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Dear SIGCIS Workshop Participants!

Thank you for reading this partial draft of one of my dissertation chapters!

I'm submitting to your review a draft of a chapter from the middle of my dissertation, therefore to contextualize the writing that you will be reading, I include below an abstract of my whole dissertation project and a chapter outline.

As you will see, this early draft of Chapter 2 is based primarily on empirical research of my three national cases. I haven't yet integrated into it any secondary literature. I would be very grateful for your suggestions of references that you feel would be interesting for me to incorporate/reflect upon, especially from the literature on the history of computing, given the topics that I am exploring in this chapter or in the dissertation as a whole.

This early draft is also missing complete footnotes– they are currently just notes for myself and references that I need to tidy up.

I'm grateful for all of your comments, which will no doubt make the next draft of this significantly better!

Best wishes,
Margo

Dissertation abstract

Making the Citizen of the Information Age: A comparative study of computer literacy programs for children, 1960s-1990s

My dissertation is a comparative history of the first computer literacy programs for children. The project examines how programs to introduce children to computers in the United States, France, and the Soviet Union from the 1960s to 1990s embodied political, epistemic, and moral debates about the kind of citizen required for life in the 21st century. I analyze historic archival material and personal interviews using the Science and Technology Studies (STS) method of cross-national comparison and the framework of coproduction in order to show computer literacy programs to be sites in which key epistemic and normative debates of the second half of the 20th c. play out.

The designers of computer literacy programs identified computer literacy both as a set of practical skills necessary for life in the information age and as a formative practice for disciplining a

citizen's mind. Debates about what it means to be and how to become computer literate entailed commitments to what it meant to think well and be a full human being and were framed in the rhetoric of citizenship. Such debates included, for instance, whether to focus on the teaching of typing and programming skills or on algorithmic ways of thinking and whether to use ready-made software to deliver content or let students play with an open-ended software environment.

Despite wide agreement that computer literacy could be a solution to economic and educational problems facing the three countries, there was no one such thing as "computer literacy." The actors differed on the methods they would use and in their opinions about what kinds of knowledge and skills that were important to foster. To ground the study I focus on a few representative pioneers from the three countries and their respective programs: Seymour Papert and Patrick Suppes in the US, Jacques Perriault and Jean-Jacques Servan-Schreiber in France, and Andrei Ershov in the Soviet Union. These individuals and their colleagues were the most influential and distinct set of actors developing computers in education in the three countries. I show the complexity and nuances of disagreement among these pioneers, especially in a time of Cold War, economic troubles, and educational upheavals. At the same time, I demonstrate how they struggled with the same fundamental question about the ideal form of the future citizen in relation to the growing role of the computer in public life.

Chapter outline:

Ch. 0: Introduction
This chapter situates my study in relation to the historiography of personal computing and introduces the concepts of citizenship and subjectivity that I explore in the dissertation. It also lays out my comparative, cross-national methodology and why I have chosen this to frame my topic.

Ch. 1: Building the Literate Nation

The goal of this chapter is to situate the national computer literacy projects in the context of the history of computing and the socio-political aspirations and concerns of the United States, France, and Soviet Union in the 1960s - 1980s. Specifically, I will examine how computer literacy became part of the three countries' national education programs. How did the idea of integrating computers into public education systems arise in the three countries? What were the technical and socio-political developments that computer literacy programs relied upon and, in turn, helped shape? What did governments and program leaders think was at stake in computer literacy programs?

A focus on the relationship between traditional literacy and computer literacy in the three sets of programs that I am examining will serve as a unifying thread through this chapter.

Ch. 2: Entrepreneurs of the Mind

The personalities and backgrounds of the four individual leaders of these programs is an indispensable part of the programs' design and implementation. In this chapter, I will focus on the biographies of the program leaders in each country in an effort to understand how they became advocates for the computer in the classroom. For this purpose, I will examine the personal and academic writings of Papert, Baudé, Servan-Schreiber, and Ershov in order to understand how they balanced their private interests in promoting computer education for children with public concerns of nation-building and national economic competitiveness. For example, Papert and Ershov shared in common their mathematical background, proximity to computer scientists, and interest in computer programming languages in relation to human languages. Servan-Schreiber, on the other hand, was not a mathematician but a journalist and politician. How did their social and professional backgrounds influence their ideas about computer education? Where did they draw their inspiration from, and what (foreign) models did they seek most to emulate? What was the role of these individual-entrepreneurs vis-à-vis the role of the state in education? More specifically, did they define state policy or attempt to act outside of the state system? How did their private contacts in the computer education field relate to the relationships among their respective states (in particular, to Cold War ideologies)?

The methodological lens for this chapter will be "selves," which refers both to the subjectivity of the program leaders and that of the computer literate public they were trying to build through their programs. I will answer the questions above by focusing on the coproduction of theories of human nature and the study of human (child) learning with the development of the computer (hardware and software), the AI work on machine learning, and the emergence of computer science as a discipline.

Ch. 3: Computers in the Classroom

In this chapter I will focus on the design and implementation of the four pioneering computer literacy programs within their particular institutional contexts: those advocated by Papert (US), Baudé (France), Servan-Schreiber (France), and Ershov (USSR). As part of this chapter, I will examine the significance of the different types of institutional structures that the programs were part of, i.e., MIT and National Science Foundation in the United States, EPI and CMI in France, Novosibirsk Akademgorodok in Soviet Union. Questions I would like to address in this chapter include: How were the computer literacy programs conceived and organized within the institutions they were affiliated with, and what did those affiliations imply? What hardware and software did they use? What developmental stages of children did they target? What psychological (e.g. Piaget's constructivism) or philosophical theories did they rely upon? What was the relationship of the structure and content of programs to the socio-political and technical contexts in which they were designed? How long did they last and what were their perceived successes and failures?

My methodological lens for this chapter will be "bodies," or the way in which the programs adopted particular understanding of the body/senses/haptics (i.e., human-computer interactions) for learning and as part of being human, and how they began to naturalize certain practices of body movement and thought in gendered ways. This will include attention to the kinds of physical spaces/arrangements that the program leaders believed computer education required to be successful and which education would help to promote. I will show how these spatial arrangements and bodily practices imply, reflect and try to stabilize particular social orders (teacher/student relationships, human beings in the workforce/as human resources).

Ch. 4: The Child, the Computer, and the Collective

In this chapter I will compare the different socio-cultural attitudes toward children as knowing and learning agents in the three cultures that underlie the computer literacy programs in the three countries. The writings of Papert, Baudé, Servan-Schreiber, and Ershov echo the vision of children in modern societies as the bearers of the future and the hope of a better world to come. Studying how and for what reasons the computer literacy programs focused on children can reveal underlying attitudes towards each nation's socio-technical future and the nature of a polity's responsibility to this future. For example, Jean-Jacques Servan-Schreiber said in an interview that children can learn to use the computer faster and are more adept at using it than are adults (Servan-Schreiber 1983). How do statements about children and computers such as Servan-Schreiber's reflect anxieties about losing touch with the next generation, of not being able to relate to them or to understand their world? Imaginations of the future are usually continuous extrapolations from realities of today. Yet here is a technology that potentially reverses the normal gap between the young and the old, rendering the young more adept as social beings. To what extent was this a concern and what was the role of (computer) education in preparing citizens for this socio-technical future?

The methodological lens for this chapter will be "citizens." Specifically, focusing in on the educational context, I will investigate the kinds of rights and responsibilities children are thought to have in the three societies, their relationship to figures of authority, and theories of human development that guide education.

Ch. 5: Utopian Visions and Realities

In this chapter I will evaluate the programs retrospectively by comparing the national education aspirations for computer literacy programs (Chapter 1) and their leaders' visions for them (Chapter 2) to the actual programs implemented (Chapter 3). Did these programs achieve permanence? How (if at all) did they change? What did the programs produce (e.g., quantitatively)? Did the entrepreneurs of the mind change their approaches over the years? I expect that theories of education that differed from those of the pioneers or ones that were in disagreement with computer education in general will provide useful context for understanding the success or failure of these programs relative to their own aspirations. Specifically, I will examine competing psychological and philosophical ideas about the formation of the individual in relation to the collective. In conclusion, I plan to reevaluate the universalizing and flattening claims about knowledge and citizenship in the information age in light of my research.

Chapter 2: Entrepreneurs of the Mind

Once, in man's ancient past, the notion of using tools to multiply his physical effectiveness occurred. This was a revolution of such consequence, that even today some are tempted to define man as the 'tool-using animal'. We are on the verge of another such revolution. Only this time, the tools are of the mind. -- Papert and Goldstein, LOGO Proposal 1976-1979, p. 5.

Introduction to chapter

In this chapter, I look at the lives of Seymour Papert, Jean-Jacques Servan-Schreiber, and Andrei Ershov to elicit their visions for the computer literacy programs that they designed. What did they want to achieve by designing their respective programs and what was at stake for them in achieving it? By describing the pioneers' education, personal and professional backgrounds, work trajectory, sources of inspiration and influence, my aim is to reveal the motivations and intent that they had in designing the programs that is not easy to observe by focusing on the programs themselves.

I argue that the pioneers were "entrepreneurs of the mind" because they ventured to transform with their programs the foundations of how people think and learn. By exploring the biographies of the pioneers I will convey how their backgrounds demonstrate an orientation to focus on topics of the mind. The significance of making the mind the focus of their programs is that these programs were not just tools to learn mathematics better or to learn computer skills or programming. These individuals sought to affect with their programs important structures of the mind, which could eventually have consequences for how people think of themselves and relate to others.

What emerges from a comparative analysis of the three pioneers is that while their understandings of the right way to influence the mind with the computer differed, they all believed the computer to be a natural complement to the mind. They considered the computer a "tool of the mind" that could extend and enhance the mind and as a result bring about individual and social fulfillment, for example, by opening up the capacity for more effective learning, emancipating the individual from oppressive social structures, and helping to create a more productive social order.

Seymour Papert

In 1976, as an already seasoned researcher of computers in education, Seymour Papert (1928-) identified computers to be “tools of the mind” that would transform individual and collective psychology and lead to a “revolution” in how we think about the human being.[1] The lifetime of Papert's work indicates his wish to guide this “revolution” towards a synthesis of the human mind with the machine of the computer that would lead to improved learning.

Papert traces his interest in the workings of the human mind and of the mechanisms of learning to his childhood. As a child, Papert was fascinated with playing with gears. In his famous 1980 book on computers in education, *Mindstorms,* Papert recounts how he "fell in love" with gears, which were for him a cognitive and sensorial learning tool. This early encounter with gears inspired his interest in mathematics and became the experience upon which he based his own understanding of how learning works.[2] This combination of interest in mathematics and learning persisted and informed one another through Papert's long and productive career. Papert studied mathematics in college in South Africa (where he was born) and later also in England, earning his second PhD in mathematics from Cambridge University in 1959. Math served as the subject of choice for Papert to think about learning[3] and in his efforts to reform the school education system with computers. In 1967 he became a professor of applied math and the director of the MIT Artificial Intelligence (AI) Laboratory and soon after began a project under the auspices of the AI Lab to develop the computer language for children, LOGO. Papert collaborated with other researchers at the AI Lab and MIT, notably Marvin Minsky and Sherry Turkle, as well as computer scientists, psychologists, teachers, and students in the Boston area and internationally to transform LOGO from a computer language to a method of learning that sought to be an alternative to the way that learning took place in American schools. Having studied with Jean Piaget in Geneva and being his long-term friend and collaborator, Papert was vocal about the theory of learning that he called “constructionism” behind the practical program he devised. Developing LOGO was for Papert always oriented towards advancing his interest in understanding of how learning takes place and in helping to improve this function of the mind.

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1 [Same ref as epigraph, also (14, Papert, "Computers and People," 1977).
2 Papert, *Mindstorms* 1980, p. 10.
3 Ibid.

Papert and Jean Piaget

Papert drew inspiration for thinking expansively about his work with computers in terms of mind and learning from his work with Genevan psychologist (Papert would say, philosopher) Jean Piaget. As Piaget's student and collaborator, he became familiar with and contributed to Piaget's work on "genetic epistemology," or the study of the genesis and evolution of knowledge in human beings. From numerous observations of children, Piaget concluded that people acquire knowledge in a way that he termed "constructivism": by interacting with their environment according to their needs. For example, a child begins to speak in order to communicate her desire or feeling to another person. She experiments and tests out words on the basis of sounds and words that she already knows, combining them with what is available in the environment around her, to compose new sounds and phrases. Piaget's theory was tremendously influential in 20th century psychology, pedagogy, and epistemology and it served an important role in helping to define "computer literacy" as distinct from the drill-and-practice use of computers in education.[4]

Papert came to know Piaget when Piaget invited him in 1959 to work in his Center for Genetic Epistemology in Geneva. Papert had just completed his PhD in mathematics from Cambridge University that same year and Piaget seemed to have liked Papert's dissertation on "Lattices in Logic and Topology."[5] Papert spent six years in Geneva, from 1959-1965, where he and Piaget worked together on the branch of genetic epistemology concerned with the development of mathematical reasoning in children.[6]

Papert's unique way of interpreting the contemporary significance of Piaget and Piaget's thought reflects his own interest in scientific understanding and steering human thought and learning. Papert said that Piaget never considered himself to be a child psychologist, but an epistemologist– someone concerned with what knowledge is and how it develops. According to Papert, it is Piaget that brought epistemology from out of its home in philosophy and made it a science in its own right.[7] Papert argued that genetic epistemology was a new scientific approach to the study of knowledge and mind. Not only did Piaget

4 See, for example, Arthur Leuhrmann's definition of "computer literacy" as discussed in Chapter 1.
5 Research this first encounter/what led Piaget to Papert more.
6 Piaget published his first major study of this process in *A Child's Conception of Number,* 1941.
7 Reference to Papert on Piaget. ?? Papert, p. 2, "Introduction to *Embodiments of Mind* by Warren S. McCulloch," *Embodiments of Mind* published by MIT Press, Cambridge, MA, 1965.

develop this epistemological science, but also influenced other contemporary fields. Notably, Papert considered Piaget's epistemological theories to serve as the foundation for the emergence of the field of cybernetics, the interdisciplinary study of control and communication in animals and machines that took off in the post-World War II environment in the United States.[8]

Papert argued that constructivist theory paved the way for developments in cybernetics by demonstrating that it was possible to deduce the workings of the mind from informational (as opposed to physical) processes (e.g. learning). Papert described how a number of early researchers associated with cybernetics, specifically Kenneth Craik, Julian Bigelow, Arturo Rosenbleuth, Norbert Wiener, Warren McCulloch and Walter Pitts, were engaged in bringing about an epistemological revolution complementary to Piaget's genetic epistemology. The "common feature" between these cyberneticians' and Piaget's work, according to Papert, was "the recognition that the laws governing the embodiment of mind should be sought among the laws governing information rather than energy or matter."[9] Both Piaget and the above-mentioned cyberneticians emphasized the importance of informational processes of the mind (learning, computation) instead of changes in matter or electric signals.[10] This attention to information flows enabled the cyberneticians to conceive of the resemblance between the way that human beings and computers think based on information processes even though the matter– human biology/neural networks v. computer/electrical wiring– was very different. Papert believed that information-processing models of the mind and developments in artificial intelligence in general owed much to Piaget's constructivist theory. Papert thus inscribed Piaget directly into the lineage of cybernetics and artificial intelligence, emphasizing the theories about the mind that were at the origin of these computer-based enterprises. Working at the AI Lab beginning from the mid-1960s, Papert was a direct inheritor of the cybernetics tradition. By establishing a continuity between the work of the early cyberneticians and that of Piaget, Papert revealed how he saw his own role:

8 Reference.

9 Papert, p. 2, "Introduction to *Embodiments of Mind* by Warren S. McCulloch," *Embodiments of Mind* published by MIT Press, Cambridge, MA, 1965.

10 For example, beginning in the 1930s many neurophysiologists used the electroencephalograph (EEG) machine to measure changes in electricity flowing through the brain. These studies were the subject of numerous hypotheses about the way that the brain works.

to bring together active research on computers as information systems at MIT with Piaget's information-based theories of learning in order to develop the human mind with the computer according to constructivist principles.

Papert was always certain that human interaction with computers would bring about psychological change in human beings. He presented the computer as, "the biggest 'experiment' in psychology ever 'performed.'"[11] He was, however, concerned that the general state of anxiety[12] about the role of computer technology in the transformation of individual and social life had led to fear and, worse, denial of the power of computers and AI to affect individual and collective psychology. For example, in a lively critique of a fellow MIT colleague, philosopher H. L. Dreyfus', Papert argued that his generation must come to face the reality of computer developments:

> The steady encroachment of the computer must be *faced*. It is cowardice to respond by filling 'humanities' departments with 'phenomenologists' who assure us that the computer is barred by its finite number of states from encroaching further into the areas of activity they regard as 'uniquely human.'[13]

He added that instead of proving to people like Dreyfus why their pessimistic perspective on the future capabilities of the computer were false, he preferred "to probe the problems we all have in integrating man and machine into a coherent system of thought."[14] In this early suggestion for a project, Papert set the tone for the kind of work he would pursue with LOGO: to integrate knowledge about humans and computers into one system of thought so as to show (to nay-sayers like Dreyfus) that human beings and computers could not only co-exist, but in fact benefit one another.

While practically searching for ways to "integrate" humans and machines during the course of his experiments with LOGO and child learning in the 1970s, Papert formulated his own theory about knowledge. As a true disciple of Piaget, Papert was concerned about developing understanding of the human mind. His theory, which he termed "constructionism" (with an "N"), is closely related to Piaget's "constructivism" (with a "V"). Both theories emphasize the role of active making, or construction, of knowledge by the individual. There is

11 Papert, "Computers and People," 1977, p. 14.
12 For a discussion about this "anxiety," what it is, how it presented itself at the time, and its role in the development of computer literacy programs see section "A Time of Anxiety" in Chapter 1.
13 AIM-154, p. 3.
14 AIM-154, p. 4.

an important difference between the two theories, however, that arose as a result of Papert's work with children and computers. This difference consisted in the role of "concrete thinking," or thinking through abstract problems with the help of an object. For Piaget, concrete thinking was only a stage on the way to the development of higher-order abstract thinking. Papert, on the other hand, did not consider concrete thinking a stage, but a *style* of thought in its own right. Papert claimed that with intimate use of "computational objects," or robotic or virtual objects manipulated by or created with the help of computers, thinking could stay concrete, or even show a "reversal" of Piagetian stages: abstract thinking could become concrete thinking.[15] Interaction with computational objects, he argued, prompted a general "revaluation of the concrete," which, he claimed, had larger ramification than just in learning.[16]

Constructionism was Papert's answer, I argue, to the challenge he articulated in his critique of Dryfus: of how to successfully integrate "man and machine into a coherent system of thought."[17] It is significant that constructionism, though clearly influenced by Papert's early work with Piaget, was developed only during the course of Papert's work with LOGO. While observing children interacting with LOGO, Papert claimed to learn something about the way that the human mind works and, more specifically, how children acquire new knowledge. At the same time as constructionism emerged from Papert's work, it also served as a guide for this work. For instance, LOGO was designed to reinforce the supposedly natural "concrete thinking." Making children into (even more of) concrete thinkers had, according to Papert, important political consequences. In the rest of the section that follows, I will describe Papert's involvement in the LOGO project, highlighting how his constructivist ideas of the workings of the human mind influenced LOGO and, how, at the same time, LOGO sought to promote constructionist ways of thinking and knowledge-making.

<u>LOGO – A children's computer language</u>

Papert saw LOGO as a tool to produce "megachange" in education. Although the way that the LOGO researchers before Papert joined the project thought about the language

15 Papert, "Computers and People," 1977, p. 14.
16 Turkle and Papert, p. 162.
17 AIM-154, p. 4.

reflected ways of thinking about the role of computers in education that were novel at the time, Papert's ideas about what the language could do to human thinking was unprecedented. I argue that it is Papert's grand vision of LOGO as a tool with which to transform the processes of human learning and thinking that led him to become recognized as LOGO's chief developer and proponent.

The LOGO project, however, began without Papert and without this grand vision. Work on LOGO began in 1967 at the Educational Technology Department in Bolt, Beranek, and Newman (BBN) technology research corporation in Cambridge, MA,[18] as a project to design a new programming language for education. The Educational Technology Department (ETD) had been formed two years earlier, in 1965, by Wallace Feurzeig. The founding of ETD marked a change in the company's work in the field of education and technology. Before 1965, the company was developing computer-based tutorial environments and now shifted its attention to investigating *programming languages as educational environments*. This change within the company reflected a greater shift away from "top down" drill-and-practice-type projects that saw the computer as a tool to facilitate learning of already-existent educational content and towards frameworks of "computer literacy," in which the computer was envisioned as a tool to transform what education could be. Feurzeig led a group of researchers at ETD on its first project, STRINGCOMP, a computer language that embodied more constructivist, "bottom-up," principles. Feurzeig adapted STRINGCOMP from the language TELECOMP (a language originally designed for scientific and engineering computation) to create an educational environment for learning mathematics by allowing elementary and middle school students to make non-numerical manipulations with strings. STRINGCOMP was tested in eight elementary and middle school mathematics classrooms in the Boston area in 1965-66.

The success of the constructivist approach, the absence of a computer language for an educational purpose and the strong national priority of developing American mathematics and

18 BBN's location in Cambridge, MA, is not incidental. Walter Rosenblith describes it as a consulting company for acoustics in architecture issues that formed out of MIT's Acoustics Laboratory. Bolt was a physicist and director of the Acoustics Laboratory, and Beranek was the technical director of the lab, and Newman was the expert in architecture. (Interview with Walter Rosenblith by Eden Miller, Marstons Mills, Massachusetts, Session 2 - July 19, 2000, tape four, side one. Transcription p.4). BBN's role in the history of educational technology is significant. In 1969, just two years after beginning the LOGO project, BBN was awarded the commission from the US government to build the ARPANET.

science education post-Sputnik, combined to create the parameters for ETD's second project: another computer language for children that would become LOGO.

With the support secured to begin work on a computer language for children, Feurzeig invited Papert in 1967 to become a consultant on the project. Papert had recently returned from Geneva where he studied and collaborated with Jean Piaget, the world's authority on constructivism. That same year Papert had also joined the MIT mathematics faculty as professor and became the director of MIT's AI Lab. Work on LOGO sat squarely at the intersection of Papert's interest and expertise in constructivism and mathematics. Papert joined Feurzeig and a team of ETD engineers and educators, including Daniel Bobrow, Richard Grant, Cynthia Solomon.[19] Together, the researchers set out the following requirements for this new educational computer language:

> Third-graders with very little preparation should be able to use it for simple tasks.
>
> Its structure should embody mathematically important concepts with minimal interference from programming conventions.
>
> It should permit the expression of mathematically rich non-numerical algorithms, as well as numerical ones.[20]

These criteria revealed the new language's peculiarities that Papert would later evolve in order to help the language become a general tool for influencing thought and learning. For example, here was a language conceived for young children who were not expected to be nor to become mathematicians, programers, or otherwise specialists in computers. The criteria were explicitly formulated away from specialized preparation while programming conventions were seen as "interfering" with the primary goal of communicating mathematical concepts. The requirements emphasize "expression," pointing to the idea that would become core to LOGO, namely that children could express themselves– including their physical and aesthetic inclinations– through the new programming language. The programming language was envisioned to express ideas and thoughts in words as its name, "LOGO," suggests[21]. Feurzeig

19 The same year that Papert joined the MIT mathematics faculty as professor and became the director of MIT's AI Lab.
20 Ibid, 291.
21 The decision to call the new programming language "LOGO" both masks and reveals the new relationship between words and thoughts that the language's designers had in mind. The name "LOGO" brings to mind traditional words, such as the ones written on a page, and at the same time challenges this traditional word with the idea that computer code is more than just a word but is also an action. See Chapter 1 for a discussion of this in the context of the relation between traditional literacy and computer literacy and for examples of how other scholars (and patent law) have thought

selected this name as an explicit reference to the Greek $\lambda o \gamma o \sigma$ (logos), "the word or form which expresses a thought; also the thought itself."[22] The use of word (e.g., "Forward," "Left") rather than number commands also had an instrumental purpose consistent with the criteria, i.e. to require little preparation to master. Word commands were considered to be easier to understand and learn both for children and adults.[23] These criteria, the language's name, and its constructivist underpinnings set the language up to become a tool for the general shaping of minds.

While it was under the auspices of BBN, however, LOGO remained a relatively instrumental (applications limited to teach mathematics) and small-scale project. Papert developed LOGO's functional specifications while Bobrow made the first implementation in LISP on a Scientific Data Systems SDS-940 computer. The first version of LOGO was tested with fifth and sixth grade math students at Hanscom Field School in Lincoln, MA in the summer of 1967, with the support of the U.S. Office of Naval Research.[24] This first test revealed that the language was not immediately considered appropriate for the younger (10 year old) children that it was targeted for as well as that it was thought of largely in relation to mathematics education and considered in terms of strategic military interests. In the 1967-68 year, the ETD group created an expanded version of LOGO which was implemented on the DEC PDP-1[25] computer by Charles R. Morgan and from September 1968 through November 1969, the National Science Foundation supported the first "intensive program of experimental teaching of LOGO-based mathematics in elementary and secondary school."[26] 1969 also saw the first experimental use of LOGO with children under 10 years old. The classroom work was carried out at the Emerson School in Newton, MA.[27] This second version of LOGO had now expanded to younger children and came under the auspices of the NSF instead of the Office for Naval Research, however it still had a relatively instrumental application to teach mathematics. Papert and his colleagues recognized the potential of LOGO to play a more expansive and transformative role in education, which was a large part

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about computer code in relation to words.

22 Ibid., citing Webster-Merriam Dictionary, 1923.

23 Feurzeig [ibid?]

24 Feurzeig and Papert, 1968. [for reference, see Feurzeig's article]

25 [Compare the SDS-940 and DEC PDP-1 machines. Was one considered simpler to use than the other?]

26 Feurzeig et al., 1969.

27 Ibid., p. 293.

of the decision to move work on LOGO under the auspices of the AI Lab at MIT where Papert was director.[28] At MIT the theoretical and practical development of LOGO would continue for over twenty years and it would become, according to Papert, its key visionary, the source of transformation to how people learn.

Growing LOGO at MIT – "A totally different learning environment"

In bringing LOGO to MIT, Papert hoped that it would be possible to use it to build a "totally different learning environment" as compared to the learning environment of public American schools at the time.[29] Experiences with Piaget led Papert to articulate this big goal for education– and for the formation of the human being. The new learning environment would be one that began neither with the existing school system's problems nor from a technology that could provide a solution, but from a vision of what constituted good learning.[30] Papert's vision of good learning came from his understanding of the workings of the human mind as understood by constructivism and from the LOGO project, which involved the application of constructivist theories to education with computers.

The creation of a "totally different learning environment" required first its own environment to call home. In 1969, the year before Papert officially brought LOGO to MIT, he began plans to build the Children's Learning Lab.[31] The Lab would be housed on the first floor of a building across from the MIT campus called "Technology Square." Technology Square was already headquarters to the AI Lab (on the top floor) and a number of other prominent computer researchers.[32] Papert and fellow AI Lab member, Marvin Minsky, put the Children's Learning Lab under the auspices and research program of the AI Lab. Papert's decision to house the LOGO research at the AI Lab was significant for the language's subsequent development and reflected Papert's belief that research on the children's computer language was central to both understanding the human mind and influencing it.

The name and activities of the Learning Lab that Papert set up were indicative of this vision for LOGO. Learning Lab was intended as a space to conduct "learning research" and

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28 Need to find out what the full reasoning/motivation for this move was.
29 Reference
30 Papert, "Some Poetic and Social Criteria for Education Design," appendix to 1976 NSF grant, also LOGO MEMO 27.
31 Records about the building of the Lab at the MIT Archives date from 1969-1974.
32 [MIT 2003 article on Technology Square]

"learning experiments"[33] with elementary school children. Children and teachers from schools in the Boston area came to the lab where Papert and his colleagues could study how children interact with computers and train teachers in the use of LOGO in the classroom. It was a site of simultaneous development and improvement of the LOGO language and software based upon feedback from teachers and students and, at the same time, a place to study how children learn. In addition to using the Lab to study learning, Papert's colleagues from artificial intelligence were also interested in the activities of the Learning Lab for the development of emergent AI, which depended upon the design of *computers* that were capable of learning.[34] The name "Children's Learning Lab" therefore had two meanings: a place for children to learn about computers and a place for psychologists, AI specialists and other interested academics to learn about how learning takes place in human beings so as to apply these lessons to the designs of machines. Even before LOGO arrived to MIT, its future location in the Children's Learning Lab as part of the AI Laboratory reflected Papert's grand venture of it to become a tool for simultaneously studying and transforming the human mind.

Microworlds

Under Papert's direction, work of the "LOGO Group" at MIT continued to develop the constructivist principles at the foundation of the computer language and designing the language and accompanying hardware in such a way that it could be used to influence human thinking and learning. In the work of Papert and colleagues at MIT in the 1970s, we can see the pursuit of Papert's "entrepreneur of the mind" vision that the child would learn subjects like mathematics, but also *how to relate to others and the world*, within the structures provided by LOGO.

Papert and his colleagues sought to achieve this broad vision by using LOGO to create "microworlds," or simulated worlds in the computer that contain the right kinds of resources for the child to draw upon for learning. The idea of a "microworld" came from constructivism. Constructivism emphasizds the importance of the "world" or surroundings of the child, from

33 Goldstein and Papert, 1976.
34 [see Papert working paper and Papert's ideas about the two types of AI in *Daedalus*]

which the child draws resources for learning.[35] The real world of the school in which structured learning usually takes place, Papert argued, did not always contain the proper resources for learning, but in the microworld all of the appropriate resources could be provided.[36]

Papert believed that in the computer microworld children could learn more "naturally" than in the classroom. He described learning math with LOGO to be a more natural way of learning, consistent with constructivist insights about how learning takes place. Papert believed that the reason why subjects like math and grammar as "traditionally" taught in schools may appear to children as dreary and difficult to learn (with the consequence that not everyone learns them) was that they were "denatured" from "real" mathematics and true grammar. Children are forced to learn this "artificial" and "denatured" type of math or grammar, while for their adult specialists these subjects are fun, dynamic, and intertwined in complex ways with other aspects of life. These subjects *must* be denatured, thought Papert, in order to be taught in the traditional way in school because the school relies upon the "static" "technology of paper and pencil." In contrast, the "dynamic technology of computers" could be the basis of teaching these subjects in a fun and complex way, much like students of all ages learn to dance in a Samba School– Papert's preferred example of a successful and good model of learning.[37] What made the computer "dynamic" in Papert's eyes was that it was a kind of "Proteus tool,"[38] an ever-adaptable technology that, through the flexibility of the microworld, could mold to the learning needs and style of expression of each child. However, LOGO microworlds did not mold to any *a priori* learning needs or style of expression of the child, but created their own structures according to which learning needs and expression would be defined. The manner in which LOGO informed the learning mind can be seen by analyzing the specific material artifacts and educational content that Papert and his colleagues designed. I describe in detail the way in which these artifacts and content informed children's activities and interactions in Chapter 3. In the remaining part of this chapter, I want to introduce two of the most important aspects of LOGO that were used to generate

35 Reference from Piaget
36 Reference
37 Ibid., p. 3.
38 Reference. In calling the computer a "Proteus tool" Papert refers to the constantly changing nature of the sea that the Greek god Proteus represents in Greek mythology.

rich and flexible microworlds– the LOGO Turtle and Turtle Geometry– and to show how they were central to Papert's toolkit for venturing to transform the mind.

Constructionism

In order to understand the significance of the LOGO Turtle and Turtle Geometry for the formation of the child's mind, it is essential to see them in the context of Papert's theory of "constructionism." The LOGO Turtle and Turtle Geometry were tools that both enabled Papert to formulate the theory of constructionism and, with the help of which, Papert and colleagues could promote "concrete thinking" in children. The original specifications for the new programing language for children developed by BBN researchers did not explicitly call for a "computational object" like the LOGO Turtle. Constructivist insights that children learn abstract thinking through the engagement with concrete objects in their environment prompted the idea to create a "computational object" to facilitate the child's learning, exploration, and creation with the programming language.

Research on what would become the LOGO Turtle began in the early 1970s at BBN and developed at MIT in the first wave of NSF funding for LOGO between 1973 and 1976. The first LOGO-controlled robotic turtle was created in 1971 based on the work done at BBN and with the help of consultant Mike Paterson.[39] The first remote-controlled Turtle named "Irving" was designed in 1972 by Paul Wexelblat at BBN. The choice of the Turtle form for this educational robot was likely not accidental. A few early animatronic and cybernetic "creatures," for example Grey Walter's tortoises and Claude Shannon's "Theseus," took the turtle form. These creatures were landmark creations of machines capable of learning. Now, the LOGO Turtle was another turtle cousin would be helping children to learn and give researchers insight into child learning. Thus, the LOGO Turtle joined a long lineage of devices for the exploration through technology the workings of the human mind.

Irving and its subsequent clones were approximately one foot in diameter with a transparent dome. It could be controlled through LOGO commands via a radio transceiver attached to a teletype terminal connected to a remote computer. It could be programmed to

39 Ibid.

move in the direction of the four cardinal points an increment of distance specified by the programmer. When prompted by a simple command, the Turtle could turn to a specified increment of angle, lower a retractable pen and "draw" while moving. Contact sensors on its antennas "knew" when it encountered an obstacle. The same year that the robotic turtle appeared, the MIT LOGO Group created a "virtual" Turtle (represented by a little isosceles triangle on the computer screen) that used the functionality of the computer graphic display to draw on the screen instead of on real paper.

The Turtle, whether a physical robot or virtual representation, was central to the MIT LOGO Group's work. The LOGO Turtle and its accompanying Turtle Geometry were part of the first wave[40] (1973-1976) of LOGO research at MIT focused on developing objects and content for use in teaching to support the ability of LOGO to generate rich and flexible microworlds.

The use of the LOGO Turtle as a "dynamic technology" of computers in the classroom required "inventing" "some real mathematics suitable for children and which can be meaningfully embedded in a feasible technology."[41] Papert and his colleagues developed what they called "real mathematics" (as opposed to "denatured") called Turtle Geometry. The program encouraged children to learn geometry (shapes, angles) by playing with the Turtle – making it move around the floor or screen and draw various figures. Papert prided himself on the fact that by mastering simple computer commands (e.g. "Forward," "Left), the child could create infinitely complex and beautiful shapes. The geometry lesson that such activity taught would take place in a playful and curious process of relating and experimenting with the Turtle.

Ironically, "real" math needed to be "invented" to be effectively embedded in the computer form for teaching. Papert's understanding of what constitutes "real" mathematics was informed by his understanding of constructivism and the role of the "world" in learning. According to Papert, Turtle Geometry, the invented mathematics for use with the computer, was "real" because it gave its user access to a contextualized (micro)world where mathematical concepts had tangible meaning according to what children already knew or understood.

40 These "waves" are designated by two rounds of NSF funding for LOGO research. Reference
41 Ibid.

Papert expressed the reality of the mathematical experience with Turtle Geometry by using his favorite metaphor of dancing:

> Learning math by talking to Turtles is like learning dancing by dancing with people while learning math by doing pencil and paper 'sums' is like learning dancing by rote memory of pencil and paper diagrams of dancing 'steps'.[42]

For the purposes of learning, the microworld enlivened the subject that is taught in it, making it much more "real" than had it been taught in an "artificial" or "denatured" way with pencil and paper. But the educational power of Turtle Geometry as conceived by Papert was intended to be much more than just a way to teach mathematics.

The NSF grant that Papert and the LOGO Group wrote up to fund the development of Turtle Geometry was framed as a much broader study of "children's thinking and elementary education."[43] The goal of the project was to also act upon children's thinking *about* elementary education by integrating together different knowledge disciplines:

> The methods already developed in our project add new dimensions to the possibilities of curriculum reform in mathematics, physics, biology, and other conventional school subjects. They also allow us to remove artificial barriers between 'subjects,' and so to integrate mathematics with the other sciences, to integrate science with linguistics and other academic areas and even to establish links between 'academic' work and freer activities such as music and gymnastics. Partly through removing these barriers, partly independently, we are able to achieve a more involved and personal participation of children in their work.[44]

Beyond just teaching mathematics, the Turtle was an instrument for bringing together psychological theories of human and machine in order to integrate different fields of knowledge and make learning more natural.

Once a number of objects and ideas for use in education had been developed, Papert and his LOGO Group colleagues turned their attention to "well-planned and rigorously controlled experiments" to test their approach to education.[45] For the second three-year segment of NSF funding (1976-1979), they proposed to develop a "learner-centered theory of

42 Papert, "Some Poetic..." p. 4.
43 NSF Grant reference.
44 AIM-246, p. 2, emphasis added, LOGO Memo 1 (AIM-246, 1971), reproduces the text of Papert's NSF grant application.
45 Papert and Goldstein, 1976, "LOGO Proposal 1976-1979."

cognition" that is not only "about" children, but also "for" children.[46] To develop theories "about" children, Papert proposed to use the computer itself:

> [T]he computer presence helps us acquire psychological knowledge. It does this partly by creating new situations which allow us to obtain data about the processes of learning and thinking. It helps also by providing new models for building psychological theories.[47]

Papert sought out to "use computational ideas as a model for explicating various cognitive phenomena."[48] In other words, by using the informational-processing image of the mind and assuming a kind of equivalence between computer and mind, Papert and his colleagues drew conclusions about the functioning of the mind based on what they observed to take place in computers.[49]

They did not want to stop, however, at just developing theories of cognition, but rather sought to "develop insights into the learning process that, if taught to the student, can serve to improve his problem solving performance."[50] In other words, they aspired to create a feedback loop between studying and improving human cognition with computers.

Studying children's interaction with "computational objects" such as the Turtle at the Learning Lab and in schools was the primary material for this second phase of the LOGO Group's work on the study of cognition with and through computers. The study of children's interaction with computation objects was interesting to the researchers from the point of view of learning about the human mind because of the position "on the boundary between the physical and the abstract"[51] that the objects occupied:

> In our context, the computer is not merely a device for manipulating symbols. It actually controls real, physical processes: motors that turn, trucks that move, boxes that emit sounds. By programming it, the child is able to produce an endless variety of actions in a completely intelligible, controlled way. New mathematical concepts translate directly into new power for action. Self-generated projects induce an immediate and practical need to understand the mathematics of movement, the physics of moving bodies and the formal structure of sound patterns.[52]

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46 Ibid., p. 26-27.
47 Papert, "Computers and People," 1977, p. 14.
48 Reference.
49 [Examples of theories they came up with?]
50 Ibid., p. 26.
51 *Constructionism,* Turkle and Papert, 179.
52 AIM-246, p.3.

According to Papert, the unique capacity of the computer to span the abstract world of symbols and the concrete world of physical movement and sound, enabled a special kind of learning and thinking. Observing children "playing" with the Turtle, Papert and his colleagues saw that children engaged in "concrete thinking." Papert believed that by engaging with these new entities, children could learn abstract thinking through the practice and experimentation (making) with the concrete. These observations of children's interactions with computational objects led Papert to posit his theory of "constructionism."

Papert and his colleagues argued that by privileging concrete thinking computers contributed to two important social changes. First, Papert believed that children's intimate interaction with computational objects would create a new cognitive paradigm, one which would be more distinct from the pre-computer world than "pre-urban jungle villages."[53] Papert saw constructionism as an alternative epistemological paradigm, one capable of bringing about what he called an "epistemological perestroika," or a transformation in the "structure of knowledge itself."[54] He used the Perestroika of the Gorbachev era as a metaphor of how change can happen quickly and unexpectedly in areas that seem impregnable to change and how attempts at small changes (he liked to call these "jiggering") are not adequate to fix a major structural problem. Papert saw parallels between the five year plan economic system of the Soviet Union and the twelve year educational plan (according to which it is decided when a child would learn what). He believed that only by changing the established paradigm of knowledge could education be changed for the better.[55]

Second, constructionism was such a radically different epistemological paradigm that it would enable what Papert called "megachange" in education. Computers helped to make the school a more "natural" and less "technical" place of learning. Papert acknowledged the apparent irony of this idea. It is surprising, Papert wrote, "that technology should be the instrument for the achievement of a less technical form of education."[56] In this context, "technical education" meant education focused on the memorization of abstract concepts that were removed from real-life significance and were outside of the realm of tangible experience.

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53 Papert, Computers and People 1977.
54 Perestroika 22.

55 Perestroika 14.
56 Perestroika 18.

School is technical, Papert argued, because it privileged centralized, bureaucratic planning of what should be taught and hierarchical execution of these plans by servile teachers. Education could be more “natural” if computers could act as intermediaries between the realm of the abstract and concrete. With constructionism, Papert sought to "release [the] teacher from the role of technician and education for its technical form."[57] Thus, with computers, education in the classroom could come closer to the already natural process of learning.

By opposing the constructionist epistemology to the dominant paradigm of knowledge that kept the school technical, Papert opposed not only the existent school system, its planning, bureaucracy and manner of organizing the relations between teachers and students, but also the "hard" and "planning" (as opposed to "soft" and "*bricoleur*[58]") approach to computer science, as well as abstract, formal, and logical paradigm in scientific thought.[59] In this mission, he and his colleagues (notably Sherry Turkle) considered the constructionist project to be an ally of feminism, Africanism, sociology of science, and object-oriented developments in computing,[60] all of which seek to challenge dominant and "conservative" modes of social organization and epistemological orientation.

I began this section by quoting Papert and Goldstein saying that they believed that the computer would bring about a revolution in human life similar to the one that took place when human beings started to use tools. Their statement implies that this technological revolution required a revision of the definition of human being. But then what would this new definition of human be? If the tool revolution prompted the definition of human to be “tool-using animal,” then how would human be defined vis-à-vis the “tools of the mind”? It seems that the history of Papert's work, especially his search for a system of thought that would integrate human and machine, provides a hint of the answer. For Papert, the computer as tool of the mind was one of the most natural tools, one capable of positively enhancing the humanity of its user and lead to more effective learning and just social order.

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57 Perestroika 18.

58 See discussion of *bricoleur* in the context of computer literacy programs in Chapter 1.

59 Turkle and Papert 162.

60 Papert saw the developments in computer-related research fields such as artificial intelligence and cybernetics to support the epistemological Perestroika that he advocated. He said that "emergent AI" (Turkle and Papert 1991; Papert 1988 in Daedalus), object-oriented trends in computation, and hacker-bricoleurs who are "counter-cultural programmers" (as opposed to the "hard" and "planner" style of programing) (Turkle and Papert 1991) share the same epistemological orientation, consistent with his work in education.

Jean-Jacques Servan-Schreiber

In France, Jean-Jacques Servan-Schreiber (1924 – 2006) conducted a very different style of entrepreneurship of the mind with the computer from that of Seymour Papert. Servan-Schreiber was not a mathematician or computer scientist, but a journalist and politician for whom the stakes of computer education were always articulated in nationally strategic terms instead of in terms of epistemological theories and ideas about the best or most natural way to learn. Servan-Schreiber was concerned about France's waning economic and political position in the world and through studying these concerns he came to the belief that general computer literacy would enable France to reclaim its economic and political strength. Despite this different background, concerns, and manner of pursuing public computer literacy, Servan-Schreiber believed that computer literacy would help to develop the mind of the French citizen, both fulfilling that person's sense of self and increasing her contribution to society. Servan-Schreiber facilitated the entrepreneurship-of-the-self with the computer.

These ideas about people using computers to enhance their minds in the context of France's economic challenges, originated from and further contributed to Servan-Schreiber's concept of *la ressource humaine* (human resource). *La ressource humaine* was an idea about what a person means in a social, political, economic context of his or her country. It was the idea of people as resources, or, more specifically, people as bearers of certain capabilities of the mind (skills, faculties, knowledge) that serve as resources for herself and for society.

Servan-Schreiber pursued his vision of developing *la ressource humaine* with the computer by creating in 1981 a public institution called the *Centre Mondial Informatique*[61] *et*

61 *Informatique* is a term selected by Bull engineer Philip Dreyfus in 1962 to translate into French the English "computer science." The term combines the words "information" and "automatique." Before the French, the term was already used by German and it is used in Italian, Spanish, Portuguese, and Russian. Although "informatique" was intended to be the translation of "computer science," there are important differences in what the terms emphasize. Donald Knuth writes that "American researchers have been reluctant to embrace that term [*informatique*] because it seems to place undue emphasis on the stuff that computers manipulate rather than on the processes of manipulation themselves" (Knuth 1996: 3). Unlike "computer science," *informatique* is not only a field of study or a discipline, but refers also to computer hardware, software, and the uses to which they are put. To preserve this polyphony of meanings, I use the original French term throughout this paper when citing French sources. To investigate in relation to citizenship: Ivan Illich has an insightful description of the uniqueness of this term in the French language: "Seule la langue français connaît le terme 'informatique'. Dans aucune autre langue un seul mot englobe l'appareil, le programme, le technicien et jusqu'aux utopies de l'utilisateur. Pour traduire ce

Ressource Humaine (World Computing and Human Resource Center, CMI). The CMI was intended to introduce people to computers. Instead of developing a children's computer language as a way to influence human thinking, Servan-Schreiber founded the institution of the CMI, which, during the course of its brief lifetime would venture to realize the vision of the *la ressource humaine* by the way in which it brought together under one roof children, the French public, international computer researchers, and different kinds of computing equipment and software. In this section of the chapter, I will show how Servan-Schreiber ventured to transform the human mind with computer literacy by tracing the notion of *la ressource humaine* and the role of the computer in its development from its conceptual origins before the CMI through the Center's activities.

La ressource humaine

Servan-Schreiber' concept of *la ressource humaine* developed over the course of three decades, likely originating at the time, when, in 1953, as a 29 year old recently returned from abroad, he began publishing in his political journal, *l'Express*. The concept, however, was not formalized until 1981, when Servan-Schreiber first described it in relation to the development of a computing center that had the presidential mandate of forming the French citizen with the computer. In the intervening decades we can see how issues like colonization and social improvement that concerned Servan-Schreiber serve as the foundation for the way in which he begins to think about the role of computers in emancipating individuals in society and generating social well-being.

Servan-Schreiber began to actively criticize colonialism as a young journalist. In 1953, he and fellow journalist Françoise Giroud created a Saturday supplement called *L'Express* to Servan-Schreiber's father's economic newspaper *Les Échos*. *L'Express* focused on political issues, notably on France's involvement in Indochina. The popularity of the supplement soon made it an independent publication. The journal attracted a generation of young executives who had lived through the aftermath of the French Liberation. These readers were

terme en allemand, et encore en anglais, je dois dire: "L'informatique, c'est l'usage de l'ordinateur dans un état régi par le code Napoléon". Vous seuls pouvez distinguer l'informatique de l'esprit, comme vous distinguez l'amour du mariage et la société civile de la société politique." Illich, "Le contenu et la portée du livre," materials for unpublished book, *La cité du futur*, June 12, 1980.

dissatisfied with France's embroilment in colonial wars, which they perceived to be of another age, distrustful of ideology, and wished to be governed by skilled, practical individuals.[62] They shared Servan-Schreiber' conviction that France must grant its colonies independence and so flocked to *L'Express* and Servan-Schreiber as a key representative of this idea. The journal strongly criticized the French-Algerian war, with contributions from authors and public intellectuals such as François Mauriac, Albert Camus, and Jean-Paul Sartre. It was through this publication that Servan-Schreiber developed first hand knowledge of colonization; a concept he would draw on later for ideas of how the computer could improve society by informing each individual mind.

First-hand experiences in the Algerian war prompted him to think about the individual plight of colonized peoples. Perhaps as punishment by the government for his strong criticism of the war,[63] Servan-Schreiber was drafted as a pilot in Algeria. Upon returning to France, he published a critical account of his experience in his first book, *Lieutenant en Algérie* (1957). This book, together with the articles of *l'Express,* highlighted issues of how people's opportunities for personal growth and for social growth are limited because of imposition of the colonial power.

In two important publications, *Le Défi américain* (*The American Challenge,* 1967) and *Le Défi mondial* (*The Global Challenge,* 1980), Servan-Schreiber articulates two ideas that would later find crystallization in his concept of *la ressource humaine*. In *Le Défi américain* Servan-Schreiber argues for the need to transform French society through a particular kind of managerial education of its citizens and in *Le Défi mondial* he articulates how knowledge of computers and computerization of society are necessary for France to remain globally competitive.

After years of writing for and expanding *l'Express* to include reflections on different political and social issues, such as new technologies, women's rights, and comparative economy, Servan-Schreiber organized his experiences, observations, and ideas in an important book titled, *Le Défi américain* (*The American Challenge*), 1967.[64] In this book, Servan-

62 Spécial Servan-Schreiber, *L'Express,* 2006. p. 2.
63 Ibid., p. 3.
64 The title of Servan-Schreiber' book echos that of his father, *L'Exèmple américain* (*The American Example).* Need to understand what Servan-Schreiber' father's book was about and how the two relate.

Schreiber presents the first major characterization of the concept of *la ressource humaine* (without yet using the term itself) that would influence his ideas for computer literacy as a national agenda for France. *Le Défi américain* advanced the argument that the United States was outpacing France, not only in economic terms, but, most importantly, in cultural and social. Servan-Schreiber describes the "challenge" presented to France by the US in the following apocalyptic way: "a foreign challenger [is] breaking down the political and psychological framework of our societies. We are witnessing the prelude to our own historical bankruptcy."[65] The reason for this, according to Servan-Schreiber, was America's superior managerial and organizational abilities and the relative lack of a strong foundation of management in France and Europe as a whole. In other words, American success, according to Servan-Schreiber, is primarily built upon not "hard" traditional industry and capital, but on a particular kind of "soft" knowledge: the knowledge of effective organization and management. Respectively, Servan-Schreiber says that the answer to this challenge lies not in prohibiting of American investment[66] and, above all, not in nationalizing French industry,[67] but in education[68]. He advocates reforms in general, technical, and, especially, managerial education in France.[69] What France lacked, in other words, was a particular aspect of a human resource: the resource for effectively managing business organizations and society, and what it required to regain its preeminence was the development of this most valuable "resource" that the nation possesses: the minds of its citizens.

Le Défi américain was an enormous success. It was very widely read in France and abroad. It sold the most copies in the 'political essay' category in France (even to this day[70]) and has been translated into fifteen languages.[71] This success, combined with the personality of the author, set him up for direct involvement in the future of French politics.[72]

65 (xiii)
66 (30)
67 (42)
68 (80)
69 (81)
70 Verify Wikipedia.
71 Wikipedia, Servan-Schreiber (French), accessed January 9, 2013.
72 This involvement was expected. In the introduction to the English translation of *Le Défi américain,* Arthur Schlesinger Jr. wrote, in premonition, "It would not be surprising if he [Servan-Schreiber] himself were to take a promiment role in shaping the European response to the American challenge." Schlesinger, *Le Défi américain* preface, xii. Throughout the 1970s Servan-Schreiber participated in many regional political campaigns, as part of the Parti Radical-Socialiste. Running with Françoise Giroud for the European Elections of 1979, Servan-Schreiber obtained under 2% of the vote and retired from direct politics. Because he had used the money he obtained from selling *L'Express* to invest in his campaigns, he had little left after

In 1980, armed with his political experience, Servan-Schreiber significantly expanded his ideas in another book about the challenge facing France from abroad. In *Le Défi mondial* (*The Global Challenge*), Servan-Schreiber redirects his attention from managerial issues to technological ones, emphasizing the absence of adequate technological, especially computing, competence in France. What was presented as a largely cultural (managerial) challenge in the 1967 *Défi américain* appears as a technical challenge in the 1980 *Défi mondial.* In *Défi américain,* the "war" against France is being waged largely with "creative imagination and organizational talent."[73] The computer is one source of imagination and organizational talent of the Americans, but it is not itself the instrument of the economic and cultural war. By 1980, Servan-Schreiber describes American and Japanese superiority in terms of the advanced state of computerization (*informatisation*) of their societies. It is their successful computerization that is a direct threat to France. Only by herself mastering *informatique* can France hope to be able to compete with the rest of the world. Servan-Schreiber advises his readers not to resist computerization, but instead to embrace its benefits. Servan-Schreiber presents the computer as a threat when it is in the hands of the foreigner and a means of defense when it is in one's own. Servan-Schreiber saw the ability of the population to take advantage of the increasing computerization of society as key to helping France keep up with the rest of the world (and especially the US and Japan) in terms of the economy and culture.

By tracing the evolution of Servan-Schreiber's publications, we see how what begins as his concern for colonized peoples elsewhere gradually develops into concern about the livelihood of France in the global economy and the crystallization of a solution to this problem: the education of French citizens with and about the computer. Once Servan-Schreiber begins work on computer literacy in France, he articulates another link between colonization and computer literacy: computer literacy is the only means to emancipate oneself from the colonizing power of one's own nation.

Making the *Centre Mondial Informatique*

Without yet using the term *la ressource humaine*, Servan-Schreiber had built a set of observations identifying a French deficit about this particular type of human resources. His

the loss.

73 (xiii)

next step was to develop solution to correct this deficit. His entrepreneurial idea was to make a center in Paris where people can come and interact with computers outside of any other formalized context (e.g., school classroom, work office). It is notable, that although he identified the problem of the deficit to have political and economic consequences, his vision of the solution is to create a space where French citizens and foreign visitors have an open invitation to come to explore the technology creatively, instead of, for example, focusing on the development of school computer programs or computer training for working adults. Servan-Schreiber proposed his idea to President François Mitterrand, whom he knew personally and Mitterrand commissioned him to conduct a study about the feasibility of such a center.[74]

Mitterrand tasked Servan-Schreiber with the job to research the possibility of a Center that would be focused on mastering *informatique* so as to make of it an instrument of a new kind of economic and social development.[75] In a public letter to Servan-Schreiber, Mitterrand asks Servan-Schreiber to give his recommendations about how to go about setting up such a center, to which Mitterrand referred to in a narrower way as the “center of technological observation.”[76] Mitterrand lays out the goals of this center to include: collect information about global developments in micro-electronics for the medium and long-runs; elaborate the scenarios for the role of France in these developments and the stakes (for France) of each; study the ways in which the transfer of knowledge, education, and distribution of information about computers takes place so as to be able to increase the capacity of each person to have a job in tomorrow's society; develop new software for the personal computer; propose a strategy for knowledge-transfer to Third-World countries, adapted to the economic, social and cultural conditions of each.[77] Under the guise of “technological observation,” which suggests an experimental space for observing citizens' interaction with the computer, Mitterrand, with Servan-Schreiber's encouragement, actually called for a laboratory for actively forming the citizen with the computer.

In response to Mitterrand's commission, Servan-Schreiber proposed the plan for the

74 Mitterrand's commission letter.
75 (Letter from François Mitterrand to Servan-Schreiber, July 10, 1981, found in report of Oct. 26, 1981 by Servan-Schreiber to Mitterrand).
76 (centre d'observation technologique,” Letter from François Mitterrand to Servan-Schreiber, July 10, 1981, 20)
77 (Letter from François Mitterrand to Servan-Schreiber, July 10, 1981, 19-20)

Centre Mondial Informatique et la Ressource Humaine. This proposal was the first major mention of the concept of *la ressource humaine.*[78] Servan-Schreiber identified *la ressource humaine* as the fundamental object for the government to pay attention to and to develop as a top national priority.[79] "This revolutionary science," i.e. computerization, writes Servan-Schreiber to Mitterrand,

> that has created the large [automatized] systems and the powerful robots, possesses also, under the guise of '*micro-informatique,*' an unlimited capacity to increase without end, to nurture the human faculties of each, their capacity for new activity, new creativity, and new jobs.[80]

Servan- identifies human faculties to be limited, to be not fully achieved. They can only be fully realized with the help of the computer. Servan-Schreiber finds that the mastery of *informatique* brings not only economic advantage to France, but also social progress in the guise of the development of human faculties, specifically towards new kinds of activities and greater creativity.[81] The development of the *ressource humaine* would be the foundation of a new economy, the economy of the "société informatisée" ("informatized" society). In this society, the jobs would use the human capacity to feel, imagine, and communicate."[82] The new economy would use these human resources to create new growth, both economic and social. It is notable that Servan-Schreiber crystalized the concept of *la ressource humaine* in the formal plan to create a center to introduce computers. There is a fundamental tie between the naming of the concept and the proposal for a public computing center as a plan for forming the French citizen's mind with the computer.

The concept of *la ressource humaine* is interchangeable in Servan-Schreiber's writings

78 Verify this.

79 4, 1981 report by Servan-Schreiber to Mitterrand. This focus on *la ressource humaine* was explicitly Servan-Schreiber's. Upon commissioning Servan-Schreiber in 1981 to explore the possibility of a French computer center, Mitterrand did not use the idea of *ressource humaine* to articulate his idea for why such a center would be needed and what work would be done there. Instead, he spoke practically and instrumentally about the computer. He seems to care primarily about the place of France in the global development of micro-electronics and the preparation of French citizens with the computer for a new economy.

80 [Rapport à M. le Président de la République, Servan-Schreiber, Octobre 1981, p. 23, "Cette science révolutionnaire qui a crée les gros systèmes et les puissants robots, poséde aussi, sous la forme de la 'micro-informatique', une capacité illimitée pour accroître sans cesse, faire éclore les facultés humaines de chacun, ses capacités vers de nouvelles activités, de nouvelles créativités, de nouveaux emplois.]

81 [Ibid., "L'informatisation peut permettre aux hommes, quels que soient leur niveau, ou leur âge, de retrouver une utilité sociale, une vocation personnelle. Alors l'automatisation de l'économie sera bénéfique et naturelle. Les duex progrès, le social et l'économique, qui aujourd'hui s'opposent, pourront avancer de front" (23)

82 ("Emplois qui font appel essentiellement aux capacités humaines de sentir, d'imaginer, de communiquer, etc." 1981 report by Servan-Schreiber to Mitterrand, 29 underlined for emphasis in original)

with the idea of "human faculties." This link reveals more about how Servan-Schreiber thought about human being as resource. It suggests that what was most important in Servan-Schreiber's understanding of the human being was the mind. Servan-Schreiber believed that the advantages of computerization came specifically through this individual medium of developing each person's faculties.

> The specific virtue of computerization is that it allowes the deployment of personal faculties: the more it supports the individualization of education, of knowledge acquisition, of action, the better it will enable the best use of each person's capabilities.[83]

The reference to personal "faculties" dates back to the *Déclaration des droits de l'homme et du citoyen.* The word "faculty" comes from the the Latin *facultat* meaning power, ability, opportunity, and also resources and wealth.[84] In the 19th century, the individual was considered the owner of one's faculties– attributes of oneself, especially of the mind, which included one's will. It was the individual who controlled these attributes and could manage them (e.g squander or grow) as one liked.[85] The reason that the computer is uniquely positioned to develop and deploy these faculties is because, unlike other technologies, it is not an instrument that "multiplies the capacity to produce, but an instrument that multiplies the capacity of each person to develop oneself, to learn, to create."[86] Servan-Schreiber' conception of the human (found already in his 1967 book, *Le Défi américain*) was of someone who possessed faculties and of the CMI was as a place for the development and deployment of human "faculties" with the computer.

Life of the Center: Personal, universal, and French

The launch of the CMI was an opportunity for Servan-Schreiber to realize his vision for *la ressource humaine*--the vision of the human being as resource for oneself and society that is

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83 La vertu particulière de l'informatisation, c'est bien de permettre le déploiment des facultés personnelles: plus elle favorisera l'individualisation de la formation, de l'acquisition de connaissances, de l'action, plus s'accélèrera le processus qui fournira en contrepartie la meilleure utilisation des aptitudes de chacun (393).

84 OED.

85 See footnote 49 in previous draft.

86 "La novation essentielle qu'apporte l'informatique 'personnelle,' par rapport à tous les progrès du passé, c'est de n'être pas seulement un instrument de multiplication de la capacité à produire mais un instrument de multiplication de la capacité des hommes à se développer, à apprendre, à créer" (1981 report by Servan-Schreiber to Mitterrand 24, underlined for emphasis in original).

developed with and through the computer.[87] The activities and projects of the CMI shed light on how Servan-Schreiber conceived of actually going about developing *la ressource humaine* with the computer.

With the support of François Mitterrand, Servan-Schreiber opened the Center in the central and wealthy Parisian location on the Avenue de Matignon in 1981. The CMI was an experimental space that consisted of two floors. The heart of the Center on the first floor was a Hall for initiation into *informatique* ("Hall d'initiation á l'informatique") to which came 40,000 people per year. From the outside of the building, the glass façade of the Hall looked like a *vitrine* of a store. All kinds of computers and software were available for people to come and play with in the Hall. On the 2nd floor was the center for research and development and the offices of CMI's scientific advisors. The social experimental space below was linked with the research and experiment on the technology above. Thus, the CMI was a model of work on future products and a show-floor for the experimentation on these products by the curious public.

The CMI was not primarily intended to deliver structured learning of computer skills or of programming, but was instead a place to *experience* the computer. The Center was never explicitly concerned with computers in education, or what is referred to in French as *informatique scolaire,* or "school informatics." The CMI offered programs in computer training (*formation*), but these were reserved for older unemployed students who, the argument went, could become more desirable in the job market if they knew how to apply computers to their areas of work. Even when their programs concerned children, as the introduction of personal computers into Belle-de-Mai community in Marseille partly did, the people describing these programs were careful to point out that the program was not about *informatique scolaire*, but about the broader project of developing *informatique quotidienne* or "informatics of daily life." Although Servan-Schreiber himself never discussed explicitly the difference between the two, we can interpret this focus on "quotidienne" instead of "scolaire" as an attempt to move *informatique* closer to the day-to-day activities of the general public and away from more instrumental learning of how to program or using computers to teach school subjects.

87 To research further: In what ways does he define *la ressource humaine* differently in the proposal for the CMI than in *Défi mondial*?

The CMI was not so much for learning computers as for "learning how to learn" with the computer. In other words, it was focused more on the sharpening and improvement of a person's skills rather than on the development of any specific knowledge content. The inside flap of an informational folder about the CMI contained a photograph of a child's fingers gently hovering over a keyboard and, on the opposite panel, a quote from Kuan-Tzu: "If you give a man a fish, he will have a single meal. If you teach him how to fish, he will eat all of his life."[88] Kuan-Tzu's famous statement resonated strongly with Servan-Schreiber' thinking. It not only figures on the CMI folder, but also as an epigraph to his 1967 *Le Défi américain.*[89] The quotation summarizes how Servan-Schreiber viewed the role of the computer in the development of *la ressource humaine*: learning how to use the computer is supposed to serve the person in a multitude of ways. Servan-Schreiber envisioned the computer to be not for a pre-defined, narrow task, but for open-ended, imaginative development of the mind's faculties. One example that Servan-Schreiber gives of how this happens resembles the way in which Papert thinks of computers. Servan-Schreiber contrasts how learning to speak comes naturally to a child while learning to write and read do not. This is not because, says Servan-Schreiber, of the biological structure of the brain, but because of the cultural environment that are not favorable to reading and writing. With the help of the computer, for which the keyboard is an essential component, the child learns to read and write effortlessly (while pursuing another task, interesting and meaningful to her). But, says Servan-Schreiber, learning to read and write is only a convenient example: by working with the computer the child foremost "learns-to-learn" – this is the foremost skill that will serve her for the rest of his life and which was, according to Servan-Schrieber, largely responsible for the unique capacity of the computer to develop the *ressource humaine.*[90]

Instead of offering explicit computer training, the CMI provided more subtly the first formative lessons in computer literacy to the visitor by curating in particular ways her encounter with the computer. Being exposed to the R&D, being able to test the latest

88 CMI informational folder, presented by Servan-Schreiber to Mitterrand, December 15, 1982, Extrait 6539.
89 1969 Atheneum (New York) edition of *The American Challenge.*
90 Servan-Schreiber, Rapport à M. le Président de la République, Servan-Schreiber, Octobre 1981, Section: La mise en oeuvre, "Parce que le clavier est 'compris' par l'ordinateur, parce que l'enfant découvre qu'il peut déclencher, en jouant sur le clavier, des images et des signes et les mettre en mouvement sur l'écran, les conditions se créent naturellement pour que l'enfant apprenne, sans contrainte et continue, de lui-même, 'd'apprendre à apprendre' – bien au-delà de l'écriture, et de la lecture qui ne sont ici qu'un exemple" (28).

informatique developments, being able to have one-on-one use of the computer, was itself already a kind of education model for each visitor. This education encouraged citizens' active participation in the development of the future technology, their enrollment as consumers and partners in development in exchange for the ability to "play" and experiment for free. This experimental play (in lieu of structured interaction) was a central activity that the CMI sought to foster. The formation of *la ressource humaine* was not to be a forced activity, but an open and creative one willingly chosen by the curious visitor to the Center.

Additionally, the link between the public and the computing industry that CMI nurtured sought to train the visitor to stay abreast of the developments in the technology and to be in touch with the industry and experts through intermediaries like CMI researchers and Hall staff. This carefully curated technological awareness reflected a fundamental tension in Servan-Schreiber's understanding of the human being as *la ressource humaine* between the emancipatory and the subjectifying interpretations of this concept.

Servan-Schreiber believed that to successfully develop a person's faculties with the computer required a one-on-one interaction between human and computer. This one-to-one ratio was for Servan-Schreiber just as, or perhaps even more, important than the software with which one interacted and this idea influenced the physical arrangement of the center.[91] Servan-Schreiber makes this vision of "personal" interaction with the computer clear in the following passage:

> Everyone must possess a computer. A situation in which there are only a few computers in a classroom cannot lead to any valuable results. There needs to be one computer for each person. It's a personal tool. Also, the computer and its 'language' need to be conceived in such a way to be adapted to the faculties of everyone. Then, gradually, by everyone.[92]

The idea of the computer as a "personal tool," customizable to the needs of each person, reflects Servan-Schreiber' understanding of the computer as "personal and universal."[93] The

91 I will analyze in more depth the physical arrangement of the CMI and its significance in the following chapter.
92 [Reference]
93 "The real instrument of the *informatique* revolution, applied to education and to the development of abilities and knowledge will be 'the personal and universal computer,' as defined by Dr. Alan Kay's team," writes Servan-Schreiber. ("Le véritable instrument de la révolution informatique, appliquée à la formation, au développement des aptitudes et des connaissances sera 'l'ordinateur personnel et universel', répondant aux critères définis en particulier par l'équipe du Dr. Alan Kay" (Servan-Schreiber, Section "La mise en oeuvre", Rapport à M. le Président de la République, Servan-Schreiber, Octobre 1981, 29). Servan-Schreiber makes Alan Kay's definition of personal and universal computer [what is this definition/what are the criteria?]

computer was uniquely able to develop the human faculties because of its universality[94].

Even though it was based in a central Parisian location, the Center sought to impart upon the visitor a certain cosmopolitanism. The understanding of the computer as both "personal and universal" corresponded to the mission of the CMI to help to both develop *la ressource humaine* of each person and, at the same time, to be a global initiative. The official goal of the CMI was to be, from its central Parisian location, an *international* ("world") center for computing. In addition to French engineers and computer scientists, the CMI counted in its leadership an Austrian economist[95] and American engineers (most notably, Seymour Papert, Nicholas Negroponte, Alan Kay, Raj Reddy). A significant portion of the center's work was devoted to using computers to develop (economically and culturally) former French colonies in Western Africa and to research effective methods of "knowledge transfer" between "North" and "South" or "First" and "Third world" countries.

Mitterrand's socialist political stance informed the international mission of the CMI. In a speech delivered at the Carnegie-Mellon University (CMU) to CMU's president, Richard Cyert, on March 27, 1984, Mitterrand described how the economic crisis of the 1970s had been created by an indifference of the developed countries to the plight of the people living in the periphery. The realization of this problem since the 1970s required that developed countries like France and the United States address this problem by starting, at the "planetary scale," a "large [process] of knowledge transfer, of know-well, of know-more."[96] Mitterrand so emphasized the idea of knowledge (rather than technology or money) as the essential and valuable resource that he even developed two new knowledge-related terms "know-well" and "know-more," which positively qualify and embellish knowledge.

Servan-Schreiber stood firmly by Mitterrand's international attitude. He also envisioned the whole world to be consumed by the "industrial crisis," which left people unemployed and disadvantaged in France as well as in the developing world.[97] His book *Le Défi mondial,* Servan-Schreiber argued that without improvement in *la ressource humaine* throughout the world, improvement in France could not take place. The challenge, in his

94 Servan-Schreiber claimed that he took this understanding of the computer as at once personal and universal from American computer scientist Alan Kay. [Reference]
95 See list of participants from archives. Economist: Adam Sh[?]
96 François Mitterrand, "Les nouveaux outils peuvent sauver les hommes" to CMU president, 27 Mars 1984.
97 Servan-Schreiber, "Section: Le tiers monde comme partenaire," report to Mitterrand about CMI, p. 31.

mind, was to mobilize together "the interdependence of people" with the "technological revolution" of the computer. In his proposal for the CMI, Servan-Schreiber called for politicians to stop thinking about the Third World in terms of the transfer of technology: "It is no longer about implanting machines, but about training human beings."[98] This international vision shared by Mitterrand and Servan-Schreiber involved making the "Third World" a "partner" in computer research[99]:

> The new vocation of *micro-informatique* technologies that the Center must give rise to is a human vocation. [...] It is also a universal vocation, concerning each man and each woman on the planet. It will not be 'reserved' to the countries that are currently developed. This would be a negation of its very nature and forgetting of its objective: to unite the world that is made of partners 'finding' their interest in the 'common interest,' towards the indispensable 'planetary new deal.'[100]

This idea was reflected in the CMI research agenda and in the projects that the CMI undertook in former French colonies like Algeria and Morocco.[101] This internationalism attracted foreign scientists to CMI as well as sought to create the CMI as an institution into an exportable model that could be transferred to other countries to form their own citizens as human resources.[102] The CMI imparted upon its visitor the feeling of participating in a global

98 Il faut cesser de penser au Tiers Monde dans les termes, dépassés, de 'transfert de technologie.' Il s'agit maintenant d'autre chose. Il ne s'agit pas d'implanter des machines, mais de former les hommes. (31-2).

99 "La vocation nouvelle que doit faire naître le Centre, pour les technologies de la micro-informatique, est très précisément une vocation humaine. C'est la maîtrise à conquérir. Elle est aussi une vocation universelle, concernant enfin chaque homme et chaque femme de la planète. Elle ne saurait être 'réservée' aux pays actuellement développés. Ce serait la négation même de sa nature, et l'oubli de son objectif: unifier un monde fait de partenaires 'trouvant' leur intérêt dans l'intérêt commun', vers l'indispensable 'new-deal planétaire.'" Servan-Schreiber, "Section: Le tiers monde comme partenaire," report to Mitterrand about CMI, p. 31.

100 Servan-Schreiber, "Section: Le tiers monde comme partenaire," report to Mitterrand about CMI, p. 32.

101 In his report to Mitterrand about the CMI, Servan-Schreiber cites 1979 as a time of a "mobilisation intellectuelle" around the project of the *Défi mondial* with the birth of a group in the Summer of 1981 called "Groupe de Paris": "Ce groupe, né à Paris en effet, s'est réuni définir les voies et moyens d'une approche globale d'un monde soudain aggloméré, radicalement différent, soumis tout entier à l'ébranlement de la révolution informatique. D'emblée le groupe s'est constiué inter-culturel, et pluri-national. Ses meneurs, on le vera [page 24] one été, ensemble, des Européens (Karl Schiller, Samuel Pisar, Peter Huggler), des Japonais (Doko, Nahajima, Iwata), des Arabes (Ali Khalifa Al Saba, Abdulatif Al Hamad, Zaki Yamani), des Affricains (Leopold Senghor, Hogbe-Nlend); puis très rapidement des scientifiques des pôles d'excellence mondiaux" (5).

"...à partir de la crise mondiale, se sont donné pour tâche de réfléchir ensemble aux voies d'un nouveau développement, hors d'un 'univers à somme nulle' où l'on se contente de chercher à répartir la pénurie" (24).

The group's focus is to combine three "priorités" that have usually been studied separately:

- la crise du monde industriel
- la misère des pays sous-développés
- la maîtrise de la révolution scientifique

102 See Mitterrand 05.2013 archives for letters from Raj Reddy, Alan Kay, and Papert expressing their interest in the CMI

project, suggesting that the mind informed by the computer could become a valuable resource of global applicability.

Despite the centrality of its "world" mission, the CMI was nevertheless a "French project" and encouraged its visitors to keep their Frenchness while developing themselves as human resources[103] This double responsibility of the CMI towards "each and every man and woman on the planet" and towards "the French people"[104] created a tension on both the discursive and industrial levels. In many of his speeches about the CMI, Mitterrand compared the "knowledge revolution" brought about by *informatique* with the French Revolution and emphasized how the French people were able to perceptively capitalize upon the revolutionary moment for human advantages.[105]

The CMI took on the complex identity of being, at the same time, for each individual person, a French idea and "project,"[106] and in the interest of the global population. This nexus of concern about personal, French, and global at the CMI was reflected in the concept of *la ressource humaine,* which was simultaneously of and for the individual while also in the service of the nation and seemingly universally-valid.

These three notions of self, nation, and world came to the fore in one televised interview with Servan-Schreiber. When asked what relationship there was between his concern for the war in Algeria and computers, Servan-Schreiber answered that "decolonization" was at stake in both. He envisioned that computerization would bring about the "decolonization" of the French person.[107] Servan-Schreiber saw the "same struggle" for

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because of its international goals. Also, important political leaders who were to visit the CMI included: Belisari Betancur, Président de la Colombie, et Fédérateur du réseau informatique des pays du Pacte Andin (Amérique Latine); Shimon Pérès, Premier Ministre d'Israël, qui a personnellement, à Paris, donné sur place ses instructions pour lier le Centre aux Univesités et aus Industries de son pays. Rajiv Gandhi, Premier Ministre de l'Inde, qui avait organisé sa visite personnelle au Centre, annulée au moment des drames qui ont abouti à l'assassinat d'Indira, et qui clôturera sa prochaine visite officielle en France, au mois de Juin, par un Dimanche au Centre. […] Ministre d'Etat, Habibi Bourguiba Junior, de Tunisie; Président Emilio Colombo, d'Italie (et du Comité Technologique de l'ONU)" (Servan-Schreiber Report to Mitterrand on CMI, p. 16).

103François Mitterrand, "Les nouveaux outils peuvent sauver les hommes" to CMU president, 27 Mars 1984, p. 44 (emphasized in original).

104"La peuple français," Mitterrand, "La France à Carnegie-Mellon," par M. François Mitterrand, Pittsburgh, 27 Mars 1984, w/ Prof. Richard Cyert, Président CMU lecture "Nous sommes fiers de cette alliance."

105Mitterrand, "La France à Carnegie-Mellon," par M. François Mitterrand, Pittsburgh, 27 Mars 1984, w/ Prof. Richard Cyert, Président CMU lecture "Nous sommes fiers de cette alliance," p. 40, and in his speech at the inauguration of the CMI.

106 "Un projet français," see Servan-Schreiber' final letter to Mitterrand announcing that he is quitting the leadership of CMI.

107 Reference. March 24, 1982 news hour on French public Channel 2.

individual freedom and autonomy at stake in both the decolonization of Algeria through war and in the decolonization of the French through computerization. Servan-Schreiber drew a parallel between an international socio-political event and the broader context of global nation-state relations of the mid-20th century– the issue of national self-determination– with the self-determination of each individual human being vis-à-vis other people and their own state. With this parallel, Servan-Schreiber suggested that the French– especially French youth– were colonized by some inarticulate combination of their own government and the structure of their societies (e.g. strong centralized state). This colonization was both the result of explicit policies and unwitting habits or established orders. In fact, according to Servan-Schreiber' statement, it may be that had there not been the computer to reveal the extent to which people were "colonized," no one might have noticed.

This colonization-over-the-self, Servan-Schreiber argued, restricted the French people's autonomy to create their own destiny and to build their own life and career. The process of decolonizing the French with the computer promised to bring back all of these freedoms, assumed to be each individual's inalienable right, as well as to lead to a general state of blossoming and fulfillment of each person. Decolonization would take place as a non-violent struggle (echos of the rhetoric of arm-less "war" from *Le Défi américain* and of "deployment" of faculties from *Le Défi mondial*), led through the education of all the French, and especially of the youth, with and about computers. The audience of this interview could witness this "solution" enacted on their TV screens: as Servan-Schreiber spoke two children in the foreground worked quietly and diligently on the computer.

Servan-Schreiber' concept of *la ressource humaine* shared this fundamental faith in the self-determination and independence of each human being, one that is not only right, but natural. His idea extended beyond the particular case of France (though he takes it up as his prime example and concern) to the fate of all human beings. Other related statements by Servan-Schreiber implied that in order for the French citizen to be fully decolonized with the computer and for the benefits of computerization to be fully reached, the Algerian and Colombian, etc. citizen would also need to be technologically decolonized in this way. Servan-Schreiber frequently stated that computerization will only achieve its full potential if it takes place together with globalization.[108] This example points to the complex interaction among concern for the personal, for the French, and for the global at the heart of Servan-Schreiber' thinking about human beings and the social function of computers.

Each person as entrepreneur of the mind

The CMI's mission to develop the *informatique quotidienne* or "informatics of daily life" instead of human interaction with computers in a specific social context like work or school, suggest, as Servan-Schreiber frequently alluded, that the project was cultural rather than technological. This statement, however, is puzzling because the kind of culture that Servan-Schreiber sought to study and advance at the CMI was *culture informatique* (computing culture, a concept prevalent in French discussions of computer literacy, which I analyze in Chapter 1).

Culture informatique is, of course, a technical culture. Although neither Servan-Schreiber and Mitterrand (both of whom use this term[109]) define *culture informatique*, their contemporary computer researchers do. *Culture informatique* was "a set of knowledge and know-how that enables a person to be at ease with a computer and with computer tools."[110] This knowledge and know-how includes the ability to represent the world to oneself and to think through problems in a way that resembles a tree-diagram, following logical statements like an algorithm.[111] It is telling that neither Servan-Schreiber and Mitterrand went into such detail of the definition of *culture informatique.* What is significant is that for them this technicity is lost, or becomes imperceptible, when the computer becomes part of the fabric of daily life.

The idea of *la ressource humaine,* upon which the entire CMI projects depended, posits the human being *of* the computer, whose full potential as at once an individual, a universal person "of the world" and a citizen of a specific nationality and culture, can only be reached *with and through* the computer. In fact, the very nature of the computer– the history of its

108 *Le Défi mondial*

109"Une idée fixe," a comment by François Mitterrand, le 26 Février 1983, à la réunion des 120 Directeurs des Grandes Écoles, quoted in Servan-Schreiber, "Rapport Moral (1982-1985) ou La naissance d'un Projet Français" [sur la vie du Centre] Paris, le 26 mars 1985.

110Duchateau, 1.

111Ibid., 2.

production in specific countries, the relation between the hardware and software that makes it run– is what comes to define *la ressource humaine* in this tripartite way. Yet, despite this, the idea of *la ressource humaine* has a life of its own seemingly independently of the computer: it is, after all, only about the development of the human faculties, which have been in existence since at least the 18th century, or about the relationship between the individual citizen and her nation-state.

Servan-Schreiber' concept of *la ressource humaine* seems to provide an answer to the enticing and unresolved puzzle that Papert and Goldstein present: if the use of computers– tools of the mind– is just as transformative for humans as the use of plain tools, which prompted the definition of a human being to be *relative to* the tool, then what should the new definition of human being be? Servan-Schreiber might answer: the user of the tools of the mind should be known as a "human resource." If we accept this answer, then the evolution of the definition of human suggests that people went from being users of tools to being "useful" (resources) themselves.

While Papert was an entrepreneur of the mind who used LOGO to form the minds of children according to an understanding of what is "natural" to the human mind, Servan-Schreiber sought to make each person into an entrepreneur of his or her own mind according to the concept of *la ressource humaine* by giving them access to computers. As an entrepreneur develops her organization by managing and growing the company's resources, Servan-Schreiber hoped that computer literacy would allow each person to become an effective manager of his or her own faculties and deploy them in the most effective way.

Andrei Ershov

Andrei Ershov (1931-1988) was a Russian mathematician and computer scientist who was one of the strongest proponents of the introduction of the general public to computers in the Soviet Union. He had very strong ideas about what the public knowledge of computers could help to accomplish in the Soviet Union. The computer fit right in with Ershov's understanding of Soviet values of collectivity, planning, and industrialization. It also fit with Ershov's stated understanding of human nature and child development, which can be broadly characterized by the qualities of the Soviet Man. This understanding of the ideal human as action-oriented and industrious influenced the way in which Ershov conceived the nation-wide computer literacy curriculum for the Soviet Union. The curriculum emphasized the development of the human via the mind according to the qualities necessary for algorithmic thinking. Ershov was a vocal proponent of the concept of "second literacy," which he deemed to be general public knowledge of computers and of programming. Ershov's reference to the knowledge of computers as "second" literacy echoes the idea of "second nature," i.e. something that comes easily to a person but which is not *a priori* given and thus must be learned. This notion characterizes well his vision of computers as logical, "natural" extensions of human thought and action.

Ershov's early work at the Computing Center in Novosibirsk

Ershov's interest in thinking about the human mind with and through the computer can be traced to his days as a student working on theoretical programming and algorithmic theory. Ershov studied mathematics in the Moscow State University under the direction of Soviet mathematician Alexey Lyapunov (1911-1973). Lyapunov's interest in cybernetics encouraged the young Ershov to become interested in computer programming. He finished his degree in 1958 defending a thesis titled, "Some questions of algorithmic theory related to programming.[112] The topic of Ershov's dissertation reveals an early interest in theoretical ("meta") questions concerning programming. Especially notable is his early attention to the algorithm, which would later become an important aspect of what he considered to be essential for children to learn about computing.

In 1957 Ershov was appointed to direct the automatization of programming in the newly created Soviet Academy of Sciences Computing Center (formerly part of the Institute of Mathematics[113]). Unlike the Parisian *Centre Mondial Informatique,* whose goal was to facilitate the introduction of computing into society, the Novosibirsk Computing Center was a community of mathematicians and programmers devoted to theoretical research and the

112"Некоторые вопросы теории алгорифмов, связанные с программированием."

113That the Computer Center was formerly part of the Institute of Mathematics is mentioned by Ershov in "ALPHA - an automatic programming system of high efficiency". Дата: 26.09.1964 Названия статей: "ALPHA - an automatic programming system of high efficiency," p. 1. Ershov's former teacher, Lyapunov was his neighbor and colleague because since 1961 Lyapunov was working in the mathematics faculty of the Siberian Division of the Academy of Sciences and created there a center for the study of cybernetics.

development of programming languages mainly for quantitative applications.[114] Ershov's own research at this time was on automatic programming, the development of interpreters, assemblers, compilers, and generators in order to enable the programmer to work at a higher-level computer language while the “lower,” tedious levels of programming were automatized.[115] Ershov's early work on simplifying and making more interesting the work of the human-programmer in relation to the computer is an interest that informed his later work with the introduction of computing in schools.[116]

Ershov's leadership role at the head of the programming department of the Computing Center caused him to consider the future of programming in the Soviet Union and what minimal programming skill of the population would be required to derive from computers the social utility that they were imagined to bring.[117] In this position, Ershov was responsible for both administrative and pedagogical work, as the department was one of the few in the Soviet Union to train computer programmers.[118] Because of his concern for the future of programming and his personal experience with the training of programmers, Ershov was asked in March 1970 by the Soviet government to produce a brief statement about the extent of programming preparedness in the Soviet Union. Ershov reported that the Soviet Union was significantly lagging behind the US in both the production of electronic calculating machines and in the training of professional programmers to supply these machines with programs

114 While the CMI was located on purpose at the heart of Paris, the Novosibirsk Academgorodok was in Siberia, on the outskirts of the Soviet Union and far from Moscow. In Chapter 3, I explore the significance of the location of these two centers vis-à-vis centers of power for the kinds of work on computing and the public that transpired there.

115In __ Ershov published an early book on automatic programming titled, *The programming program for the electronic calculating machine BESM*. The book was read and well-received abroad by computer scientists. On the concept of automatic programming, see Mildred Koss quoted in Chun, Wendy. "On Software, or the Persistence of Visual Knowledge." Grey Room 18. Boston: 2004, pg. 30. Also David Parnas on history of automatic programming, e.g. D. L. Parnas. "Software Aspects of Strategic Defense Systems." American Scientist. November 1985.

116Ershov's attention to the automatization of programming in the early part of his career evolved significantly in his later work on the development of what he referred to as “school informatics” (школьная информатика, shkol'naaia informatika). According to Ershov, the automatization of school with computers, another name for which is “programmed learning,” was only one not very technically-feasible and undesirable path that the role of the computer could take in education. Instead, Ershov found much more promising and interesting to pursue the teaching of algorithmic thinking (supported by programming skills) to children and to apply the informational management capacities of the computer towards creating and transferring pedagogical knowledge throughout the USSR.

117The Computer Center was formerly part of the Institute of Mathematics (Ershov in "ALPHA - an automatic programming system of high efficiency". Дата: 26.09.1964, p. 1). In ___, Ershov was asked to take on the task of organizing the programming department at the Center.

118In 1970 only seven to eight universities in the Soviet Union trained programmers. In addition to the Novosibirsk State University (NGU), these included: МГУ, ЛГУ, КГУ, МФТИ, МЭСИ. Справка о потребностях и обеспеченности по кадрам программистов для ЭВМ на 1970-1975 гг. Дата: 23.03.1970 Авторы: Андрей Петрович Ершов, Адресаты: Михаил Алексеевич Лаврентьев http://ershov.iis.nsk.su/archive/eaindex.asp?did=32722 required for them to be useful to society.[119] Social utility, in the Soviet case, was defined in terms of direct application of programs to agricultural, industrial, and managerial tasks.[120] In this brief report, he clearly presented the bigger of the two challenges to be that of training programmers. Ershov's report suggested that without a quantitative increase in universities and faculty that can train students and qualitative innovation in the way that programmers are trained, the Soviet Union would not be able to effectively introduce computers into society despite increasing the number of machines manufactured (as was planned for the 5 year plan for 1970-1975[121]).[122] Despite Ershov's work on developing programming curriculum at his institute and also for the entire Soviet Union and his concern for the future of programming, it was only in 1970, after a visit to the US, that he became seriously interested in– and convinced of the feasibility of– more general computer education.

Algorithmic thinking

One of the stops on Ershov's work visit to the US in October and November 1970 was MIT. At MIT, Ershov met Seymour Papert and Marvin Minsky and the two men shared with him their approach to computers in education. In a talk he gave at the 1972 Spring Joint Computer Conference, Ershov cites his meeting with Papert as the pivotal moment after which he became convinced that computers could be used to introduce the experiences and "morals" of programmers to the entire population.[123] From the early 1970s until the end of his life, Ershov devoted his career to being an entrepreneur of the mind: developing curriculum and software to train people of all ages throughout the Soviet Union to think "algorithmically."

Ershov's meeting with Papert enabled him to imagine how his great admiration of the

119 Ershov's comparison of the US and USSR: "In US there are about 50,000 electronic calculating machines and 50,000 systems programmers. In USSR there are 3,500 electronic calculating machines and only 3,000 systems programmers. In US there are 40 types of electronic calculating machines, in USSR only 15, therefore 1,200 programmers focus on one type of EVM in US while only 200 programmers develop one type in USSR. "This means that our machines are six times less well equipped with programming" (1). Справка о потребностях и обеспеченности по кадрам программистов для ЭВМ на 1970-1975 гг. Дата: 23.03.1970; Авторы: Андрей Петрович Ершов. Адресаты: Михаил Алексеевич Лаврентьев, http://ershov.iis.nsk.su/archive/eaindex.asp?did=32722

120 This definition of social utility is markedly different from the one that Jean-Jacques Servan-Schreiber considered.

121 [Find out the details of this plan: is it only about manufacturing the machines without any public education efforts to 'accept' them?]

122 Справка о потребностях и обеспеченности по кадрам программистов для ЭВМ на 1970-1975 гг. Дата: 23.03.1970, p. 2.

123 Aesthetics and the Human Factor in Programming, A.P. Ershov, Luncheon Address at the 1972 Spring Joint Computer Conference. Published in Communications of the ACM, July 1972, Volume 15, No. 7, p. 505.

work of programmers and the programmer's role in society could be amplified to the entire population. Ershov held the professional programmer in very high esteem, as a member of society who unlocks new knowledge about the world and enables this knowledge to be useful for the benefit of society.[124] He paralleled the invention of printing with the invention of computing and the role of authors and printers with the role of programmers:

> The accumulation of books, each one embodying its author's view of the external world, broadened a social process of understanding. In the same way, programs and data banks accumulate informational and operational models of the world, and allow us not only to influence but also to predict[125] the world's evolution, giving us in this way an unheard of power over nature.[126]

The programmer in Ershov's description unlocks new knowledge by organizing data banks and devising new programming techniques to effectively analyze the data in order to create better, more accurate models of the world. In order to perform this important social role effectively, Ershov believed that the programmer had to be a kind of Renaissance man, or a person of many talents:

> In his work, the programmer is challenged to combine, with the ability of a first-class abstractions, a more practical, a more Edisonian talent, enabling him to build useful engines out of zeros and ones, alone. He must join the accuracy of a bank clerk with the acumen of a scout, and to these add the powers of fantasy of an author of detective stories and the sober practicality of a businessman. To top all this off, he must have a taste for collective work and a feeling for the corporate interests of his employer.[127]

In addition to being talented in these diverse and sometimes even contradictory ways (accuracy of a bank clerk and fantasy of a detective author), the programmer had to possess unique capacities of the mind, above those of the "average man." Ershov described how psychologists had discovered that an "average" person thinks five to six positions ahead while the programmer must contain the entire structure of the program in his mind and, two to three positions on top of that. The programmer thus had extraordinary mental capacity and they worked at the "limits of human knowledge."[128] Encouraged by his meeting with Papert

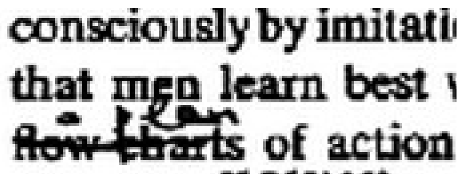
124 Reference.
125 [Using the computer to predict future scenarios is reminiscent of the kind of knowledge that students were taught by using computer simulations. Relate this to 'future-thinking' that some cultural analysts in the 1970s thought was a crucial skill of the person of the information age.]
126 Ibid., p. 504.
127 Ibid., p. 502.
128 p. 502.

and Minsky, Ershov believed that it was possible to train these talents and qualities of the mind, which he referred to by the term "algorithmic thinking," in the human being in order to produce a computer programmer.

In fact, in Papert and Minsky's work, Ershov believed to have found proof that algorithmic thinking was natural to the child's process of learning. This served as validation for Ershov's own value of algorithmic thinking. Ershov wrote of Papert and Minsky's work in the following way:

> Minsky and Papert threw overboard the cliché that children learn subconsciously by imitation. They proved that men learn best when they form flow charts [crossed out and instead written above: a plan] of action in their heads, when subroutines [written above: processes] are separated out and informational connections traced.[129]

Image 1: Ershov edits technical language out of his article.[130]


consciously by imitati
that men learn best
flow charts of action

Ershov's interpretation of Papert's and Minsky's it is interesting despite being seemingly incorrect (e.g. Minsky and Papert did not intend to overthrow the role of imitation in learning and their work did not prove that people learn by organizing thought into flow charts),[131] because of what it reveals about Ershov's own understanding of human learning. Ershov appears to have believed that algorithmic thinking was a necessary component of all learning. The changes that Ershov made to the passage reflect the move away from the use of even more technical language ("flow chart," "subroutines") to describe the process of learning. Ershov believed that he had found in the work of Papert and Minsky proof that algorithmic thinking was a full-fledged epistemological theory.

Not only did Papert's work validate Ershov's own value of algorithmic thinking, but it also inspired Ershov to consider all human learning could be improved by coming to think

129 The edits to the text that Ershov made were intended for his speech at the English Club in the Academicians' House of the Siberian Division of the Soviet Academy of Sciences.
130 Archive.
131 Explore in more depth the ways in which Ershov's interpretation of Papert and Minsky's work differs from the authors' own presentation of what their research reveals.

algorithmically. Following his encounter with Papert, Ershov came to believe that this kind of training of the mind– training in algorithmic thinking– could begin early in the life of a person. Ershov wrote:

> This [effectiveness of Papert's teaching methods] shows that man can greatly strengthen his intellect, if he is able to integrate into his nature the habit of planning his actions, of working out general rules, and of applying them to concrete situations: to organize rules; to express them in a structured way; in other words, to program.[132]

Ershov claimed that programming is the tool to improve one's intellect. This claim is not surprising coming from someone who believed the mind itself to develop according to algorithmic processes. Programming was for Ershov both a description of the processes of the natural world (programs are everywhere already found in nature, and especially in the mind of the human being) and a technique by which a human being could improve her nature and gain an unprecedented "power over nature."[133] After his encounter with Papert, Ershov believed that everyone's intellect can take advantage of the benefits that come with learning to program. Programming need not remain an elite profession: the "Edisonian talent" and the modeling capacity of the mind can be learned by and strengthened in all people. Ershov's subsequent efforts to introduce programming into education were not only instrumental for the sake of increasing the number of programmers in the Soviet Union, but sought to advance the normative goal of creating a society of algorithmically thinking people, whom he thought to be more full human beings and better members of society.

Ershov's normative goal to educate algorithmically thinking people coincided with the Soviet government's project to form a "new Soviet man." This national project was proclaimed as an objective at the 22nd Communist Party Congress in 1961 by Nikita Khrushev.[134] The role of the new Soviet man was to usher in the "creative transformation of the world."[135]Although the specifics qualities of the Soviet man were not spelled out by Khurshev, the significance of the project is that the human being was seen as one of the three principal sites of the construction of communism. The formation of a new human being was

132 [Reference]
1331972 article, p. 504.
134 [There is a fascinating connection to explore between the political uptake of cybernetics (which, until the late 1950s was banned from the Soviet Union) and the birth of the idea of the "Soviet Man." It may be possible to show the coproduction of these two, which would show the dependency of the notion of the imaginary of the Soviet Man on the computer.]
135 Peter Waail and Alexander Genis, p. 13.

to be carried out alongside the building of the material-technical base and the creation of new relations of production.[136] Khrushev's announcement began an official era of the first communist "laboratory" on the human being that adopted a “constructivist” approach, by which a “new” person was explicitly fabricated through bodily (e.g. medical practices and body disciplines) and social (education, social relations and responsibilities) forces. Ershov's experiments with educating people in the Soviet Union with and through the computer coincided with and supported this national project.

<u>“School Informatics”: Ershov's approach to developing the person with the computer</u>

In 1979, Ershov and his colleagues Gennady Zvenigorodsky and Uriy Pervin wrote a treatise where they laid out their vision for children's education with the computer called, “School informatics: Conceptions, current state, perspectives.” They defined “informatics” as “the science of the structure of information and methods of its treatment using an electronic calculating machine [abbreviated in Russian by the authors as “EVM,” which stands for *elektronnaiia vysheslitel'naiia mashina*]].”[137] They identified national education to be one of the realms where informatics could be applied and proposed to call it “school informatics.” “School informatics,” therefore, was “the branch of informatics that can be taught in secondary schools. It is concerned with the development of the programs through technical, pedagogical/methodological and organizational aspects of the application of computers to the education process.”[138]

School informatics for the authors was a way to develop in the entire population a “style of thought” known as algorithmic thinking. When the authors elaborated upon the different aspects (technical, pedagogical/methodological, and organizational) of the introduction of “school informatics,” they revealed that for them the introduction of “school informatics” is less about teaching programming than it is about helping students to develop “a style of thought” most commonly found among programmers.[139] The authors believed that this “style of thought,” also described as “specific habits [navyki] of mental processes,” is essential for everyone in the Soviet Union to know. Ershov et al. are careful to distinguish

136 Ibid., p. 14.
137 Ershov et al. “School Informatics,” p. 4.
138 Ibid., p. 5.
139Ibid., p. 9.

two types of computer users: programmers (creators of software) and users of software. Though they say that the users of software do not need to know how to program, they do need to partake in the programmers' "style of thought."[140]

According to Ershov and his colleagues, the "algorithmic thinking" style of thought consisted of:

1) "the ability to plan out the structure of an action,"
2) the ability to understand and to build informational structures to describe objects and systems,
3) the ability to organize the search for information so as to solve a given problem,
4) the ability to clearly and correctly formulate one's thoughts in writing (i.e. writing instructions to a computer),
5) the habit of using the computer at the right time to solve problems of any kind, and
6) mastery of technical skills to interact with the computer (e.g. typing).[141]

In defining the abilities that comprise "algorithmic thinking," it is interesting that Ershov and his colleagues put in last place the possession of "hard skills" such as typing. Instead, "algorithmic thinking" was dominated by disciplining one's thought in approaching problems and proceeding in solving them and training the habit of using the computer for such problem-solving. In Ershov's characterization, algorithmic thinking was the way of thinking that a human being must adopt to interact with the world (analyze it, solve problems in it) *via* the computer and to make the computer a useful tool for understanding and interacting with the world.

Despite the fact that very few people outside of the professional programming community had contact with a computer in the late 1970s in the Soviet Union and therefore few had the direct need for algorithmic thinking, Ershov and his colleagues believed that this style of thought was indispensable to all people:

> All of the above-mentioned habits and skills [that define algorithmic thinking] have a general cultural, educational, and human value and are necessary for almost every human being in the contemporary world, independent of his level of education or profession. This is what determines the need to form these habits and skills as part of

140Ibid.
141 p. 9-12.

general education.[142]

This fascinating glimpse into the motivation of the authors for seeking to introduce "school informatics" into general education in the Soviet Union remains enigmatic. The authors do not explain elsewhere in the document what it is about the contemporary world that makes it necessary for every person to be able to think algorithmically.

The approach that Ershov and his colleagues proposed to use to effectively reach the goal of an algorithmically thinking population supports their vision of algorithmic thinking as a universal (and universally necessary) style of thought. Ershov and his colleagues advocated a specific way of teaching school informatics. They claimed that school informatics should be taught using a specially-designed programming language for children. They denounced trying to teach school informatics with an already existing programming language– not explicitly designed for an educational purpose– or teaching the concepts abstractly, without any practice in programming at all. The problem they saw with teaching school informatics using an existing programming language is that these languages contain too much technical detail which is not necessary to develop the main aspects of computer thinking.[143] On the opposite extreme, trying to teach school informatics without programming was, in their eyes, a better approach of the two because it can still allow children to master the main theoretical aspects of programming. The risk of this approach, however, was that students would not see the reason for why they would need to know these concepts.[144] In other words, they considered programming an actual computer to be essential to develop sound algorithmic thinking, but the programming must be purposefully simplified so as not to obscure with unnecessary technicalities the more widely applicable lessons of algorithmic thinking.

Ershov and his colleagues developed the specifications for an ideal computer language. They proposed that it should reflect all of the main programming concepts and it must be logically clear. It should be written in Russian (with the possibility of translating it into other languages of the Soviet republics) and its syntax should be close to Russian, although also distinct so as to clearly signify to the student that they are dealing with another language. The structure of the educational language needed to be able to methodologically

142Ibid., p. 13.
143 Ibid., p. 21.
144 Ibid., p. 22.

interface with the standard programming languages so that learning the educational language would make it easier for the student to later learn the standard programming languages. Additionally, the language should be powerful enough to let if be used to study different school subjects and to program different kinds of computers and robots. Finally, the language should also collect data about students' mistakes so as to better understand the learners' difficulties.[145]

A comparison of Ershov and his colleagues' requirements for an educational programming language with those of the BBN group (the result of which was LOGO) reveals the different approaches of the two groups to transforming the mind with the computer. The main difference between the Soviet and American groups concerned the role of mathematics in the educational programming language. For Ershov and colleagues the language had to embody key programming concepts, while for the BBN group, the language was to embody *mathematically* important concepts. Both groups, however, agree that the language should present these concepts with, as the BBN group put it, "minimal interference from programming conventions."[146] Ershov and his colleagues sought to establish algorithmic thinking as specifically a domain of programming rather than of mathematics. According to Ershov, although mathematics could provide some of the lessons for algorithmic thinking, only a foundation in programming concepts could fully create this new "style of thought."[147] They envisioned the formation of the general public to be modeled on the training of the computer programmer whose style of thought was to be generalized to the population as a whole. The original vision for LOGO was that it should more narrowly be a language to teach mathematical concepts and allow children to express mathematical ideas intuitively. Only later, as I have described, did Papert set out for LOGO the vision of transforming the learning process more generally. Despite these differences in the original requirements for the design of the programing language that could be used to transform the mind of the general

145 Ibid., p. 24-5.
146 Wally for BBN, p. 291.
147 Ershov "School Informatics," p. 14. Ershov explains that no single subject—including mathematics--contains enough of a developed conceptual tool kit to communicate the algorithmic thinking ideas, habits, and skills. They site the work of V. M. Monakhov et al., "The formation of algorithmic culture of a school child throught the process of teaching mathematics," 1978 Монахов В.М. и др. Формирование алгоритмийеской культуры школьника при обучении математике. Пособие для учителей. М. 'Просвещение', 1978. These authors, write Ershov et al., realized that mathematical concepts were not enough to teach algorithmic skills. Instead, they needed to use concepts from programming and even terminology and symbols of programming languages (Ershov, p. 13-14).

public with the computer, during the course of putting the language in the practice of education, both groups moved away from disciplinary concerns towards the formation of a more general “computer sensibility” and fostering “computer culture.”

[At this time, my discussion of Ershov isn't finished. I would like to continue this section by speaking about the specifics of the children's programming language, *Scholnitsa,* that Ershov and his colleagues designed and the manner in which they went about teaching this language in special summer camps. I hope to show what this language and its implementation inside and outside of the Soviet educational system reveals about Ershov's specific approach to shaping the mind with the computer.]

Conclusion: Enhancing the natural capacities of the mind

Image 2: “Asia Salikhova behind the terminal BESM-6,” September 30, 1979 (?)[148]

Seymour Papert, Jean-Jacques Servan-Schreiber and Andrei Ershov each in their own way sought to influence the way in which the computer, “the tool of the mind,” formed the

148 Ershov archive.

minds of children and the general public. Despite differences in their intellectual backgrounds, the stakes and goals of their work, and the socio-cultural context in which they lived and worked, all three "entrepreneurs of the mind" shared the vision that by developing the mind with the computer they could enhance the mind's natural qualities.   Papert, Servan-Schreiber, and Ershov identified concrete thinking, "resourcefulness" of human faculties, and algorithmic thinking, respectively, as innately human qualities– at once specifically national and universal. These natural qualities of the mind, which characterize the person at once as a national of one specific country *and* as a universal representative of the "tool using animal" species, could be extended and developed by becoming computer literate in the diverse ways that these pioneers envisioned. Each pioneer's idea of human nature evolved with his specific work on the computer literacy programs, revealing that the understanding of human as concrete thinking, resourceful, and programming was a result of active work with the computer, i.e. studying processes of learning with and through the computer.[149]

The mind, however, was not the only site for the computer's work on the human being. In the following chapter I explore how the human body was imagined to be similarly "extended" and actualized through the process of becoming computer literate.

149 In the final chapter of the dissertation I show the influence that Papert, Servan-Schreiber, and Ershov—and their respective theories of human being—had on other thinkers and conceptions of the human at this time. This helps to establish how the way of thinking of human vis-à-vis the computer was actually influential and consistent with other human sciences that were not explicitly working with computers. In other words, this demonstrates that the introduction of the computer into public life did transform ideas and understandings of human being.