Defense Science Board

Task Force on Supercomputer Applications

Meeting Minutes

<u>Date/Place</u>

9:30 a.m. - 5:30 p.m. 16 August 1983
9:00 a.m. - 3:30 p.m. 17 August 1983
Stanford University, California

<u>Attendees</u>
Task Force Members:
Dr. Joshua Lederberg, Chairman
CDR Ronald B. Ohlander, Executive Secretary
Lt. Gen. John H. Cushman USA (ret)
Adm. Bobby Inman, USN (ret)
Lt. Gen. Philip D. Shutler, USMC (ret)
Dr. Charles M. Herzfeld

Invited Guest Participants:
Dr. Stephen Lukasik

<u>Business</u>

The fifth meeting of the DSB Task Force on Supercomputer Applications was opened by the Chairman, Prof. Joshua Lederberg. The primary objectives of this meeting were to gain additional familiarity with military defense systems requirements and artificial intelligence (AI) technology and to determine an outline for the content of the final report.

Prof. Lederberg recapitulated some of the objectives of the task force. The purpose of the task force is to determine appropriate military applications for exploitation on a new class of super symbolic processors. Since DARPA had requested the DSB study, the task force should take into consideration DARPA's Survivability and Strategic Computing program in its deliberations, but any recommendations for applications should stand on their own merit.

There was also some discussion on current task force assessment of the most promising military applications. Autonomous vehicle applications were thought to have great potential impact on the military and would require massive amounts of computing power in relatively small packages. Command and control was also believed to offer significant opportunities for exploitation of super-intelligent computers but it was agreed that this was a very large domain and some focusing of scope would be necessary to bound potential applications in this area. One generic applications area that

offered benefits for a number of more specific applications areas is AI-based simulation. Simulation was perceived as a necessary ingredient for training, wargaming, analysis, forecasting, and evaluation of speculative scenarios.

After the brief introductory remarks, the task force then received additional inputs in the series of briefings on military applications and AI technology. Copies of briefing charts are appended to these minutes.

The first presentation was provided by Prof. Tom Binford of Stanford who discussed some of the computational requirements of various kind of automated vision systems. For example, the processing rate for a cruise missile application was estimated to be 20,000 pixels/sec. while the rate for an airborne autonomous vehicle might be as high as 100,000,000 pixels/sec. A chart was presented that showed the shortfalls between these requirements and current computational capacities of commercial machines. It was also pointed out that low-level vision operations were most likely highly tractable with parallel architectures but that the means of optimally employing such architectures for intermediate and high level vision processes were not clear at this time. A great deal of work would have to be done to develop appropriate software that would take advantage of highly parallel architectures at these levels. The availability of such architectures would give rise to fundamentally new ways of thinking about vision processing.

The second presentation was provided by Dr. Stephen Lukasik of Northrop, Corp. Dr. Lukasik pointed out that the task force should consider some short-term applications along with the more long-term issues. One example might be smart munitions with on board processors for precision targeting. Other applications that were highlighted as being important were training, real-time EW analysis, planning, and intelligent number-crunching. Dr. Lukasik also thought that DARPA should be more focused on embedded computers.

The task force next had some discussion with Prof. Ed. Feigenbaum of Stanford University. Prof. Feigenbaum stated that current resources were very limiting and that scientists worked at the edge of the capability of their tools. In order to make the advances that were needed for future requirements for expert systems, super-intelligent computation capacity would be required. Some examples of problems requiring this capacity include: analysis and fusion of large amounts of sensor; situation assessment and mission planning; sophisticated interaction with the user; training and education; knowledge acquisition; and VLSI design. VLSI design capability could be demonstrated but not implemented because current processors were too slow. A factor of 1,000 to 10,000 times the processing power of a Xerox 1100 computer is required for the VLSI design problem. Prof. Feigenbaum categorized AI problems in two classes: those that required heavy inferencing, which are in the minority; and those that require searching for and applying knowledge, which are in the majority. Prof. Feigenbaum felt that applications should be incremental in nature and address key problems. Task force reaction was that 2 or 3 long term projects should be undertaken that include incremental demonstrable outputs.

The third presentation was conducted by Dr. Rick Hayes-Roth of Teknowledge Corp. who briefed the task force on expert system technology and current market for expert systems. It was his judgment that awareness for such systems had increased enormously in the commercial world. He also felt that successful developments required that the interested company invest in training knowledge engineers of their own for participation in the construction of expert systems and for subsequent maintenance of the system. It took about 6 months to successfully train a knowledge engineer. Dr. Hayes-Roth felt that the transition of expert system technology to the military would take a much longer time than for industry, about 10 years, unless some specific steps were taken to speed up the process.

The final presentation was given by Prof. Doug Lenat of Stanford and Al Clarkson of ESL, Inc. Prof.

Lenat discussed the current status on machine learning. It was his contention that the various forms of learning had to be better understood and integrated, on a selective basis, to solve difficult problems. He also talked about Eurisko, a discovery program that he had developed at Stanford. Eurisko could discover useful heuristics about a number of task domains. Al Clarkson then discussed Eurisko's application to the intelligence analysis domain. He described a research task that they were performing which utilized Eurisko's capabilities to generate military crisis scenarios. The scenario generation would also provide indicators and warnings that could be expected.

The task force next discussed possible candidate applications that could investigated in detail by task subgroups. The candidates included: 1) autonomous vehicles; 2) adaptive Electronic Warfare analysis; 3) ballistic missile defense - - either the AEGIS Cruise Missile Defense System or the Patriot program; and 4) an automated pilot assistant. These candidate applications were to be discussed further at the next meeting and, if found acceptable, task subgroups would be formed to study the applications in some detail and report findings to the full task force.

The last order of business for the full task force in attendance involved future meetings. As previously discussed, the next meeting would take place at Carnegie-Mellon (CMU) University on the 22nd and 23rd of September with a subsequent meeting being held at DARPA on the 28th of October. The meeting at CMU would include a brief of their supercomputer efforts and a tour of the robotics lab.

The remaining portion of the meeting involved the Chairman and Executive Secretary and concerned determining the content and format of the final task force report. It was tentatively decided that the report would consist of tow major sections. The first section would be historical in nature and address the role that computers have played in military systems. Some description of current applications would be provided. In addition, emphasis would be placed on the larger, mainframe applications.

The second major section would start out by addressing the state-of-the-art of supercomputer technology today, i.e., linear supercomputers and VHSIC technology. There would also be a discussion of current status of AI technology. Next would come plausibility arguments for the successful exploitation of parallelism to achieve substantially faster processing rates at lower cost. There would also be a plausibility argument for the exploitation of AI to military problems. These introductory subsections would be followed by three or four chapters, each one addressing a major super-intelligent computer application.