A Report on My Visit to ICOT
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SUMMARY:

The main activities of my visit to ICOT were:

% Discussions with the management of ICOT concerning their mission, and in evaluating ICOT's successes during these last ten years.

% Discussion with members regarding their research.

% A talk given at ASTEM in Kyoto and also at ICOT, on my views of the future of automated proof discovery, the great successes so far, the barrier that seems to block further real progress, some work which seems to show that the barrier can be breached.

REPORT:

I will briefly discuss each of these activities, give my views on how the whole ICOT project has succeeded, the quality of the individual research, concerns, and where future efforts might be directed.

Dr. Fujita and his colleagues provided an atmosphere which was very conducive to successful communication. The various people could not have been more (genuinely) friendly, and this helps to seal bonds between our countries (and our research groups) which can be very helpful to both sides over the years, and makes it easier to ignore the wrongful Japan-bashing and American-bashing, that seems to be reemerging.

The briefings were well prepared and quite informative.

My first comments will be general in nature.

I believe that it was an excellent idea to select a specific area, namely LP (logic programming), on which to concentrate. That has helped to keep a vision before the researchers and has made their scientific interactions more effective. Furthermore, I believe that LP was a good choice - I believe that more now than I did 10 years ago.

All in all, important gains have been accomplished, and if LP does indeed emerge as the "vehicle" of the future, then your languages

(KL1,...) and machines (Psy,...PIM,...) will hold a position of leadership that will be hard to beat, of value to Japan and to all the world.

I am impressed by many of the applications, like chip routing, legal reasoning, etc. (and others that I had no time to hear about).

I do have a concern or two:

> Can you attribute these successes to the Choice of LP, or would they have been attained by any concentrated effort on languages and machines, especially parallel machines?
>
> How well will they compete against other parallel languages such as parallel C machines and parallel LISP?

I'm sure that you have shown or will show clearly why LP is making the crucial difference. If done, then you and your backers, such as me, can rest assured that the 21st century will be well served.

Secondly, I am very pleased with the size of some of your experiments, such as the chip routing one. Unfortunely, I did not have time enough to see many other substantial examples on which you methods have been tested. Because until one shows that the methods work on large examples, some skeptics will refuse to be impressed. If it is a legal system, then it should handle a large DB of legal rules and precedence; if it is a theorem prover, then it should prove hard theorems - and hopefully show that that can help with attaining new marketable technology. These remarks apply to other research groups as well, especially in USA, but you have been bold enough to cast yourselves as the leaders of the next generation, models for all to follow.

One issue that I am NOT concerned about is ICOT's level of success in research of the basic areas of AI. When ICOT was formed it was expected by many that it would make great progress in the basic areas of AI such such as: KB (Knowledge-based) systems, Natural Language Understanding, Intelligent Data Bases, Pattern Recognition, etc. Some such scientific progress has been made by you, especially in KB systems. However, I NEVER believed that such expectations were realistic for ICOT or any comparable research laboratory, so I do not fault ICOT for its lack of world shaking discoveries in AI. ICOT has made reasonable progress in these areas, and outstanding progress in the LP language and machine development areas.

I also believe that you are wise in making extensive use of foreign scientists, to help bring members up to date on certain techniques that are to be adopted and/or extended. Willingness to listen is a valuable trait, not shared by some USA scientific groups.

You have managed to attract the world's best consultants in most areas. I wonder if you appreciate the value of Mark Stickel, who is

right at the top of his field, but also a doer, and one who knows practically everything about the important areas of automated reasoning. I would not just get his advice on his areas of specialty such as PTTP, abduction, bottom-up, but expect to obtain from him (humbly stated) wisdom on nearby fields. (Francois Bry also seems bright and knowledgeable, but I do not know him very well).

The work on the legal adviser seems very promising to me. I was particularly intrigued with the use of two engines, Inference and Case Based, working together to achieve a goal. (Also the demonstration was well done and interesting.) As this is tried on larger, more realistic situations, I'm sure that changes will be needed, and made, and this might very well become the standard for our courts. Certainly some system will. Already a great deal of computing is used by lawyers but the next generation systems are yet to arrive.

The Analogical Reasoning project, as described by Arima, is intriguing. It is still in its infancy but seems to have started with the important idea of formalizing the concepts first. Although researchers often get mired down in the details of such formalization and never emerge to do interesting things, I feel your group will not fall in that trap.

Logic Program Synthisis, as described by Kawamura, is also an important subject for the future. Actually we are talking about implementing a high-level language. How good is your project? I am not knowledgeable enough to judge. It looks correct. Again, I would have to see an example where a few, easy to give, commands by an non-expert programer resulted in a reliable and useful piece of code.

I was really impressed by the papers and presentation of and Inoue and Ohta on abduction, non-monotonic deduction, bottum-up reasoning, and linear systems. I believe that their work is at the forefront of that technology and these researchers have made important contributions, and are getting to be well known. Mark Stickel is the best judge I know for their work.

My technical talks with Fujita-san, Sakai, Stickel, and Bry, were very stimulating and exciting. I enjoyed them and learned a lot.

My discussions with Furukava-san were very interesting also, relating to KB language and the Quixote system. This work should help determine whether LP will be a key to upping the grade of KB systems in Japan and the world. (or will we forever retain LISP and C for building these important systems?)

As for my own lecture (given twice) I identified the worlds best stand-alone provers: Argonne's OTTER, Stickels PTTP, Loveland's Meteor, Plaisted's Prover (there are others), and I claimed that they are "a thousand times" faster than humans on almost all of the problems in reasoning that we encounter. But also argued that there

are important theorems, especially in higher mathematics, that our wonderful provers cannot handle. My remarks urged others to maintain confidence that the "barrier" to these hard theorems can be "breached," and described three provers of ours, STR+VE, STR+VE Subset, and SET-VAR that have made some inroads on it.

I also discussed "the most important topic" for the future of automatic proof discovery, namely Analogy. Without knowledge from the past even people have trouble with these difficult theorems from mathematics, and without methods like analogy, people cannot apply that knowledge. I stated and emphasized my criterion for success, that one should not be pleased with a new analogy-prover until it is able to prove all theorems proved by existing provers and some substantial new ones as well. We are working on several such difficult examples related to the completeness theorem for ground resolution.

I also made some remarks about interactive provers, what form they must have if they are to be accepted and used by professional mathematicians. This is an important sub-area of automatic deduction.

All and all I was most pleased with my visit to ICOT, and impressed with its progress. I also greatly appreciate the kind and stimulating atmosphere that I observed there.

Woodrow W. Bledsoe 17 Aug 1989
VITA

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Born: November 12, 1921, Maysville, Oklahoma, USA

Education:

B.S. University of Utah, Salt Lake City, Utah, 1948 (Mathematics)
Ph.D. University of California, Berkeley, California, 1953 (Mathematics)

Professional Experience:

Professor of Mathematics and Computer Science, The University of Texas at Austin, 1966-present (acting chairman, Dept. of Mathematics, 1967-69, Chairman 1973-75). Ashbel Smith Professor of Mathematics and Computer Science 1981-87. Peter O'Donnel, Jr, chair in Computing Systems, 1987- present.

Vice President and Director of Artificial Intelligence, MCC (Micro- electronics and Computer Technology Corporation), Austin, Texas, June 1, 1984-August 31, 1987 . (On Leave of absence from the University of Texas).

Visiting Professor of Computer Science at Carnegie-Mellon U., Jan-June 1978

Visiting Professor of Electrical Engineering, Massachusetts Institute of Technology, 1970-71.

Mathematician, Research, Panoramic Research Inc., Palo Alto, California, 1960-65 (President 1963-65)

Mathematician, Staff member, Sandia Corporation (AEC), Albuquerque, New Mexico, 1953-60 (Head, Mathematics Department, 1957-60)

Lecturer in Mathematics, University of California, Berkeley, California, 1951-53

Membership in Societies, etc.:

American Mathematical Society
Mathatical Association of America
American Association of Artificial Intelligence - Fellow 1990 - initial group.
Association for Computing Machinery
Sigma Xi

Member, Board of Editors, International Journal of Artificial Intelligence, 1972-present - also Review Editor 1973-77

General chairman, International Joint Conference on Artificial Intelligence, MIT, August 22-25, 1977

Member, Board of Trustees, International Joint Conference on Artificial Intelligence (1978-83) (Chairman 1976-77)

Chairman of an IJCAI committee to determine criteria for a prize for an extraordinary theorem proving feat by a computer program (1980 - 1985)
Orginizer of a special Session on Automatic Theorem Proving at the annual meeting of the AMS, Denver, Jan 6-7, 1983.
President, American Association of Artificial Intelligence, 1984-85.
Member, Fellows Selection Committee, American Association of Artificial Intelligence, 1990-present.
Received the Fredkin Foundation "Milestone Prize" for career accomplishments in Automated Theorem Proving, American Mathematical Society Meeting. San Francisco, Ca Jan 18, 1991.
International Joint Conferences on Artificial Intelligence, Distinguished Service Award, August 29, 1991.

Grants: NSF since 1967.
Current: NSF, 1983-86 418,216.
Automatic Theorem Proving and applications
Tentative Approval: NSF, 1986-89 abt. 523,000.

Current Area of Interest:
Automatic Theorem Proving (proving mathematical theorems by computer)
Artificial Intelligence
Program Verification
Pattern Recognition
Set Theory
Measure Theory