1991 and assesses end-user expenditures. Forecasts are made in local currency and converted into U.S. dollars for aggregation and comparative purposes.

- The forecasts include assumptions about the rate of inflation in each country as follows:

  - France - 4%.

  - Italy - 6%.

  - U.K. - 5%.

  - West Germany - 1.5%.

- In order to maintain a fair comparison between the different country markets throughout the five-year forecast period, the U.S. dollar conversion rates used have been adjusted to reflect the assumed differences in inflation rates.

- U.S. inflation was assumed to be 3.5%.

- Exhibit VIII-1 sets out the assumed conversion rates used in preparing this forecast.

EXHIBIT VIII-1

U.S. DOLLAR CONVERSION RATE ASSUMPTIONS

CURRENCY	1986	1987	1988	1989	1990	1991
French Francs	6.99	7.02	7.06	7.09	7.12	7.16
Italian Lira	1,492	1,529	1,567	1,607	1,617	1,688
Pounds Sterling	0.65	0.66	0.67	0.68	0.69	0.70
Deutsche Marks	2.18	2.14	2.09	2.05	2.01	1.97

- In no regard should these conversion rates be interpreted as a forecast of exchange rates. They are calculated on the basis of prevailing exchange rates and used simply as an index to eradicate distortions that would otherwise arise as a result of the use of different inflation rate assumptions for different countries.

- We have assessed the market as consisting of the following components:

  - Development Software. This includes products described in earlier sections--programming languages, expert systems generators, and integrated software tools. We see expert system generators, particularly now that these tools and the applications developed using them can be ported to PC systems, as being the most likely growth area here.

  - Applications Software. This category includes end-user system packages and natural language processing systems. Again, earlier report content describes these categories. INPUT believes that natural language systems could represent a valuable 'add on' feature to other types of systems. End-user applications packages should start to emerge in the next year or so as suitable generic applications are identified.

  - Consultancy. This should have an important role to play in the development of the market as a whole in terms of: first, promoting management awareness of A.I.; and, second, identifying suitable areas for commercial use of A.I. We see this as a steady growth area.

  - System development services. These are likely to be initially important in addressing the current shortage of qualified A.I. staff. Economically it will make considerable sense for those companies currently 'testing the water' to delay the commitment to recruit A.I. staff for pilot and first phase projects.

- Integrated Systems. This was a difficult market area to define, mainly because at the moment there is almost no parallel to a mature OEM-based integrated system market such as exists in, say, the CAD area. As a starting point, we looked at companies such as Artificial Intelligence Ltd., which is providing hardware and development software with a value-added component. As the market develops, however, we see the emergence of integrated systems which will, of course, more closely parallel the existing integrated system market in other areas of computing.

2. OVERALL GROWTH

- INPUT forecasts that the market for A.I. products and services will grow from around $80 million in 1986 to about $750 million by 1991.

- This forecast represents an annual average growth rate of 56% during the five-year period to 1991.

- This forecast and those for each of the four country markets shown in both local and U.S. currency are summarised in Exhibit VIII-2.

- Forecasts for each component of the A.I. market (as defined above) shown in U.S. currency are summarised in Exhibit VIII-3.

- Forecasts for each of the country markets (shown in local currency) are summarised in Exhibits VIII-4 through VIII-7.

- Overall market growth is being driven by the following factors:

  - Improvement in the computing function by the provision of better programming tools and 'expert' interfaces to existing applications such as data bases and information systems, modelling and simulation, and CAD.

EXHIBIT VIII-2

MARKET FORECAST FOR A.I. SOFTWARE AND SERVICES IN WESTERN EUROPE, 1986-1991 COUNTRY ANALYSIS

MARKET SUBSECTOR		1986	1987	1988	1989	1990	1991	AAGR: 86-91 (Percent)
France	Local Curency	60	135	245	395	560	735	65%
	$ Millions	9	19	35	56	78	103	
Italy	Local Curency	3	8	18	32	46	72	88%
	$ Millions	2	5	11	20	27	42	
United Kingdom	Local Curency	25	42	72	109	159	215	54%
	$ Millions	40	64	107	160	230	305	
West Germany	Local Curency	60	110	190	290	420	595	58%
	$ Millions	29	52	91	124	207	330	
Total	$ Millions	80	140	244	360	542	750	56%

EXHIBIT VIII-3

MARKET FORECAST FOR A.I. IN EUROPE, 1986-1991

COMPONENT SUBSECTOR	$ MILLIONS						AAGR (86-91) Percent
	1986	1987	1988	1989	1990	1991	
Development Software	38	55	73	86	101	120	26%
Application Software	4	8	16	29	54	88	86%
Subtotal Software	42	63	89	115	155	208	38%
Consultancy	14	29	63	96	146	196	70%
System Development	14	29	63	106	179	262	80%
Subtotal Professional Services	28	58	126	202	325	458	75%
Integrated Systems	10	19	29	43	62	84	53%
Total Market	80	140	244	360	542	750	56%

EXHIBIT VIII-4

MARKET FORECAST FOR A.I. IN FRANCE, 1986-1991

COMPONENT SUBSECTOR	FF MILLIONS						AAGR (86-91) Percent
	1986	1987	1988	1989	1990	1991	
Development Software	30	70	100	130	170	220	50%
Application Software	<5	10	25	40	60	80	70%
Subtotal Software	30	80	125	170	230	300	60%
Consultancy	10	20	50	100	140	180	78%
System Development	10	20	50	100	160	220	86%
Subtotal Professional Services	20	40	100	200	300	400	82%
Integrated Systems	10	15	20	25	30	35	28%
Total Market	60	135	245	395	560	735	65%

EXHIBIT VIII-5

MARKET FORECAST FOR A.I. IN ITALY, 1986-1991

COMPONENT SUBSECTOR	Lira BILLIONS						AAGR (86-91) Percent
	1986	1987	1988	1989	1990	1991	
Development Software	1	4	8	14	16	20	82%
Application Software	-	-	2	3	6	10	70%
Subtotal Software	1	4	10	17	22	30	97%
Consultancy	1	2	3	6	10	15	72%
System Development	1	2	3	6	11	17	76%
Subtotal Professional Services	2	4	6	12	21	32	74%
Integrated Systems	-	-	2	3	5	10	70%
Total Market	3	8	18	32	48	72	88%

EXHIBIT VIII-6

MARKET FORECAST FOR A.I. IN THE U.K., 1986-1991

COMPONENT SUBSECTOR	£ MILLIONS						AAGR (86-91) Percent
	1986	1987	1988	1989	1990	1991	
Development Software	10	13	17	20	23	25	20%
Application Software	<1	1	3	6	12	20	80%
Subtotal Software	10	14	20	26	35	45	35%
Consultancy	5	10	20	30	45	60	64%
System Development	5	10	20	35	55	80	74%
Subtotal Professional Services	10	20	40	65	100	140	70%
Integrated Systems	5	8	12	18	24	30	43%
Total Market	25	42	72	109	159	215	54%

EXHIBIT VIII-7

MARKET FORECAST FOR A.I. IN WEST GERMANY, 1986-1991

COMPONENT SUBSECTOR	DM MILLIONS						AAGR (86-91) Percent
	1986	1987	1988	1989	1990	1991	
Development Software	40	50	60	70	80	90	18%
Application Software	5	10	15	30	50	85	76%
Subtotal Software	45	60	75	100	130	175	31%
Consultancy	10	20	50	80	110	150	72%
System Development	10	20	50	85	140	210	84%
Subtotal Professional Services	20	40	100	165	250	360	78%
Integrated Systems	<5	10	15	25	40	60	56%
Total Market	65	110	190	290	420	595	58%

- The need to approach problems which are not susceptible to conventional computing techniques, typically those requiring some form of knowledge representation.

- Increased use of expert systems in areas like diagnostics, operations support, and training to disseminate some of the expertise of human specialists.

- The extension of the role of computers in decision support in expert systems and improved interfaces to existing decision support systems.

- Although the A.I. market is currently at an inventive stage of development, INPUT believes that there exists a congruence of factors which points to significant growth opportunities in this area.

3. MARKET SECTOR GROWTH RATES

- INPUT forecasts that professional services (i.e., consultancy and system development) offer the biggest opportunities for vendors of A.I. products and services.

- Growth in A.I. professional services at an annual average rate of around 75% will take this sector from 35% of the total market in 1986 to nearly 60% at the end of the forecast period.

- The shift in market focus towards end-user systems will also open up growth opportunities in the area of specialist application software products.

- Growth in application software at an annual average rate of over 80% will take this sector from only $4 million in 1986 to over $85 million by the end of the forecast period.

4. COUNTRY MARKET GROWTH

- Western European country markets for A.I. can be categorised under three broad classifications--the Anglo-Saxon (United Kingdom), the Teutonic (West Germany), and the Romantic (Italy and France).

- The United Kingdom market which accounts for only 24% of the total for the four major country markets for information services represents 50% of the total market for A.I. at $40 million in 1986.

- The United Kindgom is forecast to remain as the largest of the four major country markets throughout the forecast period. Growth is forecast at an average annual rate of 54% to reach over $300 million by 1991.

- The West German market is also characterised by high levels of serious interest in the adoption of A.I.

- The West German market which accounts for 28% of the total market for information services represents 38% of the four major country markets total for A.I. at $29 million in 1986.

- Growth in the West German market is forecast at an annual rate of 58% to reach $300 million by 1991.

- The French and Italian markets are, however, at a much more embryonic stage of development.

- The French market which accounts for 33% of the total market for information services represents only 11% of the total market for A.I. at $9 million in 1986.

- However, INPUT forecasts high average annual growth rates for these markets (i.e., France - 65% and Italy - 88%), as users reach to catch up with developments in technology.

IX SELECTED VENDOR PROFILES

IX SELECTED VENDOR PROFILES

- These have been selected to give a flavour of the A.I. market at the present time.

- In addition to that, several indicators of the likely future direction of the market (as perceived by vendors) are highlighted.

A. SYMBOLICS (U.K.)

1. BACKGROUND INFORMATION

- Symbolics was founded in the U.S. in 1980, and its history has coincided exactly with the major growth period for the commercialisation of A.I.

- The company has its roots in the famous Massachussetts Institute of Technology (MIT) and the association is maintained still.

- Although Symbolics is one of the big names in artificial intelligence, the company stresses that their market includes other areas of advanced computing as well.

- Prior to October 1985, Symbolics marketed their products in the U.K. via a third-party OEM arrangement. Since that time they have opened a U.K. base and they can be contacted on (1) 0494-443711.

- Revenue was declared at $114 million at the end of June 1986.

- Symbolics has an installed customer base of over 2,500 of which Europe accounts for roughly 10%. Within Europe, Germany and the U.K. account for the majority of installed sites representing 50% and 25%, respectively, of the European customer base.

- Symbolics claims and demonstrates a conservative growth rate figure of 60% annually. They believe that that figure will be comfortably surpassed in the current year and thereafter.

2. PRODUCTS AND SERVICES

- Symbolics' reputation is built upon the power of their 36-bit processors--currently the 3600 range. The machines are LISP engines (see Chapter V, Section D) and are targetted at advanced applications and development projects--not only in A.I. but in areas such as simulation, computer modelling, and process control--in which processing power is at a premium.

- So far as software supply is concerned, Symbolics operates a dual policy. On one front they operate with third-party suppliers of high calibre software. At the same time they offer a range of their own development tools.

- The core of the Symbolics system is their LISP dialect which fulfills all the requirements of the Common LISP standards for applications portability. In addition to that, and in order to make the systems suitable for a wide range of applications, they supply PROLOG (two compatible syntaxes), PASCAL, FORTRAN, and ADA. 'C' is soon to be added to the range.

- Third-party suppliers of software suitable for A.I. development include other well known A.I. companies, notably:

- Intellicorp, offering the KEE software environment.

- Carnegie Group, offering KNOWLEDGECRAFT and LANGUAGE-CRAFT.

- The Inference Corporation, offering ART.

- Symbolics systems support standard communication protocols and can be networked both locally and remotely with other manufacturers hardware.

- The Symbolics service package includes user training, consultancy, and assistance with selecting appropriate software for user applications.

3. MARKET APPROACH

- Symbolics has a clear-cut marketing strategy which could be summed up informally by the phrase 'if you want real processing power, we've got it'. The machines are extremely powerful, and the third-party software they support tends to be sophisticated and expensive.

- The systems, therefore, are targetted at users who have complex applications and research requirements.

- Their U.S. market breaks down roughly as follows:

  - Defence and aerospace including many DARPA (Defense and Advanced Research Projects Authority)-sponsored projects--40%.

  - Major industries, including petrochemical, electronics, and automotive--25%.

  - Academic and research--15%.

- The remainder comprises financial services, software houses, and a range of manufacturing and service industries.

- Their European market, although not yet as well defined as that in the U.S., shows a higher proportion of commercial and industrial customers.

- In common with many companies in the A.I. market, Symbolics believes that the financial services area is scheduled for a major expansion in demand and they plan to target accordingly.

- Symbolics believe that a major factor in opening up new market areas in A.I. particularly within the financial services sector, will be the availability of high performance applications packages, typically knowledge-based systems which address complex commercial problem areas.

B. ARTIFICIAL INTELLIGENCE LIMITED

I. BACKGROUND INFORMATION

- Artificial Intelligence Ltd. began trading in October 1983 and now has an installed customer base of about 120 major sites, mostly in the U.K. In addition, they have licensed market outlets for some of their products in France, Germany, Italy, Norway, Denmark, and Belgium. Artificial Intelligence Limited can be contacted on (1) 0923-47707.

- They should not be confused with the similarly named Artificial Intelligence Corporation which is an American company.

- The company was formed by two of the current directors, David Butler and David Catton, who were previously senior managers with Rank Xerox. Technical director Martin Gittins also joined from Rank Xerox where he was one of the company's leading software designers.

- The company was initially formed in order to market the Xerox 1108 range of artificial intelligence workstations with the accompanying range of LISP-based software tools. Rank Xerox retains a minority shareholding in the company and provides a member of the Board of Directors.

- Although Xerox operates in the office systems and photocopier market, they are one of the major companies with a lengthy history of involvement in the A.I. industry and are responsible for some very important developments in both hardware and software design--mainly emanating from the famous PARC (Palo Alto Research Centre) in California.

- Artificial Intelligence Ltd., therefore, started life with a high calibre product and a well known name behind them but faced the problem of both defining and penetrating a market. The history of the company over the three years (at the time of writing) of its existence well represents the way in which the U.K. and European market has formed.

- Revenue for the current financial year stands at three million pounds and a conservative annual growth rate of 50% has been demonstrated and is predicted for the immediate future.

- Staffing figures support a healthy growth rate projection from an intial staff number of 6 to one of 40 now. A 40% expansion of staff in the coming year is planned.

2. PRODUCTS AND SERVICES

- The base product for the company is the Xerox A.I. workstation, initially the 1108 range, now superceded by the new range 1185 and 1186 machines.

- The standard licensed software for the 1186 machine is Xerox's proprietary LISP dialect, InterLisp-D. In common with all the major LISP dialects,

InterLisp-D is moving towards full support of the Common Lisp compatibility standards.

- The 1185 illustrates an interesting development in terms of the A.I. market because it is specifically designed to be a delivery vehicle for end-user systems--not a development machine. The issue of delivery systems is addressed elsewhere in the report but in this connection it is interesting to note that the Xerox products not only have an end-user delivery concept within the 1185-86 range, but they have also gone for applications portability to IBM PC compatibles.

- A range of optional software tools is also available for the 1186 system; the majority are Xerox proprietary products and some are third-party supplied. They are:

  - The LOOPS object-oriented programming environment.

  - The Smalltalk A.I. language.

  - Quintus Prolog.

  - The Trillium Man Machine Interface design tool.

  - Note-Cards, an intelligent data base system.

  - KEE from Intellicorp.

- In addition to the Xerox product range, the company markets software for other hardware systems on a third-party basis:

  - Quintus Prolog is available both as a development and a run-time support environment for SUN workstations, Digital's VAX range, Apollo workstations, Burroughs CT Megaframe, NCR Tower system, and the

IBM 6150. Quintus is based on the standard Edinburgh PROLOG syntax and offers a range of development tools. It can interface to external data bases and to applications written in other languages such as PASCAL, FORTRAN, and 'C' and, on the Xerox version, InterLisp-D.

- Golden Common Lisp is available for IBM PC compatibles and has 250 installed sites in the U.K. In addition to a full LISP development environment, Golden Common Lisp features an integrated tutorial package and is consequently very popular as a low-cost entry point to LISP programming.

- Implementations for the IBM PC of both Smalltalk and PROLOG are planned for the coming year.

- The company has an expanding consultancy operation.

- Another growth area is the system development service offered by the company, they are currently undertaking expert system development work for several major organisations.

- Training courses in LISP, PROLOG, LOOPS, KEE, and Knowledge Engineering are offered on a fee paying basis.

3. MARKET APPROACH

- Initially, the company's main market was Alvey-sponsored projects which accounted for some 60% of its business.

- The current market breaks down roughly as follows:

  - Alvey sponsored projects - 40%.

- Major industries, including petrochemical, electronics, and manufacturing - 20%.

- Software houses - 20%.

- Academic sites - 15%.

- Military, aerospace, finance, and other - 5%.

- Marketing Director David Catton expects to see the picture change over the next few years. He predicts:

  - A decreasing reliance on Alvey sponsorship (which is, of course, exactly what should happen as Alvey's pump-priming role has been successful).

  - A dramatic increase in interest from the financial services sector once they are good and ready to move on the expert systems front--a view which coincides with that of INPUT.

  - An increasing demand from the smaller industrial concerns once the message has been put across that A.I. is accessible, cost-effective, and useful.

- The company believes that a wide range of products and services is necessary to attract a strong customer base. It defines a balanced product/service menu as:

  - Development systems for initial problem solving.

  - Delivery systems and run-time support software to take applications to end users on a cost-effective basis.

- A customer support, training, and consultancy package to assist customers in making maximum use of their investment.

- Once again, these ideas are in accord with those of INPUT and our perception of consensus views in the market.

C. SUN MICROSYSTEMS

1. BACKGROUND INFORMATION

- SUN (Stanford University Network Systems) was founded in 1982 and the company's world headquarters is in Mountain View, California. In common with a number of other American companies that have made a significant impact in the A.I. market, SUN, like Symbolics, represents an example of the profitable alliance of academic brilliance with entrepreneurial flair that characterises the U.S. high technology industries. Europe would do well to emulate the model.

- SUN commenced trading in the U.K. in 1984 and has been, by any standards, impressively successful. Their emergence in Europe coincided with the period when, to quote a company representative, 'A.I was just beginning to be the flavour of the month'. In the case of SUN it has proved to be one of the flavours of the last two and a half years because they have made a considerable impact in the A.I. market. They can be contacted on (1) 0276-62111.

- It should be stressed that SUN is not purely an A.I. company; in fact, world-wide it only contributes around 10% of sales revenue. But in Europe the company does 25-30% of its business with A.I. users and the hardware is the base machine for the Alvey IKBS program.

- The company currently has annual revenue of $210 million of which Europe contributes about a third. Within Europe, the U.K. is responsible for 50% of business.

- From inception, SUN has recorded a growth rate of 100% per year and their projection for the new financial year is a conservative $350 million, i.e., about 60%.

- Sixty percent of their business is done direct with end users, the remaining 40% through a network of OEMs.

- Currently, they have 1,500 installed European systems of which one-third are used for A.I. development and applications. The remainder of their sites are primarily CASE (Computer-Aided Software Engineering), CAD/CAM, and Computer-Aided Publishing.

2. PRODUCTS AND SERVICES

- SUN is first and foremost a hardware company, and they have never entered the arena of software supply apart from those software elements that accompany the machine and support its basic functions, such as language compilers, window management, communications management, and the UNIX operating system. SUN does not intend to become involved in the applications software industry in the foreseeable future.

- Given that, their service in terms of consultancy and software development does not go beyond the normal customer support level that hardware companies typically provide.

- The current product is the SUN 3 range of workstations, and the company has deliberately embraced a policy of adopting what they perceive to be the best current standards. They have gone for:

- The well known Motorola 68000 family of processors.

- UNIX 4.2, Berkeley standard operating system.

- Ethernet.

- Standard communications protocols.

- Straightforward system upgrade options.

• They sum up their development philosophy as 'open systems'. SUN hardware supports an enormous variety of software, communicates with other manufacturers' hardware, and facilitates a variety of 'add-on' features supplied by third parties.

• Currently, their top of the range machine is the SUN 3260, a four MIP machine with memory expansion up to 32 MB.

• On the software front, SUN has relied upon an extensive third-party connection. Numerous A.I. software products have been ported to SUN hardware including KEE, ART, ENVISAGE, several Prolog implementations, and a variety of expert system generators. The exception to the third-party policy is their version of Common Lisp, 'LUCID', which, because it has implications for window manager and operating system functions, has been brought in-house.

3. MARKET APPROACH

• SUN's market perceptions are interesting because, first, they are not purely an A.I. company although they see it as a very important market area, and, second, because they have only a minimal direct involvement in the software market. Nevertheless, their open systems strategy coupled with the high price/performance of the hardware has made the SUN product popular with A.I. users and software suppliers.

- SUN is beginning to see a move towards add-on hardware products specifically aimed at the A.I. market. There are now several specialist VME boards available from third parties which are added to SUN hardware configurations and are targeted at A.I. applications. Zenologic supplies an add-on Prolog co-processor to provide high processing speeds for Logic programming. SUN expects this trend to intensify.

- Although SUN themselves have no plans to enter the applications market, they predict a range of turnkey systems built around their hardware (possibly with add-ons) and supplied by SUN OEM dealers.

- They predict that a trend which has already emerged among their user base, that of bringing A.I. closer to other types of computer systems, will intensify. Currently, they mention that SUN users are beginning to interface A.I. system components with CAD systems, data base applications, operations research and simulation, and others.

- INPUT was informed that an essential component in the growth of the A.I. market is the availability of desktop machines that have the power to run complex end-user systems at an economic price. SUN anticipates that by 1988 they will be supplying 32 MB main memory systems with 1 GB hard disk storage and specialist A.I. boards for a figure around the $10,000 mark.

- From an objective standpoint (i.e., they do not sell the software concerned) SUN believes that the suppliers of specialist A.I. software need to be very aware of the danger of obsolescent product specifications and performance. As end-user knowledge of A.I. improves, as SUN believes that it is rapidly doing, the reaction of the market to price, performance, and features will become increasingly discerning.

D. SYSTEMS DESIGNERS PLC

I. BACKGROUND INFORMATION

- Systems Designers is one of the largest U.K.-based software houses and was the first company of their kind to be quoted on the Stock Exchange.

- Currently, they have a staff of some 1,500 and revenue of $55 million of which one-third is generated in the U.S. and the remainder in Europe. The U.K. represents their largest European sector.

- The company has a large customer base among the major organisations and their clients are distributed through defence, aerospace, manufacturing industry, petrochemicals, finance, telecommunications, and higher education.

- They maintain strong links with several universities, an example being their highly successful collaboration with Sussex University on the POPLOG A.I. programming system.

- The company was founded in 1969 and has steadily grown in size and reputation since then. Their world headquarters is in the U.K., and they can be contacted on (1) 0276-686200.

- At the time of writing they have about 700 user sites for their range of A.I.-related software products.

- The company is a partner in the Alvey sponsored "RESCUE" (Real Time Expert Systems Club of Users) project for which they supplied the development software ("Envisage") and the knowledge engineering expertise. The project has produced a Plant Fault Diagnosis system which is currently being tested in-place by ICI.

2. PRODUCTS AND SERVICES

- The company is active across the whole spectrum of advanced computing and, therefore, only the products relevant to A.I. will be detailed. However, an important point is that they do not see A.I. developing in isolation, but rather as becoming more and more closely integrated with established computing technology. This view has implications for their product development strategy, an important component of which is the ability to integrate A.I. tools with other types of software.

- The programming environment, POPLOG, is available to run on VAX, Hewlett-Packard, SUN, Apollo, and GEC 63 systems. POPLOG integrates three languages--PROLOG ,POP11, and Common LISP--into a single system. Functions written in all of the three languages can be integrated into a single program or application system, and facilities exist to interface to software written in other languages such as PASCAL and 'C'.

- ENVISAGE is a powerful expert system generator which currently runs on the VAX range of hardware under VMS or UNIX. Versions for SUN and IBM PC are to be launched in the near future.

- As well as the range of system development features it provides, ENVISAGE has other significant attributes. First, it is possible to interface applications developed under it to external data bases. Second, a low cost run-time support system allows end-user systems to be ported to PCs. Third, software written in other languages can be integrated with ENVISAGE-developed application systems.

- SAGE is a PC-based expert system generator. It has many features in common with ENVISAGE but is simpler, less powerful and, of course, costs less.

- SD-Prolog is a recent addition to the product range. At the time of writing it is in beta-test stage and is due for release in October 1986. SD-Prolog is a high performance PROLOG system targeted at the IBM PC-compatible market. It features full Edinburgh syntax, window management, and a range of integrated program development tools.

- Along with the software product range, the company also offer both consultancy and applications development services. Once more they stress that they do not view the product marketing and consultancy operations as being anything other than an integrated service package; in other words, customers for the software are generally customers for consultancy and backup services also. As one manager put it, 'Selling A.I. software to a customer and then walking away to let them get on with it as best they can could be very damaging for the A.I. market'.

- At the time of writing, Systems Designers have about 40 staff in the U.K. who are working in consultancy or A.I.-related applications development. The size of the operation is steadily growing as demand from their customer base increases.

- The company views consultancy and applications development as major growth areas. As an extra dimension to it, they have built up expertise in the use of A.I. software products, such as KEE from Intellicorp, which they do not themselves market but which their customers have acquired.

3. MARKET APPROACH

- The company has been active in the A.I. marketplace since 1981 and has seen it develop almost from nothing. From the earliest days, the company has been convinced of the great potential of A.I. and they now believe that it is poised to make the transition to becoming a significant component of the computer industry.

- Having said that, they have retained a realistic perspective. As one manager told INPUT, 'We are more impressed by the positive feedback we are getting from our own customers, the growth of our own A.I. operation, and the healthy job market for A.I. staff than by some of the ridiculous predictions that are put about'.

- In the course of several interviews, managers made a number of valuable points about their own and the company's perception of the market. The following represents a summary of those points:

  - A.I. will become more and more closely integrated with other types of computer applications.

  - A.I. customers will demand a comprehensive service including, typically, software products, consultancy and product support, and the capability to take A.I. systems to end users.

  - Many A.I. systems will be developed on powerful machines using sophisticated software development tools but will be delivered to end users on PCs.

  - Big companies and financial institutions will expect the same level of professionalism from A.I. suppliers as they do from the rest of the industry. They have had too many bad experiences in the past to treat A.I. as a special case.

  - The company expects the financial sector to become a major growth market as soon as the current round of demonstrator projects and feasibility studies comes to maturity.

  - They expect rapid growth in the market for expert system generators.

- They predict rapid growth in the demand for consultancy and applications development services.

- They predict rapid growth in the market for low-cost entry-level software products for PCs.

- They regard as essential the provision of runtime support to allow A.I. applications to be delivered on PCs.

- They see a promising future for A.I. in the area of providing 'intelligent' front ends to existing computer applications.

- They regard the steadily increasing number of successful A.I. projects as important stimuli for the market.

- The market indicators that they regard as most significant are the positive reaction of their own customer base to A.I. products and services and the rapid growth of demand for qualified A.I. staff.

APPENDIX A: GLOSSARY OF TERMS

APPENDIX A: GLOSSARY OF TERMS

- ARTIFICIAL INTELLIGENCE (A.I.) - A field of computer development aimed at pursuing the possibility that a computer can be made to behave in ways that humans recognise as 'intelligent' behaviour in each other.

- ARTIFICIAL INTELLIGENCE LANGUAGES - Many different computer languages exist--some of these are specifically aimed at ARTIFICIAL INTELLIGENCE applications:

  - 'C' is a high-level language used for general purposes.

  - LISP is one most commonly used in the U.S.

  - PROLOG is one widely used in applications but increasingly being used in this field of work.

    - Some of these languages (notably 'C') are widely available on many different types of equipment, and this allows programs written in them to be 'posted' easily from one system to another--hence PORTABILITY.

- EXPERT SYSTEM - A computer system that can perform at or near the level of a human expert for a specific area of expertise.

- However, today generally understood to mean any computer system that was developed by means of a loose collection of techniques associated with A.I. research.

- Note - The popular press and some vendors have already used the term 'expert system' in so many ways that it now lacks any precise meaning.

- KNOWLEDGE-BASED SYSTEMS (KBS) - A computer program that uses knowledge and inference procedures to solve difficult problems; could be loosely described as an EXPERT SYSTEM.

- KNOWLEDGE ENGINEER - An individual whose specialty is assessing problems and building knowledge based on expert systems.

- NATURAL LANGUAGE SYSTEMS - The branch of A.I. research that studies techniques that allow computer systems to accept input and produce output in a conventional language like English. These can be (but are not restricted to) interfaces to KNOWLEDGE-BASED or EXPERT SYSTEMS.

- SOFTWARE (APPLICATION) PACKAGE - A software product that provides computing facilities for a particular application, i.e., a particular EXPERT SYSTEM. This is in contrast to a CUSTOM DEVELOPMENT where a 'third party' would contract to develop the application (i.e., expert system) specifically to meet the particular needs of the client. The other option would be for the client to develop the system using his own manpower resources; this would be termed the IN-HOUSE approach.

  - If the application PACKAGE is provided with the appropriate COMPUTER HARDWARE (i.e., SYSTEM or WORKSTATION), and probably includes installation support as a complete contract, then this would be referred to as a TURNKEY SYSTEM.

- Where a user of an Artificial Intelligence system requires other services to help asist in the development of systems, these would be described generally as PROFESSIONAL SERVICES and include:

  - CONSULTANCY (i.e., general help, guidance, and advice).

  - TRAINING/EDUCATION.

- SOFTWARE TOOLS - Computer software packages that simplify the effort involved in building an expert system; another term used in this connection is EXPERT SYSTEM GENERATOR.

- Other terms which might arise are:

  - CAI - Computer-Aided Instruction (ICAI is Intelligent (CAI).

  - FIFTH GENERATION COMPUTING - A loosely used expression that incorporates artificial intelligence systems.

  - KEE - The Knowledge Engineering Environment is a package of software tools available for Intellicorp.

  - MYCIN, EMYCIN, XCON, DENDRAL, PROSPECTOR - Some names of well-known Expert System packages.

  - ROBOTICS - The branch of A.I. research that is concerned with enabling computers to 'see' and 'manipulate' objects in their surrounding environment.

APPENDIX B: ANALYSIS OF RESEARCH SAMPLE

APPENDIX B: ANALYSIS OF RESEARCH SAMPLE

- In-depth telephone interviews were conducted among a wide range of user and vendor organisations in France, Italy, West Germany, and the United Kingdom.

- Exhibit B-1 shows the analysis of the survey respondents by category and country.

EXHIBIT B-1

ANALYSIS OF RESEARCH SAMPLE

COUNTRY	TELEPHONE SURVEY OF VENDORS	TELEPHONE SURVEY OF USERS	TOTAL
United Kingdom	15	33	48
West Germany	15	50	65
France	15	44	59
Itlay	7	-	7
Total	52	127	179

APPENDIX C: USER QUESTIONNAIRE

APPENDIX C

ARTIFICIAL INTELLIGENCE USER QUESTIONNAIRE

We are currently researching the area of applied Artificial Intelligence, in particular the areas of Expert systems and Natural language systems.

Q1 A Do you currently use or have an interest in using systems of the type?

YES: CURRENTLY USING OF HAVE AN INTEREST IN USING GO TO Q2

NO GO TO Q1

ASK Q1a IF NOT CURRENTLY USING OR HAVING AN INTEREST IN USING ARTIFICIAL INTELLIGENCE SYSTEMS. OTHERS GO TO Q2

Q1 a You say you are not currently using or interested in using systems of this type. Can you please give me some indication of your attitude towards this type of system. What is your general view of Artificial Intelligence Systems? PROBE: What else? What else? (PROMPT: Expert Systems, Natural Language Systems)

____

____

____

____

Q1 b When would you expect your organisation to start taking a more active interest in Artificial Intelligence applications?

____

____

____

____

Q1 c How would you descibe the level of management awareness in your organisation with regard to Artificial Intelligence?

____

____

____

IN NOT CURRENTLY USING OR INTERESTED IN USING S.I. SYSTEMS. THANK RESPONDENTS AND CLOSE.

ASK ALL WHO ARE USING OR PLANNING TO USE OR HAVE AN INTEREST IN USING ARTIFICIAL INTELLIGENCE SYSTEMS

Q2 a At what development stage is the Artificial Intelligence activity in your organisation at the moment?

IF NECESSARY PROMPT: For example is it at the Preliminary Assessment stage, Early Development Stage, Advanced Use Stage etc.

____

____

____

And where would you expect it to be in 2 years time?

____

____

____

Q2 b How would you describe the level of management awareness in your organisation with regard to Artificial Intelligence?

____

____

____

Q3 a Are you actually using any artificial intelligence products at the moment?

Yes	1	Q3 b
No	2	Q3 c

Q3 b IF YES AT Q3a. Can you tell me the name of these products and who supplied them? WRITE IN FOR EACH PRODUCT USED.

PRODUCT	SUPPLIER/VENDOR
a. ______________	______________
b. ______________	______________
c. ______________	______________
d. ______________	______________

ASK ALL

Q3 c Are you planning to use any artificial intelligence products?

Yes	1	Q3 d
No	2	Q4

IF YES AT Q3 c

Q3 d Which products are you considering? WRITE IN BELOW. And who would supply this product? WRITE IN BELOW.

PRODUCT	SUPPLIER/VENDOR
a. ______________	______________
b. ______________	______________
c. ______________	______________
d. ______________	______________

Q4 I would now like to read out a list of types of Artificial Intelligence products and services. Please can you tell me how important each one would be to your organisation. Please say whether it would be essential, important, useful or of no interest. READ OUT LIST OF PRODUCT AND SERVICE AREAS BELOW.

PRODUCT/SERVICE AREAS	Essential	Impt.	Useful	No Interest	Do Not Know
Systems Development Services	1	1	1	1	1
Availability of systems on standalone workstations	2	2	2	2	2
Consultancy Services	3	3	3	3	3
Application Development Tools	4	4	4	4	4
Specific Application Packages	5	5	5	5	5
Natural Language Systems	6	6	6	6	6

And what other types of Artificial Intelligence product or service areas would be important to your company? WRITE IN BELOW. ASK FOR EACH ONE. How important is it?

PRODUCT AND SERVICE AREAS	ESSENTIAL	IMPORTANT	USEFUL
______________________	1	1	1
______________________	2	2	2
______________________	3	3	3

Q5 a I'd now like to read out some potential areas for the application of Artificial Intelligence Systems. Please could you tell me how you rate your company's level of interest in each of the areas. For each one please say whether your level of interest is high, medium or low.

	LEVEL OF INTEREST			
	HIGH	MEDIUM	LOW	DON' KNOW
o As an extension of traditional programming	1	1	1	1
o As a front end to a software package to increase 'ease-of use' (e.g., a DBMS, Computer Performance Measurement Package etc.)	2	2	2	2
o Education and training applications	3	3	3	3
o Check list for low-level employees (e.g., manuals brochure production, staff regulations, knowledge distribution)	4	4	4	4
o Manufacturing operations (e.g., circuit board assembly, factory scheduling/process control)	5	5	5	5
o Equipment maintenance	6	6	6	6
o Intelligent Office Systems	7	7	7	7
o Marketing/Selling (e.g., complex advice on product use)	8	8	8	8
o Financial Planning (e.g., tax advice)	9	9	9	9
o Technical (e.g., geological, medical, oil, etc. - please state)	0	0	0	0

Q5 b And what other potential areas for the application of Artificial Intelligence are your company interested in? INTERVIEWER WRITE IN OTHER AREAS AND CODE LEVEL OF INTEREST.

	HIGH	MEDIUM	LOW
______________________	1	1	1
______________________	2	2	2
______________________	3	3	3

Q6 I would now like you to consider your reasons for using or planning to use Artificial Intelligence Systems. I am going to read out some reasons which could be considered as important. Please could you write them down as I read them to you. AFTER READING SAY: And what other reasons does your company have for using or planning to use A.I. systems. NOTE OTHER MENTIONS BELOW. I would now like you to rank these reasons according to how important each one Is to your company as reasons for using or planning to use Artificial Intelligence Systems. Please rank as 1 the reason which you consider most important and rank as 2 the next most important and so on. Which do you think is the most important reason? And next? And next? etc. WRITE IN RANKS BELOW. ENSURE ALL REASONS HAVE BEEN GIVEN A RANK

REASON	RANK
Tackling previously intractable problems	( )
Enabling managers to more quickly assimilate and analyse Information	( )
An extention of traditional programming	( )
Reduce costs	( )
Provide ease of use features for software packages	( )
Dissemination of an expert's knowledge	( )
Improve productivity amongst low-level employees	( )
Declining hardware costs making Artificial Intelligence systems a practical reality	( )
Other (Please specify and give ranking).	
______________________________	( )
______________________________	( )
______________________________	( )

Q7 a I am now going to read out a list of problems which you may have encountered in developing or using Artificial Intelligence Systems. For each one I read please say whether or not it is a problem you have encountered. IF PROBLEM ASK: Would you say it was a serious problem or not? READ OUT LIST BELOW.

ITEM	SERIOUS PROBLEM	PROBLEM	NOT A PROBLEM	DO NOT KNOW
Lack of adequate and appropriate hardware	1	1	1	1
Unavailability of expertise in-house	2	2	2	2
The slowness of knowledge acquisition	3	3	3	3
Lack of development funds	4	4	4	4
The limited scope of expert systems	5	5	5	5
The need for customisation	6	6	6	6
Risk of failure in systems	7	7	7	7
Heavy demand on computing resources	8	8	8	8
Unsuitable for really complex problems	9	9	9	9
Difficulty in programming and maintaining systems	0	0	0	0
Need to purchase specific HW	X	X	X	X

Q7 b And what other problems have you encountered in developing or using Artificial Intelligence systems. FOR EACH ONE ASK: Would you say it was a serious problem or not?

	SERIOUS PROBLEM	PROBLEM
______________________________	1	1
______________________________	2	2
______________________________	3	3

Q8 a Now I would like you to think about technical developments that are needed in the areas of Artificial Intelligence. I am going to read out a list of potential technical development areas. Please can you tell me for each one whether you think it is an important area or a useful one or not an important area for technical development. READ OUT LIST.

	IMPORTANT	USEFUL	NOT IMPORTANT	DO NOT KNOW
Linking standalone systems to corporate computers	1	1	1	1
Linking to Data Base Management Systems	2	2	2	2
Developing 'run-time' systems in standard languages, e.g., 'C' so that they can run on lower cost systems and are portable	3	3	3	3
Providing a fully integrated environment	4	4	4	4
Developing more formal approaches to coping with uncertainty	5	5	5	5
Improved natural language processing	6	6	6	6
Improving the ease of programming in specialised artificial intelligence languages (e.g., LISP, PROLOG)	7	7	7	7
Improving design flexibility	8	8	8	8
Voice Input Systems	9	9	9	9
Development of rule-based systems	0	0	0	0
Development of frame-based systems	X	X	X	X

Q8 b And what other technical developments do you think are needed in the area of Artificial Intelligence? PROBE What others?

	IMPORTANT	USEFUL
______________________	1	1
______________________	2	2
______________________	3	3

ASK ALL WHO ARE CURRENTLY USING A.I. PRODUCTS/SYSTEMS YES AT Q3a OTHERS GO TO Q10

Q9 Who are the main users of Artificial Intelligence systems in your organisation

____

____

____

ASK ALL

Q10 a Do you have a specific Artificial Intelligence group in the company?
Yes ________ No _________

IN YES. OTHERS GO TO Q11

b How many personnel have been assigned to it? __________

c How many of these are knowledge engineers? ____________

ASK ALL

Q11 How involved is the DP Department in the development of Artificial Intelligence in your organisation:
PROBE: IN WHAT WAYS?

____

____

Q12 Do you have a budgeted expenditure for Artificial Intelligence systems?
Yes __________ No ___________

Q13 IF YES OTHERS GO TO Q14

What is the approximate size of your annual budget for Artificial Intelligence systems? Can you please provide some indication of how it is spent. (e.g., on SW purchase, in-house manpower, etc.)

____

____

ASK ALL

Q14 Do you plan to increase your expenditure on artificial intelligence systems?
Yes __________ No ____________

If YES what do you expect it to be in 2 years time?

____

____

Q15 What is the approximate overall size of your DP Budget?

____

____

____

Q16 What else that is relevant to your organisation's use of Artificial Intelligence that has not been covered in this questionnaire?

____

____

____

THANK RESPONDENT AND CLOSE INTERVIEW

APPENDIX D: VENDOR QUESTIONNAIRE

APPENDIX D

ARTIFICIAL INTELLIGENCE - VENDOR QUESTIONNARIE

Q1 a Firstly, I am going to read out some areas that are frequently referred to as ARTIFICIAL INTELLIGENCE. Please could you tell me how interested your company is in each one. Please say if you have no interest in the area, if it is an area you are considering moving into, or if it is an area you are active in at the moment.

READ OUT EACH AREA AND CODE APPROPRIATE.

	NO INTEREST C.	CONSIDERING C.	ACTIVE C.	DO NOT KNOW C.
Expert Systems	1	1	1	1
Expert Systems Generators	2	2	2	2
Natural Language Systems (e.g., Intellect)	3	3	3	3
Artificial Intelligence Programming Languages (e.g., LISP, PROLOG)	4	4	4	4

And what other application areas of Artificial Intelligence is your company considering or currently active in?

INTERVIEW WRITE AND OTHER AREAS AND CODE WHETHER CONSIDERATING OR ACTIVE.

	CONSIDERING C.	ACTIVE C.
OTHER AREAS ____________		
______________________		
______________________		
______________________		

SESE Sw 1

Q1 b Now, I would like to read our some types of Artificial Intelligence products and services. Please could you tell me whether your company is concerned with these types of products or services. Could you tell me for each one whether it is a product or service you have no interest in, one you are considering, or one you are active in at the moment.

READ OUT EACH PRODUCT/SERVICE AND CODE APPROPRIATE.

	NO INTEREST C.	CONSIDERING C.	ACTIVE C.	DO NOT KNOW C.
Software Tools	1	1	1	1
Package Sales	2	2	2	2
Customer Development	3	3	3	3
Consultancy Services	4	4	4	4
Turnkey System	5	5	5	5

And what other products and services in the area of Artificial Intelligence ar you considering or active with at the moment.

INTERVIEWER WRITE IN OTHER AREAS AND CODE WHETHER CONSIDERING OR ACTIVE.

	CONSIDERING C.	ACTIVE C.
OTHER AREAS __________		
____________________		
____________________		
____________________		

IF CONSIDERING OR ACTIVE IN ANY AREA OR PRODUCT/SERVICE AT Q1a OR Q1b GO TO Q3.

OTHERS ASK Q2

Q2 Why are you not considering any of these areas of Artificial Intelligence?
PROBE - What other reasons.

____

____

____

IN NOT CONSIDERING OR ACTIVE IN ANY AREA OF PRODUCT/SERVICE OTHERS GO TO Q3 THANK RESPONDENT AND CLOSE INTERVIEW.

CONTINUE INTERVIEW WITH ALL PEOPLE WHO ARE CONSIDERING OR ARE ACTIVE IN ANY AREA OR PRODUCT/SERVICE

Q3 How many Artificial Intelligence Installations do you have current in . . . .
READ OUT REGION NAME BELOW, WRITE IN BELOW LEFT

FOR EACH ONE ASK
And how many do you estimate you will have in 2 years time.
WRITE IN BELOW RIGHT
REPEAT FOR EACH REGION

	CURRENTLY	IN 2 YEARS TIME
The United Kingdom		
France		
West Germany		
Italy		
Other parts of Europe		
The United States		
Other parts of the World		

Q4 a I would like to read out some potential areas for the application of expert systems. Please could you tell me how you rate your company's level of interest in each of the areas. For each one please say whether your level of interest is high, medium, or low. READ OUT AREAS BELOW.

	LEVEL OF INTEREST			
	LOW C.	MEDIUM C.	HIGH C.	DON'T KNOW C.
o As an extension of traditional programming	1	1	1	1
o As a front end to a software package to increase 'ease-of-use' (e.g., a Data Base Management System, Computer Performance Measurement Package etc.	2	2	2	2
o Education and Training applications	3	3	3	3
o Check list for low-level employees (e.g., manuals/brochure production, staff regulations, knowledge distribution)	4	4	4	4
o Manufacturing operations (e.g., circuit board assembly, factory scheduling/process control)	5	5	5	5
o Equipment Maintenance	6	6	6	6
o Intelligent Office Systems	7	7	7	7
o Marketing/Selling (e.g., complex advice on product use)	8	8	8	8
o Financial Planning (e.g., tax advice)	9	9	9	9
o Technical applications (e.g., geological, medical, oil)	0	0	0	0

IF HAS INTEREST IN TECHNICAL APPLICATIONS, ASK WHAT PARTICULAR AREA. WRITE IN BELOW.

____

____

____

Q4 b And what other potential areas for the application of expert systems are your company interest in? INTERVIEWER WRITE IN OTHER AREAS AND CODE LEVEL OF INTEREST.

	LOW	MEDIUM	HIGH
____________________	X	X	X
____________________	Y	Y	Y
____________________	-	-	-

Q5 I would now like you to consider what are the important factors that are driving the development fo the Artificial Intelligence market. I am going to read out some factors which could be considered as important. Please, can you write them down as I read them to you. AFTER READING SAY: And what other factors do you think are Important in driving the development of the Artificial Intelligence market. NOTE OTHERS MENTIONED BELOW. I would now like you to rank these factors according to how important you think each one is. Please rank as 1 the factor which you think is the most important in driving the development of the A.I. market, as the next most important factor, and so on. Which do you think more important? And next? and next etc. WRITE IN RANKS BELOW. ENSURE ALL FACTORS HAVE BEEN GIVEN A RANK.

FACTOR	RANKING	
Tackling previously intractable problems	( )	C.
Enabling managers to more quickly assimilate and analyse information	( )	C.
The extension of traditional programming	( )	C.
Reduction in costs	( )	C.
Enhancing 'ease-of-use' features for software packages	( )	C.
Dissemination of an expert's knowledge	( )	C.
Improving productivity amongst low-level employees	( )	C.
Declining hardware costs, making A.I. systems a practical reality	( )	C.
Others (SPECIFY AND GIVE RANKING)		
____________________	( )	C.
____________________	( )	C.
____________________	( )	C.

Q6 a I am now going to read out some things which could be considered obstacles to the more widespread use of Artificial Intelligence Systems. For each one please say whether you perceive it to be an obstacle or not. READ OUT LIST BELOW. IF RESPONDENT MENTIONS ONE AS AN OBSTACLE ASK: How serious an obstacle do you think it is? Would you say it is a serious obstacle or not?

	NOT A SERIOUS OBSTACLE C.	SERIOUS OBSTACLE C.	NOT AN OBSTACLE C.	DO NOT KNOW C.
o Lack of adequate and appropriate hardware	1	1	1	1
o Insufficient accumulation of experience/techniques	2	2	2	2
o Shortage of trained knowledge engineers	3	3	3	3
o The slowness of knowledge acquisition	4	4	4	4
o Lack of development funds	5	5	5	5
o The limited application of expert systems	6	6	6	6
o The need for customisation (driving demand for system generators)	7	7	7	7
o Risk of failure in systems	8	8	8	8
o Heavy demand on computing resources for complex problems	9	9	9	9
o Difficulty in programming and maintaining systems	0	0	0	0
o The need for specific HW	X	X	X	X

Q6 b What other things do you think are obstacles to the more widespread use of Artificial Intelligence Systems? What else?

____

____

____

Q7 a Now, I would like you to think about technical development that are needed in the areas of Artificial Intelligence. I am going to read out a list of technical developments. Please can you tell me for each one whether you think it would be an important technical development or a useful technical development or not an important technical development. READ OUT LIST.

	IMPORTANT	USEFUL	NOT IMPORTANT	DO NOT KNOW
o Linking standalone computers to corporate systems	1	1	1	1
o Linking to a Data Base Management System	2	2	2	2
o Developing 'run-time' systems in standard languages, e.g., 'C' so that they can run on lower cost systems and are portable	3	3	3	3
o Providing a fully integrated environment	4	4	4	4
o Developing more formal approaches to coping with uncertainty	5	5	5	5
o Improved natural language processing	6	6	6	6
o Improving the ease of programming in specialised artificial intelligence languages (e.g., LISP, PROLOG)	7	7	7	7
o Imporving design flexibility	8	8	8	8
o Voice Input Systems	9	9	9	9
o Development of rule-based systems	0	0	0	0
o Development of frame-based systems	X	X	X	X

Q7 b And what other technical developments do you think are needed in the area of Artificial Intelligence? (PROBE) What others.

______________________________	1	1
______________________________	2	2
______________________________	3	3

Q8 I would now like you to consider what are the major marketing issues which need to be addressed by the Artificial Intelligence industry. I am going to read out some issues which could be considered as important. Please can you write them down as I read them out. AFTER READING OUT ASK: What other factors do you think are marketing issues for the Artificial Intelligence industry to face? NOTE OTHERS MENTIONED BELOW. I would now like you to rank these factors, according to how important you think each is. As before please rank as 1 the factor which you think is most important, 2 as the next most important, and so on. Which do you think is most important? And next? And next? .... etc. WRITE IN RANKS BELOW. ENSURE ALL FACTORS HAVE BEEN GIVEN A RANK.

	RANKING
Lack of clear vertical markets	( )
Scepticism of the technology	( )
Use of Artificial Intelligence jargon	( )
Low level of appreciation by general management	( )
Limitations of the product	( )
Costs (including maintenance costs)	( )
Slow rate of user take-up (therefore low initial profitability)	( )
Lack of inexpensive products in the introductor phase	( )
Lack of training/education of the client	( )
Others (SPECIFY AND GIVE RANKING)	
______________________________	( )
______________________________	( )
______________________________	( )
______________________________	( )
______________________________	( )

ASK ALL THOSE WHO ARE ACTIVE WITH PRODUCTS/SERVICES (SEE Q1b)
OTHERS GO TO Q12

Q9 What methods are you using to market your Artificial Intelligence products?

____

Q10 What are the job titles of the clients you wish to sell to?

____

____

____

____

Q11 What is the approximate amount of business that you are currently generating in the areas of Artificial Intelligence in the domestic market. WRITE IN BELOW. What is your average annual growth rate in the domestic market? WRITE IN BELOW.

What is the approximate amount of business that you are currently generating in the area of Artificial Intelligence in the rest of Europe. WRITE IN BELOW. And at which rate is it growing, that is what is your average annual growth rate in the rest of Europe. WRITE IN BELOW.

	AMOUNT OF BUSINESS	AVERAGE ANNUAL GROWTH RATE
Domestic Market	__________ pa C.	________% C.
Rest of Europe	__________ pa C.	________% C.

ASK ALL

Q12 What is your estimate of the size and growth of the Artificial Intelligence market. First of all for expert systems in the domestic market. What is your estimate of the overall size? WRITE IN BELOW. And what is your estimate of the annual average growth rate? WRITE IN BELOW.

CONTINUE FOR EACH CATEGORY. What is your estimate of the overall size of .....? What is your estimate of the annual average growth rate ....?

	OVERALL SIZE		GROWTH
Expert Systems in the domestic market	C.	pa C.	%
Expert Systems in the rest of Europe	C.	pa C.	%
Natural language systems in the domestic market	C.	pa C.	%
Natural language systems in the rest of Europe	C.	pa C.	%

What other areas do you perceive as being part of the Artificial Intelligence market, that is other than expert systems and natural language systems, WRITE IN BELOW. And what is your estimate of the overall size of ....? And what do you estimate to be the annual growth rate of ....?

In the DOMESTIC MARKET	C.	pa C.	%
In the REST OF EUROPE	C.	pa C.	%
In the DOMESTIC MARKET	C.	pa C.	%
In the REST OF EUROPE	C.	pa C.	%

Q13 Who would you consider to be your most significant competitors in the ....? WRITE IN, and in ....? WRITE IN.

	DOMESTIC MARKET	REST OF EUROPE
1.	____________	____________
2.	____________	____________
3.	____________	____________

Q14 a How many people do you have working on A.I. WRITE IN NO ( )

b. How many of these are knowledge engineers? WRITE IN NO ( )

c. How many people do you expect to have working on A.I. in 2 years time ( )

ASK Q15 FOR ALL THOSE WHO ARE ACTIVE WITH PRODUCTS/SERVICES (SEE Q1)

OTHERS: THANK RESPONDENT AND CLOSE INTERVIEW

Q15 Would you be prepared to provide INPUT with marketing material, brochures, etc., on your Artificial Intelligence products and services? Please would you send any copies of brochures etc. to:

PETER LINES

INPUT
41 Dover Street
London W1X 3RB

Yes, will send details ___________

No, will not send details ___________

THANK RESPONDENT AND CLOSE INTERVIEW