

PANEL ON THE FIFTH GENERATION PROJECT

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The aims of the 5G Project are well-known in the A.I. community: more intelligent computing systems with inferential capability, natural language processing and the ability to synthesize solutions from problem specifications. The initial presentation of the **technical means**, however, has given a more confusing picture. This confusion is in marked contrast to the highly focused objectives of the **first phase** of the project. I shall comment on these three aspects of the 5G Project below.

The aims. The general economic motivations of the Project include ones which would be common to any programme of research and development in advanced information technology: to improve the productivity of industry and to help conserve natural resources. There is a further avowed motivation, however, which helps to account for much of the Project's special character: to overtake IBM. Until the 5G Project, the strategy of the big Japanese computer manufacturers was to beat IBM at its own game. Although this strategy has been a technical success, it has been a market failure. Thus in an attempt to overcome IBM's dominance of the field, the 5G project set targets which were significantly beyond IBM's horizon.

Since the announcement of the Project, there has been much discussion about the feasibility of its aims. On the one hand, restricted natural language interfaces and program generators for limited application areas are commercially available even today. On the other hand, unrestricted natural language understanding and fully general-purpose problem-solving will not be achieved within the 5th, 6th or 7th next computer generations. Hence, I believe, the new name for the Project, "New Generation Computing".

The technical means. The main technical outline is now clear: (1) A.I. techniques for applications, (2) implemented in logic programming and (3) executed on highly parallel computers (based on dataflow and reduction architectures). It is generally accepted that A.I. techniques are needed for the new applications and that highly parallel non von Neuman computer architectures are needed to overcome the performance bottleneck of sequential execution. The choice of logic programming, however, has been generally received with bafflement, scepticism or even scorn. Reactions include: "The Japanese are good at hardware, but not so good at software", and "It will put the Japanese back 3 to 10 years". Such initial scepticism has begun to give way to quiet reappraisal. Increasingly, the experts are

beginning to conclude that, in their recognition of the central role of logic programming, the Japanese have stolen a march on the rest of the world.

The early descriptions of the project contained confusing references to other important developments in computing, such as abstract data types and object-oriented programming. It now seems clear that they have been singled out, not to be promoted in isolation, but to be integrated with logic programming. The apparent lack of emphasis on software engineering is more puzzling. Experts in software engineering regard this as a significant oversight. They argue that logic programming has not yet faced up to the problems of scale and complexity and that software engineering techniques will be needed to solve them. Logic programming enthusiasts, on the other hand, give the impression of believing that logic will solve all the world's problems and that conventional software engineering is irrelevant. The truth probably lies somewhere in between.

The First Phase. The research activity of the first three years, starting April/June 1982, has been tightly specified. At ICOT, the new research centre in Tokyo, work is organised into three groups: (1) **Machine Architecture** (14 researchers), 5 working on a personal sequential inference (PROLOG) machine (PSI), 4 on a relational database machine and 4 on the research for parallel inference machines; (2) **Language** (10 researchers), 3 working on the kernel PSI language, 3 on relational database management, 2 on higher-level problem-solving and 2 on expert system technology; (3) **Applications** (10 researchers), 5 working on the PSI programming environment and operating system and 5 on natural language and knowledge representation. Altogether, 13 out of 34 are developing the hardware and software for the personal, sequential PROLOG machine. The first prototype is due late in 1983.

In addition to ICOT, there are five working groups, each consisting of approximately 20 researchers from ETL, NTT and the universities. These meet once a month at ICOT. Moreover, NTT, ETL and the eight participating companies have their own research and development teams, also averaging 20 researchers each, to shadow the ICOT activities.

Conclusions. In my opinion, logic programming is the key to understanding the 5G Project. It is the hitherto missing link which

connects rule-based programming in A.I. with functional programming in non von Neuman computer architectures. It also links the use of logic as a program specification language in software engineering with its use as a query language in relational databases. If the Japanese share my view of the role of logic programming, then it is no wonder that they launched the Project with such a fanfare of publicity and enthusiasm.

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The personal view expressed here is a mixed appreciation of the 5G Project: support for a courageous, innovative technical stand and concern about the way the Project was, and is, presented to the world. A conjecture about its actual status is made.

It is my belief that there was a driving idea at the start, clearly voiced by K. Fuchi: to focus on a large part of the information processing field for which new applications are emerging and to propose a coherent technical approach to it. The fields of interest were those of man-machine interfaces and those requiring problem-solving capabilities. The technical approach was that of inference systems and knowledge based systems. The adoption of the logic programming paradigm and its associate, relational databases, lent coherence to the approach. The feasibility of the project was to rest on parallel machines using dataflow technology. Of course it remains to be settled in the future which precise technical studies should be pursued and which other concepts have to be introduced.

I have no choice but to give my support to such a plan and the technical foundations as I have outlined them. But we shall not know whether such a plan ever existed because it has been diluted since its presentation in two ways which are now discussed.

First, Japan decided for reasons not to be discussed here to turn these simple ideas into a much more important Project publicized to the world, rather than to give them a try in quiet. This decision created confusion because very far-reaching applications and technological goals were set up; many of these will certainly not be reached in the life time of the Project. These goals overshadowed the leading technical ideas and stirred both interest and skepticism. However,

judging from the response, the net result has been a fear that even if the Project only partially attains its goals, Japanese industry would obtain a leading position in the computer industry. Thus actions have been taken in several countries to directly counter the 5G Project, mainly in the USA and the UK. The European ESPRIT Project is not so direct a response, nor are the French national projects. By so publicizing its goals, Japan has taken a risk, not so much for itself, but for the whole field of Artificial Intelligence and is in danger of alienating its new supporters if sufficiently ambitious results are not obtained. This effect would be increased by the fact that too many new supporters are only occasional supporters, not truly convinced by the ideas of the Project. Confusion was created too by the fact that with so many goals and tools outlined in the project, it has become difficult to recognize one from the other: VLSI and networks seem to be good examples of this.

The second reason why the 5G Project has lost some of its identity is that, in order to obtain a complete and well connected plan, including all items likely to contribute to the achievement of its goals, many research themes had to be introduced, bringing other ideas which may or may not be of interest in their own right. PROLOG is an example of such a subsidiary research theme, which is also of interest in its own right. Although it is a great language, a better logic programming language is needed in the longer term for both semantic and practical reasons. It may need to be combined with LISP or functional languages for efficiency, for example. But not all features included in the technical background for the Project have this rationale: although Smalltalk or abstract data types, for example, have obvious relationships with logic programming, it would seem much more natural to study these relations than to premise the need for both - if only because human resources are limited. The final project presentation lacked direction.

Then is there still a Project? I will argue there are two. One is short term and basically underlies the first phase of the 5G Project. Its present implementation through ICOT and other groups give a hint: ICOT is a research centre, where the size of each team is small; there are also many small groups outside. They are all pursuing related research, essentially around the initial theme of the 5G Project, exploring the problems as they appear, doing good work in parallel languages, data bases, etc. This phase is in fact much more than a starting phase; it could be the only one because it is a phase in which Japan is willing to establish a technical and cultural basis in its industry. That cultural level can be said to be advanced by any standards; being shared by Japanese industry means a lot to competitors outside of Japan who know that such a high technical level in industry allows for a fast integration of academic knowledge. The actual products of the first phase (e.g. the personal PROLOG machine) are thus not so important per se at this time in comparison with the cultural endeavour. The second project, the 5G Project in

its full glory, may thus never have had any other rationale than securing the support of all parties for the first phase, which would have been difficult to raise otherwise. The second project may never start, but nevertheless Japan deserves credit for giving a much needed impetus to scientists, especially in Industry and for helping researchers focus on important matters.