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IREX Final Research Report.  
July 27, 2001

### **Topic of Research:**

This project began as a comparative history of computing in the American and former Soviet nuclear weapons programs. While I had already completed much of the research for the US portion of the project, this International Research & Exchanges Board (IREX) award was intended to allow me to gather data and conduct interviews with former Soviet computer pioneers and nuclear weapons workers. However, in the middle of my stay in Russia I was forced to refocus my efforts on open computer science research and its history. Please see my research summary and preliminary conclusions below for more detail.

### **Relevance and Contribution to Field:**

Computing is now a central means of inquiry into the natural world, ubiquitous everywhere from astrophysics to complexity studies to molecular biology, yet we understand very little about both its history and the present impact it is having on the way science is conducted. This study will supercede earlier “hardware” histories in its scope and style, and also will be forward-looking in its analysis for the near future of high-performance computing in science.

### **Summary of Approach and Methodology:**

Due to the intense climate of “spy hysteria” that erupted in the winter of 2001, combined with warnings from the US Department of Energy (DOE) to its affiliates (myself) regarding travel in Russia, I was not permitted to visit the closed cities at Sarov and Snezhinsk. At this time, no foreigners were being allowed into these sites. As a result, I turned my research more towards the computer science and cybernetic institutes in the Moscow area, with good results.

The majority of my research involved oral history interviews (some recorded if the interviewee permitted it) with Soviet computer pioneers, programmers, and physical scientists from several institutions. On a few occasions individuals refused to meet with me. The specific research sites I visited:

(In Russia)

The Moscow Physico-Technical Institute

The Institute for System Programming (RAS)

The Institute for Precision Mechanics and Computing Technology (RAS)

Obninsk Nuclear Power Engineering Facility (MINATOM)

Russian Academy of Sciences Archive\*

Moscow State University Institute for Mathematical Modeling

\*A lesser portion of my research involved note taking at the Russian Academy of Sciences' Archive, with good results.

(In Ukraine)

The V.M. Glushkov Institute of Cybernetics (UAS)

Glushkov Institute Library.

Kharkiv Institute of Physics and Technology

Chernobyl Exclusion Zone and State Complex for Radioactive Waste Management and Decontamination

### **Summary of Research Findings and Preliminary Conclusions:**

The Russians and Ukrainians are clever innovators in many respects and provide fabulous evidence that often the most complicated technological solution to a problem is not necessarily the correct or only one. Soviet scientists accomplished many of the exact same achievements as their counterparts in the West (acknowledging some instances of exact technical replications due to espionage), as they focused on and solved in most cases the same mathematical and physical problems successfully.

To my surprise, the demands of the nuclear weapons laboratories did not drive the state of the art of Soviet computer science, as was the case in the United States in the first part of the Cold War.

Most of the major computer projects in the Soviet Union were initiated (as in the United States) at academic or quasi-military institutions. Most large computer projects had some kind of military underpinning with the purpose of solving complex problems in rocketry and nuclear weapons science. But, academically-based "scientific computation" was essentially the only form of high-performance computation in the USSR (whereas distinct branches of "scientific" and "business" computing evolved in America by the 1950s), and it all originated in the universities or at the Academies of Sciences in Russia and Ukraine.

Soviet computers were built to last. Given that the machine designers knew these devices would need to be in operation for several years before they could be replaced, Soviet scientists and engineers produced computers such as BESM-6 and others that were more durable in terms of hardware than their western cousins.

Although the Soviets lagged behind the United States in terms of numbers of computers produced annually, Soviet computers were more "intellectual" than those in America. Software, for example, or more appropriately, machine assembly language was tailored to minimize use of machine memory space. In some instances programming languages such as FORTRAN were adopted from the West, modified, and used extensively in scientific applications.

Soviet-developed algorithms or calculation codes deserve special attention in that on the whole they made extremely efficient use of the computers they were developed for. Generally Russian mathematicians have tended to be exceptionally talented, and this

knowledge was applied to computer programming widely when calculations were mechanized.

In Ukraine, a combination of curiosity and serendipity allowed me to arrange for an official visit to the Chernobyl Exclusion Zone. Although not on my original research agenda, it was probably the most memorable and outstanding part of the trip. I am currently completing a paper on this topic...

I would like to note: ... That in May 2001 the Russian Academy of Sciences imposed a decree on its 357 research institutes, ordering its members to report any international activities and contacts to the Academy's Presidium. I was informed as of July 2001 that this decree was retracted, but have seen no hard evidence of this.

Generally, while most scientific institutions welcomed my visits, some did not. In addition to the problems accessing the closed nuclear cities, the Keldysh Institute of Applied Mathematics refused me entry, even to visit its museum.

I experienced no refusals of any sort in Ukraine, and found individuals and institutions there to be very friendly towards foreigners.

#### **Suggestions for Future Research Agendas:**

I have no specific suggested research agendas for computer scientists. I would like to emphasize, however, that more attention needs to be paid to the rapid environmental degradation in Russia and Ukraine. Many Soviet high-tech industries and ventures have left behind terrible legacies, such as the Chernobyl site. From meetings with individual workers at this facility and other discussions with Ukrainian scientists, US scholars and policy makers do not have a full grasp on the ongoing and potential future consequences of this event. Chernobyl is among the worst, but is only one of many examples of festering environmental problems in the CIS.