Making Citizens of the Information Age: A Comparative Study of the First Computer Literacy Programs for Children in the United States, France, and the Soviet Union, 1970-1990

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A dissertation presented

by

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to

The Department of History of Science

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

in the subject of

History of Science

Harvard University

Cambridge, Massachusetts

August 2015

Dissertation Advisor: Professor Sheila Jasanoff Margarita Boenig-Liptsin

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ABSTRACT

In this dissertation I trace the formation of citizens of the information age by comparing visions and practices to make children and the general public computer literate or cultured in the United States, France, and the Soviet Union. Computer literacy and computer culture programs in these three countries began in the early 1970s as efforts to adapt people to life in the information society as it was envisioned by scholars, thinkers, and practitioners in each cultural and sociopolitical context. The dissertation focuses on the ideas and influence of three individuals who played formative roles in propelling computer education initiatives in each country: Seymour Papert in the United States, Jean-Jacques Servan-Schreiber in France, and Andrei Ershov in the Soviet Union. According to these pioneers, to become computer literate or computer cultured meant more than developing computer skills or learning how to passively use the personal computer. Each envisioned a distinctive way of incorporating the machine into the individual human's ways of thinking and being—as a cognitive enhancement in the United States, as a culture in France, and as a partner in the Soviet Union. The resulting human-computer hybrids all demanded what I call a playful relationship to the personal computer, that is, a domain of free and unstructured, exploratory creativity. I trace the realization of these human-computer hybrids from their origins in the visions of a few pioneers to their embedding in particular hardware, software, and educational curricula,

through to their development in localized experiments with children and communities, and finally to their implementation at the scale of the nation. In that process of extension, pioneering visions bumped up against powerful sociotechnical imaginaries of the nation state in each country, and I show how, as a result of that clash, in each national case the visions of the pioneers failed to be fully realized. In conclusion, I suggest ways in which the twentieth-century imaginaries of the computer literate citizen extend beyond their points of origin and connect to aspects of the contemporary constitutions of humans in the computerized world.

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Acknowledgements

This dissertation is a collective work. I am grateful from the bottom of my heart to--

Sheila Jasanoff, Bernadette Bensaude-Vincent, Rebecca Lemov, Anne Monius, Jean-Pierre Dupuy--

For teaching me ways of thinking, for your example of scholarship and intellectual life, and for your faith in me. You have guided me in this project from its vaguest first formulations to its last period and your teachings will continue to form it--and me--in the future.

Sheila, again, and never enough--

For taking me on as your apprentice and helping to forge, word by painstaking word, intuitions into arguments.

Shana Rabinowich, Linda Schneider, Jacqueline Karaaslanian, Jean-Charles Bédague, Ksenia Tatarchenko, Loren Graham, Georges-Louis Baron, Yuri Pervin, Jacques Baudé, Jacques Perriault, Sarah Walker--

For generously sharing your experience and your time, for your helpfulness, and your patience.

Yan Liu, Oriana Walker, Ardeta Gjikola, Jenna Tonn, Megan Shields-Formato, Ben Hurlbut, Gili Vidan, Adriana Ortega, Sebastian Pfotenhauer, Joakim Juhl, Zara Mirmalek, Rachel Douglas-Jones, Daniel Prashanth, Larisa Lehmer--

For your friendship, for listening and thinking together, and for our future projects together.

Ana Maria & Jeff Boenig, Tetja Natasha & Bob Flournoy, Babushka Alla & Dedushka Vasya, Abuelitos, Ded Feliks, and *Tetja Rita*--

For your unwavering nurture in all ways.

My mother *Tania*, my father *Oleg*, my husband (½ Dr.) *Edward*, and *Max*--

For you.

(Stoop) if you are abcedminded, to this claybook, what curios of signs (please stoop), in this allaphbed! Can you rede (since We and Thou had it out already) its world?

James Joyce, *Finnegans Wake*

We are creating a new company, called Alphabet (http://abc.xyz). […] We liked the name Alphabet because it means a collection of letters that represent language, one of humanity's most important innovations, and is the core of how we index with Google search!

Larry Page, “G is for Google”

Chapter 1:
C is for Computer

For over fifty years, *Time* magazine has selected a “Person of the Year," the person who, "for better or for worse...has done the most to influence the events of the year” (*Time Person of the Year: 75th Anniversary Celebration* 2002). In its January 3, 1983 issue, *Time* announced that, for 1982, the “Machine” had become the “Person of the Year” (Friedrich et al. 1983).

The cover illustration for this issue shows George Segal's iconic plaster sculptures of two human figures, a man in the foreground and a woman further back, sitting near two micro-computers. The people are white, like blank slates, sitting passively in front of the lively, active computers displaying colored graphs on their screens. They appear "other" in relation to the machines that have, as *Time*'s caption reads, "moved into" what seems like their home. As if flash-frozen to capture the last moment of virgin humanness, the woman reclines on a wicker chair, not looking at the machine, while the man looks at the screen but does not touch the keyboard. With a stillness somewhere between holding one's breath and not breathing they seem to wait for the machines to complete their work. The stark difference between the blank, motionless people and colored, "running" computers creates an attenuated sense as if any second now, with a final push, the computer's activity will spill out of its framing screen and "move inside" the people.

The *Time* magazine cover reflected a reality of the early 1980s as experienced by people in the Western world and in Japan, where the micro-computer was increasingly seen in public places like libraries and community centers, in the workplace, in schools, and in the home. In addition to their growing visibility in daily life, computers were used to run more and more industries and provide infrastructure for governmental activities. This phenomenon was described by observers in different parts of the world as "computerization" or "informatization" of society. They predicted that the computer's presence and influence in human lives would only grow with the machines becoming smaller, faster, and cheaper.

Some worried, as people had with regard to many technologies before computers, that computerization would lead to computers replacing people by taking over central aspects of human activity, such as work and thought, and making people slaves to the machines.[1] In the early 1970s, simultaneously in different parts of the world, an alternate discourse began to emerge in which the computer was seen as the ideal instrument for adapting people to the demands of life in the information age. This is the position from which the *Time* article was written. Instead of claiming that the computer would take over human functions or replace the human, it drew attention to the beginning of a new era in the human-computer relationship enabled by the so-called “desktop revolution” that had “brought the tools that only professionals have had into the hands of the public” (Friedrich et al. 1983, 14 citing Marvin Minsky, a cognitive scientist and artificial intelligence pioneer at the Massachsetts Institute of Technology). In the new world-order brought about by this computer revolution, people would work, learn, and play together with (rather than in opposition to) computers.

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[1] Science fiction narratives frequently discussed the theme of loss of human authority and control to machines in dystopian narratives of computers run amok, see, for example Stanley Kubrick’s *2001 Space Odyssey* (1968).

According to journalists, industry leaders, and politicians who spoke of the "computer revolution" in the late 1970s and throughout the 1980s, the promised revolutionary potential of computers was due to the scale of their introduction into society at large. Although computers had been transformative to the defense, scientific, and business operations of developed nations since the 1950s, only when the idea of computers in "the hands of the public" became envisioned as a possibility did it make sense to speak in terms of the "computer revolution."[2] At this population-wide scale, questions about the relationship of people to these thinking machines took on new significance.[3] Discussions of the so-called "computer revolution" translated into discussions about the boundary between the person and the machine: about what is proper to computers and what is proper to people; what computers can and cannot help people with; what the limits of artificial intelligence are or should be.

Contemporary scholars who investigated directly the human-computer relationship described how the computer profoundly transformed the person. For example, in 1984 Sherry Turkle used participant-observation and repeat clinical studies to investigate how people's interaction with computers informed their sense of self and sense of the world as psychological beings (Turkle 1984). Turkle's seminal work

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[2] The term "computer revolution" figures prominently in many American works from the late 1970s and 1980s (For example, see the cited Time article 1983; T. Nelson 1977; Brod 1984; Service and Investigations 1985). In these examples, the authors use the term "revolution" to refer to the consequences of computers at the population-wide scale. The revolutionary potential of computers was considered both from the economic perspective (computers and computer-controlled industrial robots replacing workers) and from the more philosophical consequences of replacing and challenging human minds.

[3] This debate about the relationship of human to (specifically) the *computer* machine, can be traced back to the "imitation game" described in the famous paper by Alan Turing, "Computer Machinery and Intelligence" (1950) . In Turing's paper the relationship was only a thought experiment since no actual computer existed with which one could play such a game.

concluded that computers were more than just playthings or tools for accomplishing tasks: they had become for people “objects to think with” about their own mental processes and about the boundary between humans and machines. For Turkle’s contemporary, Donna Haraway, the “cyborg,” or hybrid between human and machine, was an agent of social and political change made possible by the new computer technologies and their attendant discourses (Haraway 1985). The cyborg, according to Haraway, was not necessarily a new physical entity created through the introduction of technology into the body. Rather, it was an allegorical figure whose existence in the imagination and in narratives circulating through society already challenged existing categories such as gender and race and led to social transformation. In studying the human-computer relationship, both Turkle and Haraway found that the most important revolutionary potential of the computer for the person lay not in its use as a tool, but in the way that the technology prompted each person to re-think his or her identity as a human being (e.g., as conscious, alive, biological, or being of a particular gender, culture or race).

Even before the publication of these important works recognizing the “revolutionary” re-thinking of the human in light of the mass introduction of computers into society, people sought actively to shape the direction that this revolution would take. One of the most direct efforts centered on expanding the role of computers in education. Around the world, mathematicians, teachers, artists, parents, and politicians debated the role that the computer should play in the education of children and in the formation of the future "citizens of the information age." Computers had been used in some university and even primary and secondary school classrooms in the United States since the early

1960s. They were, however, used mainly as tools to assist in classroom instruction, like drilling students in multiplication and division.

In the early 1970s, simultaneously and relatively independently from one another, very different conceptions of the use of computers in education began to emerge in developed countries around the world. Pioneers of this alternative approach in all three countries called for making the knowledge of how to program, use, and think with, or even *like*, the computer a basic skill of the general population. This new approach to computers in education was called a new "computer literacy" in English and also referred to as literacy in Russian[4]. In French it was referred to as a new culture (*culture informatique*). Despite the differences in the skills, knowledge, and sensibilities implied by these terms and as practiced in each country, each variant of the new culture of literacy presumed that the computer had to *reconstitute* the human—to become part of a person's cognitive and bodily habits and, by doing so, suffuse that person's sense of self, her values and ways of relating to and living with others. For its advocates, this new literacy was a way to help people adapt to this revolutionary moment and to the demands of the ensuing information age.[5]

In revolutionary moments throughout history, those in power attempt to re-form subjects to correspond to the new social order. Revolutions, whether in science (Kuhn 1962) or in social order (Taylor 2004), can be conceptualized in terms of changes in collectively held belief systems, as "the overthrow of one no longer sufficient imaginary

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[4] Unless otherwise specified, all translations from the Russian and French throughout the dissertation are my own.
[5] The ideas of what life in the information age entailed and what forms of adaptation were imagined to be necessary differed across the three countries that I study. I explore these differences and their significance in Chapter 2.

by another that looks more promising" (Jasanoff 2015, 329). Such imaginaries can be utopian or dystopian. For example, Aldous Huxley's *Brave New World* (1932), written against the backdrop of revolutionary social control and rising imaginaries of eugenic tinkering, citizens were raised artificially from human embryos in special conditioning centers and children were educated through sleep-learning processes where they were fed subconscious messages to shape them into identities appropriate for their place in the "new world." In Huxley's dystopian science fiction, the process of forming people is direct, violent, and involves technological intervention. The leaders applied coercive techniques (reproductive hatcheries, brainwashing) to force people into pre-defined social niches.

Education, and specifically the teaching of literacy, or the basic capacity to read and write, has historically been a popular, and often positive[6], technique to form people. Literacy is a powerful tool to educate the public in the terms and values of the altered imaginary, to inscribe the revolution in the hearts of the human subject, and so to make people into able citizens of the new order.[7] For example, the Reformation theologian William Tyndale translated the Bible into vernacular English with the goal to "[cause a boy that driveth the plough to know more scripture] than the clergy of the day" (Coggan 1968, 18). By writing the Bible in a language that many could understand, Tyndale's purpose was to give everyone, including children, access to the scriptures so that they

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[6] The extent to which literacy is a positive or violent tool for forming people has been, and remains, much debated (on the violent nature of literacy, see Stuckey 1991). Scholars point out that at the same time as literacy defines for people particular frames for self and world-views that can be considered limiting, it also, through these same frames teaches structures with which people can better express themselves and be more independent.

[7] In *Imagined Communities,* Benedict Anderson (1982) has argued that the specific social order established by the foundation of the nation-state has been enabled and sustained by public literacy.

might be able to interpret them for themselves rather than to rely on the institution of the church. Tyndale's act helped to spread the values of the Reformation in England and was perceived as a threat to the established powers of church and crown for which he paid with his life. In the case of the Reformation, access to a previously arcane religious text not only made an individual relationship with God into what some scholars have referred to as a "citizenship" (Furet and Ozouf 1977), but was used as a vehicle to fuel transformations to the socio-political order that also strengthened the institution of public literacy.

Public literacy campaigns have also *followed* socio-political revolutions. Literacy, in this context, is an instrument of what Michel Foucault called "governmentality," or the techniques states and other powerful organizations use to discipline their subjects through schooling and training (Foucault 1977b), as opposed to overt force or violence on their bodies, as in Huxley's novel. The power of literacy to re-form people after changes in the social order was recognized in debates about the future of countries following decolonization, when both national sovereignty and individual identities were being re-formulated (Arnove and Graff 1987; Collins and Blot 2003). One of Vladimir Lenin's first reforms after the revolution of 1917 was to launch the mass-literacy campaign known as *LikBez* (short for the Russian *likvidatsiija bezgrammotnosti*, or "liquidation of illiteracy") to "eradicate illiteracy" in the newly Soviet population (Clark 2000). Most recently, following the 2014 revolution in Ukraine, the question whether children should be taught to be literate in Ukrainian or Russian, or both, became a point of contention and even cause for military action (Stelmakh and Korytska 2014). In all of these examples, literacy campaigns formed people by inculcating values through the teaching of particular practices of reading and writing. From the correct way to hold a pen and form letters on the page to rules of grammar that encouraged particular styles of prose and speech, literacy training became a seamless and invisible part of people's quotidian life, disciplining body, mind, and spirit.[8] Change in literacy accompanies changes in social order. So it is not surprising that in the 1980s, just as *Time* magazine announced the revolution in the human-computer relation, the United States, French, and Soviet governments all supported local and national campaigns to make schoolchildren computer literate. The computer literacy programs, like language literacy in other revolutions, were strategic sites for re-forming the person with the technology of the computer for the envisioned demands of life in the so-called information age.

These programs are excellent places to look at in trying to understand this historical period in which, as contemporaries claimed, the meaning of people as humans

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[8] Anthropologists like Marcel Mauss (*La Technique du corps* 1936) and André Leroi-Gourhan ("L'illusion technologique" 1960; *La geste et la parole* 1964) have studied how the use of a tool shapes and is shaped by the practices of the hand as well as how the use of a tool informs consciousness and the attitude to reality. Learning how to wield a pen – the foundation of literacy – in a manner that is deemed beautiful and correct is simultaneously an exercise in corporal and moral discipline. So basic is this idea taught to all school children that adages have emerged in different cultures to instruct the student in a proper way. In an image of a French classroom from 1900, "Plus fait douceur que violence," ("Be more gentle than violent") is a message on the blackboard that hangs over the scene and is at once a moral lesson, a tip for correctly holding the pen, and a model of calligraphy for the students to aspire to (see, for example, a photograph of a classroom from the 1900 at the Musée National de l'Éducation, Rouen, France). In Russian, the "pressure--gently" (*nazhim-nezhno*) formula emphasizes the same light touch. A firm but light touch was necessary in order to have a fluid use of the pen, which could continue for some time (without cramping the hand of the writer) and produce beautiful, flowing letters on the page, and not destroy the gentle quill of the fountain pen or break or too quickly blunt the pencil. The union of the pen and the human hand and the idea of the ideal written product created this attention to lightness and gentleness in wielding the pen was an early, embodied and moral lesson of literacy.
Learning computer literacy, as I describe in Chapter 4, came with the need to master new techniques of the body. Although using the keyboard and computer mouse are a different anthropological given than holding a pen, (and scientific studies have been made on the effect of this difference on people's capacity to hold a pen, write in cursive, as well as on their thinking and composition of texts) the "pressure--gently" message may still apply. Images of fingers fluttering over keyboards illustrated the catalog of the CMI and are a feature of almost every film about computers, particularly ones in which students are shown working with the computer or learning to do so.

inhabiting the planet underwent a profound change thanks to the proliferation of thinking machines. But how do we historicize this moment? What precedents and vocabularies exist for attempting to characterize how people are formed at the intersection of rapid changes in technology and society?

One source is studies of technology that take the formation of human subjectivity as their core concern. For example, Sherry Turkle's (2011) and Natasha Dow-Schüll's (2012) recent works used interviews and ethnographic observation of technology users to focus on what transpires between person and machine and how people fulfill their needs for community or escape through their relationship with the technology. Turkle argued that the daily use of internet-connected devices leads to a state of being "alone together." Dow-Schüll examined the relationship of gamblers to gambling machines. She found that by purposefully subjecting themselves to what she called the "machine zone" individuals were able to use machine gambling as a way to manage the contingencies and anxieties in their lives.[9] Both studies captured consequential—and concerning—aspects of contemporary human-computer relationships; however, both focus on the voluntary use of the technology, as an activity chosen by the individual and informed by technological design rather than by top-down, culturally conditioned programs to remake humans in information societies.[10]

In a place-specific and robust study, Eden Medina, a historian of computing, explored the role of political context in relation to technology formation in her book

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[9] See Also Rob Horning's blog post "Reparative compulsions" (2013), where he applies and develops Dow-Schüll's observations about the machine zone to social media interactions.
[10] In her paper for the *History of Recent Social Science Conference* (June 6-7, 2015), Marcia Holmes used the history of the training of computer programmers in the 1950s and 1960s in the American Systems Development Corporation to speak about the formation of the creative liberal subject with the computer.

about the relationship between the cybernetics movement in Chile and the building of Salvador Allende's socialist government (2011). Medina argues that sociotechnical projects like Project Cybersyn are key sites for understanding how revolutionary ideals are implemented in daily life. Although she is interested in how revolutions materialize into new world orders, she does not discuss the way in which the new sociotechnical order imagined and pursued by the leaders of Project Cybersyn reflected on the subjectivity of Chileans.

A work that combines attention to subjectivity as well as to broader historical context in which it unfolds is Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (1999). Hayles examined how the idea of information as disembodied that arose in the field of cybernetics contributed to the creation of the state of being "posthuman." By paying attention to the body and materiality in narratives about the posthuman, Hayles finds that the posthuman is actually "grounded in embodied actuality" and, as such, is an important resource "for thinking the articulation of humans with intelligent machines" (287). Although she investigates how powerful ideas in history of computing have influenced human subjectivity, Hayles does not study how these ideas are embedded in or conditioned by specific institutional channels or practices (such as education curricula or state-society relations) that then do the work of forming people into posthuman subjects. Relatedly, although Hayles is careful to say that the experience of the posthuman is limited to some populations of people in the developed world (and particularly in the United States), her study does not allow us to say anything about the posthuman in other cultures.

Taken together, these works suggest that a different kind of study is needed in order to understand the formation of the human in a computerized world: a study that links broad-scale collective visions to their influence on people through particular institutions, practices, and technologies; that narrates the transformations in individual people in relation to changes in social order; and that looks at the developments of computers in society in different countries at the same time so as to say something more generally about the mutual shaping of computers and human subjectivity.

The “coproductionist” branch of the field of Science and Technology Studies (STS) pioneered by Sheila Jasanoff has developed methods to make sense of the emergence of a new idea of the human at the interface of technological and social systems. "Increasingly," Jasanoff writes in her definition of the concept of coproduction, "the realities of human experience emerge as joint achievements of scientific, technical, and social enterprise" (2004a, 33). The basic insight of the coproductionist approach is that our ideas about what the world is, as a matter of fact, and what the world ought to be, as a matter of social choice, are formed together. The idiom of coproduction builds upon the fundamental understanding in the field of STS that scientific conceptions of the world and the technological artifacts embodying them are contingent on cultural histories and material circumstances (Shapin and Schaffer 1985). However, coproduction goes beyond the static claims that humans and non-humans exist together as hybrid formations, in ever-tighter "imbroglios" (Latour 1993; 1999), or that "artifacts have politics" (Winner 1986). Instead, it focuses on the dynamic re-formations of the world, and of the human experience in it, as products of scientific, technological, and social activity.

The coproductionist insight about the dynamic formation of the epistemic, material, and social worlds invites investigation into how institutions created by people to order society, such as law, are coproduced along with science and technology. STS work on “bioconstitutionalism” examines the way in which the life sciences and technologies interact with social and political lives to redefine what it means to be human--a characterization that is foundational to all constitutional orders (Jasanoff 2011b). Bioconstitutionalism identifies a “constant, mutually constitutive interplay of biological and legal conceptions of life” – a dynamic in which transformations in understandings of what life is activate rethinking of law at the most basic level (2011b, 3). This work shows how scientific and technological developments are made on terrain already steeped in constitutional thinking, although, as Jasanoff indicates, these are constitutions with a small "c"—comprising not only written rules but a variety of unwritten norms generated by custom, informal behaviors, and institutional practices (10). The term constitution in the STS context refers simultaneously to the makeup of the human being ("to constitute," the verb) and to the norms according to which people live (the small "c" version of "constitution," the noun). Going beyond the domain of biology, the work on bioconstitutionalism provides a more general model for how to understand the linking of ontological and normative orders during times of change and how the presence of formal and informal (explicit and implicit) normative structures inform the ways in which people engage in re-making the world in the context of new and emerging technologies.

If we view the moment of formation of people through the computer literacy programs during the so-called computer revolution as moments of constitutional change, we are led to the following questions: How has the computer come to reconstitute the human since those early days of its diffusion through society? Who is the *person* of the personal computer? What can we say about her *constitution*, or her *make-up* as a human being and the *norms* according to which she lives? These are the questions that explore in my dissertation by studying the phenomenon of computer literacy. To get to the heart of these issues, I compare public educational programs to make children computer literate, or computer cultured, from their rise around the turn of 1970 to their peak in the mid-1980s, in the United States, France, and the Soviet Union—three countries where computer literacy projects were particularly active and which adopted an array of approaches to the task.

This dissertation extends STS work on constitutionalism to the history of computer, or information, technologies by looking at the impact of computer education programs on ideas of what it means to be a competent, functioning member of the computer society. I ask how acquiring the technical knowledge of working with computers, termed the new "literacy" or the new "culture," shaped an (altered) idea of the human being as subject and citizen. At the same time, I show through comparison how ideas of the human being and the citizen particular to each nation-state informed the design of the technology and the institutions that propagated the new literacy or culture of computing.

Professionals, such as programmers or neurosurgeons, and, increasingly, lay people, can use computer technologies to tinker with foundational elements of human subjectivity. For example, electronic implants (e.g. neural implants) can therapeutically replace or extend sensory capabilities. Similarly, but with no need for physical intrusions, knowledge of programming can become the basis for forming new solidarities,[11] thus influencing basic constitutional ideas of personhood and citizenship. Less explicitly, but perhaps more powerfully, it is largely accepted in Western society that knowledge and use of computers are linked to basic values and concepts that are important to the constitutional order. For example, in explaining Edward Snowden's actions, his supporters and opponents alike pointed to his occupation as a programmer, his involvement in geek communities such as Ars Technica, and even his generational affiliation.[12] Snowden, after all, was born in the year of *Time* magazine's "Machine of the Year," and therefore came of age in a world occupied not only by thinking humans but also by thinking machines. Everything that observers chose to say about Snowden implied that his values, his sense of self, and his feeling of responsibility were constituted by the new "computer culture." Indeed, one can see the Snowden affair as an example of a technologically mediated "constitutional moment" (Jasanoff 2011b) in which the pervasive influence of computers on how we govern ourselves made it possible for a person steeped in that culture to become a particular kind of dissident citizen.[13] To make sense of moments like these in our own day it is essential to first understand the history of the computer's development in society that made such moments possible. The history of computer literacy, *culture informatique,* and second literacy movements, all three of which sought to make the general publics of three different countries knowledgeable about computers, provides over two-decades of such formative moments. "Literacy" as

[11] For example, consider the kind of community projects organized with and around the LilyPad Arduino sewable electronics platform (see, http://lilypadarduino.org/).
[12] For example, see Broader and Shane (2013), Gellman and Markon (2013), and Brumfiel (2015).
[13] Snowden's "citizenship" is frequently evoked in relation to his revelations. This is not just because of his difficulty in finding a nation that would accept him after his revelations (reference), but also the pseudonym "Citizenfour" that he chose with which to sign his original email to the journalist where he reveals his findings about the NSA (Poitras 2014).

in "computer literacy" or "culture" as in *culture informatique,* sit at the intersection of the two meanings of “constitution”: they encompass both the (technical) knowledge that makes up competent people in a certain kind of society and the normative frames according to which people in these societies should live among others.

My focus on the development of computer education and citizenship relates my project to the history of the human sciences. This branch of the history of science concerns itself with how social order is made and sustained through scientific and technological practices (broadly defined to include psychology and economics) that, in turn, are themselves made and remade from the structures of the social order.[14] The history of pedagogy, the method and practice of teaching, is the subtopic in the history of human sciences that comes closest to my interests in computer literacy. In their 1976 article in the history of pedagogy, “Head and Hand: Rhetorical Resources in British Pedagogical Writing, 1770-1850,” Steven Shapin and Barry Barnes argued that all pedagogical approaches are “developed on the basis of particular conceptions of the constitution of the mind, the nature of thought, and the relationship of knowledge and thinking” (Shapin and Barnes 1976, 231). The authors show how these conceptions that inform pedagogy served to maintain particular constellations of social order. The discourses and practices surrounding computer literacy programs—pedagogical writings in different forms—similarly depended upon conceptions of the developing mind, of knowledge, and of computers. Moreover, these conceptions helped to imagine and construct particular forms of social order, such as the link between creativity (a quality

[14] Defined in this way, the history of human sciences shares the intellectual interests of STS.

that some of computer literacy advocates sought to foster with their programs) and a liberal national society in Cold War America (Cohen-Cole 2009; 2014).

Peter Miller and Nikolas Rose's (1994) model of "therapeutic authority" is helpful for thinking about the way in which the entrepreneurs of computer literacy programs hoped their efforts would not only give children computer skills but form their ways of thinking and knowing to be citizens in the information age. Miller and Rose identify the introduction of psychology-based explanations and interventions in areas of life previously unconcerned with psychology, such as industrial relations and organizational functioning. Part of the way in which this form of "therapeutic authority" extended itself was by supporting the rise of a new form of professional education after the end of World War II that sought to "engage [their subjects] at the level of their personality and experience" instead of merely teaching a set of skills (1994, 38). This kind of education is an example of Michel Foucault's notion of power as "action upon the conduct of conduct," a process by which power from a few individuals can influence many without direct coercion (Foucault 1982, 221). By studying the role that computer literacy plays in forming particular kinds of people, with ways of knowing that are supposed to be activated in the future, my project concentrates on the exercise of "therapeutic authority" by computer literacy entrepreneurs to shape the future of society, a practice whose relationship to the personal computer has not yet been systematically explored.

As becomes apparent even from Shapin and Barnes' essay on the history of pedagogy (1976), psychology is a major influence on this sub-field, and a preoccupation of the history of human sciences as a whole. The role of psychology in the history of human sciences is problematic because psychological approaches seem to dominate the very understanding of the "human." By making a comparison with the Soviet Union where Western psychology with its focus on individual minds (particularly Freud's psychoanalysis) was officially banned (M. A. Miller 1998), and where alternative psychological and social conceptions of the human flourished, my dissertation contributes to disentangling any seemingly given relationship that may appear to exist between the computer and a psychological understanding of the human.

Scholars from sociology, government, and history of science and technology have recently paid much attention to how interaction with computer technologies changes the way that people engage with society. The engagement with on-line worlds is said to undermine vitality of human communal relationships (Turkle 2011)[15] or empower individual's voices in the public sphere (Kahne, Middaugh, and Allen 2015; Zuckerman 2013). In their recent book on digital citizenship, Jennifer Light, Danielle Allen and contributors to their volume characterize the nature of social power, or the capacity of members of civic society for political participation, in the contemporary digital age (Allen and Light 2015). They found that with social networks and other digital tools, people practice new and different forms of participation in politics and they concluded from this that participation in politics in the digital age is different from the pre-digital era. Yet, they do not consider how this changed nature of participation in turn transforms the meaning of politics or democracy, which they hold as given. In contrast, my account

[15] There are also authors, notably Rainie and Wellman (2012), who dispute Turkle's argument that the use of networked information technology makes us "alone together." This goes to show that the pro and cons of technological effect on the human communal relationships are a much debated topic today.

examines the way that a political order is being reconstituted in the process of making citizens computer literate rather than merely adapted to a fixed category of citizen.[16] If we take seriously both the idea of constitutionalism in STS and the insight that literacy changes subjectivity as it "patterns the soul," as Plato described,[17] or makes a different entity of society, as Marshall McLuhan (1962) famously concluded,[18] then we must recognize that the very idea of contemporary citizenship is coproduced with the concept of computer literacy. In other words, I treat citizenship not as an *a priori* that can be defined abstractly, but rather as an emergent phenomenon that is actively reconfigured in the process of a public becoming computer literate, and hence becoming members of an altered imagined community (Anderson 1982).

By making people computer literate or infusing them with *culture informatique,* the pioneers of computer education envisaged giving people a sense of belonging that articulated in new ways the relationship between the local, the national and the global. By intervening in public education systems, to which nation-states delegate the authority to form their citizens, they actively involved themselves in citizen-making. Nation-

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[16] Some political theorists (e.g., Beiner 1995) have argued that the emergence of notions like "human rights," which contains an individual-universal dialectic, pose a challenge for the practice of citizenship. In my study, this individual-universal dialectic surfaces frequently. For example, Jean-Jacques Servan-Schreiber's idea of *la ressource humaine* (which I introduce in Chapter 2) sets up a dialectic between the unique individual- who possesses this resource and the universality that this concept evokes. If we treat citizenship as a dynamic notion that reflects realities of human subjectivity coproduced with developments in technology, then it is not surprising to find overlapping layers of citizenship that bridge the local and global in new ways.

[17] In *The Republic*, Book VI, Socrates asks: "Do you think, then, that there is any difference between the blind and those who are veritably deprived of the knowledge of the veritable being of things, those who have no vivid pattern in their souls and so cannot, as painters look to their models, fix their eyes on the absolute truth, and always with reference to that ideal and in the exactest possible contemplation of it establish in this world also the laws (nomima) of the beautiful, the just and the good, when that is needful, or guard and preserve those that are established?" (Plato 1946, 484c d).

[18] In fact, McLuhan postulated the emergence of a new kind of person with literacy and printing, which he termed "typographic man."

specific institutions, such as the educational system or the computer industry, were necessary conduits for computer literacy programs to reach the scales of diffusion the pioneers intended. Yet, at the same time as they depended upon them, these programs challenged these institutions to transform themselves in light of a certain leveling universal (supra-national) imaginary of the computer and the computer literate person. For example, the very idea of the "information age" was defined both in terms of national realities and interests and as a stage of global development aspired to by many nations. In this way the term assumed the existence of an overarching reality shared among nations. Computer literate people around the world would be able to access this reality, while leaving behind their non-computer literate compatriots. I explore the ways in which the idea of the "citizen" in relation to "the information age" both depended upon[19] and challenged the traditional understanding of citizenship as grounded in a national affiliation[20] and facilitated the emergence of a sense of belonging to an imagined global community.[21]

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[19] For example, I show in Chapter 2 how the very terms used to describe the programs--computer literacy, *culture informatique,* and second literacy--were strongly influenced by their respective national histories and constitutional orders.

[20] The Logo classroom can be seen as a kind of training ground for the development of a holistic and communitarian model of citizenship as “achieved membership in a self--determining ethical community." This model of citizenship is attributed to Aristotle. It is in contrast to the Lockean one that Jünger Habermas described as the “individualist and instrumentalist,” “organizational model” of citizenship, in which citizenship is “received membership in an organization which secures a legal status” (Charles Taylor, cited in Habermas 1995). The existence of different models of citizenship led Habermas to argue that the association of nationalism and citizenship was, for a brief period of time, a historical contingency and is not a conceptual link.

[21] On the emergence of a global imaginary, see Jasanoff (2012) and Miller (2015).

Imagining the computer literate citizen around the world

No venture in world-making would be possible without a vision to provide a blueprint for it and to inspire others to join the cause. A recent turn in coproductionist STS work has been to recognize the importance of aspirational collective imaginations of the future that a community strives to achieve and the role of technologies in fueling and realizing these imaginations. In a 2015 work, *Dreamscapes of Modernity*, Jasanoff defines a "sociotechnical imaginary" as a "collectively held, institutionally stabilized, and publicly performed vision of a desirable future, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff and Kim 2015, 4). Imaginaries of "computer literate" societies highlight how material technologies can be "tools to think with," to borrow Turkle's term, not only at the level of and for the benefit of a single individual (even though they were *personal* computers intended for individual use), but for collectives as they together imagine the ways that knowledge of the computer can be an answer to constitutionally important issues of what constitutes a functioning member of the polity. These include ideas about what kind of knowledge, skills, and sensibilities are necessary to be a full member of a society envisioned as having particular characteristics, and what are the right relationships between subjects and institutions, such as schools, states, and businesses. In other words, the framework of sociotechnical imaginaries directs our attention to the embedding of the ideas of the individual pioneers in their technical creations and expressions about desirable lives in their respective socio-political cultures and in the world at large. The imaginaries framework makes it possible to ground the formation of computer technology in the everyday realities and norms (*structures*) of social life. Symmetrically, it also allows one to see how the technology and the people who championed it were *agents* that challenged the established structures to influence the development of society in the directions that they deemed right and good.

Sociotechnical imaginaries arise from locally specific cultural contexts and draw upon the normative resources, histories, identities, and beliefs of these cultures. To be able to say something general about the formation of the person of the personal computer requires looking comparatively at events in different cultures. A strength and at the same time a limitation of most histories of computing is that they are deeply anchored in the cultural context of a single country, or even a single region (e.g. the Silicon Valley). This anchor allows authors to understand deeply the development of computer technology in relation to the values, ways of being, and history of a particular group or community, but it also prevents them from doing justice to the breadth of the computer revolution. They do not account for the reasons why computers came to be seen around the world--in very different cultural and political milieus--as effective tools for realizing social goals by actively forming people (such as moving all of society toward a better imagined future, or diagnosing perceived social problems that only the computer could properly address)[22]. Furthermore, they do not account for the ways in which computer education pioneers defined as the need, not just of a few elites, but of the general public *collectively,* and in particular of children, to know computers intimately.

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[22] Eden Medina in *Cybernetic Revolutionaries* (2013) is a model work in the history of computing that studies how Chilean social order was reimagined with cybernetics.

I use the method of cross-national comparison[23] to study the imaginations and practices surrounding computer literacy programs for children, as well as the reception and development of these imaginaries in the cultural and sociopolitical contexts of the United States, France, and Soviet Union. Although many countries in the developed world instituted computer literacy programs by the 1980s, these three countries make a particularly interesting comparison because of the spectrum of culture, political thought, and computing traditions that they represent and because of the positions they occupied in the world order of the second half of the twentieth century. At the same time that these differences existed and exerted influence on the development of the computer literacy programs, ideas, actors, and artifacts circulated among the three countries and facilitated the development of national programs that defined themselves at times in relationship with and at other times in opposition to one another.

Three axes of comparison stand out from the commonalities and differences represented by the United States, France, and Soviet Union as especially significant for the development of their respective computer literacy programs: 1) the political system, 2) the openness or closedness of society, 3) the traditions of thinking the human.

During the period of study, each country occupied a different position on the continuum of political systems from the market-based United States to socialist France to communist Soviet Union. Each political system had its own visions, practices, and

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[23] Examples from comparative historiography that I draw upon include Sheila Jasanoff's *Designs on Nature: Science and Democracy in Europe and the United States* (2004a) and John Carson's *The Measure of Merit: Talents, Intelligence, and Inequality in the French and American Republics, 1750-1940* (2007). Jasanoff argues that regulation of new technologies (as opposed to education) reflects fundamentally different underlying presumptions about the role and responsibility of states. Carson shows how the different uptake of intelligence tests in France and the US point to different understandings of the state's project of creating functioning citizens and discriminating among them.

institutions of subjectivity, that is, for my purposes, of the relationship of the individual to the collective and to the nation-state. Pioneers of computer literacy saw the new knowledge of the computer as a way to explicitly redefine this relationship (as in France) or hypothesized that it would be redefined in the process of acquiring the new computer-related knowledge and skills (as in the United States and Soviet Union). Although in each case computer literacy projects became national projects, each nation uniquely combined an individual pioneer's initiative with the activities of the computer industry and the national education system to realize the project. The study of computer literacy in the context of these three political systems helps to better make sense of the greater imaginaries in which computer literacy was embedded. It also helps to understand what role the knowledge of the computer played in the context of the Cold War, both from the perspective of the two world hegemons (the United States and the Soviet Union) as well as of the politically "in between" France.[24]

The United States, France, and the Soviet Union also can be compared on an axis from relatively more open to more closed societies. The concept of the "open society" was advanced by philosopher Karl Popper who defined it as one in which individuals make personal decisions as opposed to having decisions made for them by others (Popper 1945). According to this definition, democratic societies are considered to be more open than authoritarian societies because they allow their citizens personal freedoms (of movement, expression, belief) and provide transparent mechanisms and institutions for securing these freedoms. In all three countries, a computer literate general public was

[24] For justification of how France occupied an "in between" place during the Cold War, see Pierre Grosser (1995; 1997).

considered, for better or for worse, to lead to a more open society. Comparison of computer literacy and culture programs in countries of variable social openness (from the relatively open United States and France to the closed Soviet Union) helps to understand the promises and meanings of forging openness with technology.

The third axis of comparison concerns the traditions of thinking about the human, and therefore also the human-computer relationship, in each country. In the United States popular and scholarly thinking about the human-computer relationship drew extensively upon cognitive psychology. For example, drawing upon her training in psychology in *The Second Self*, Turkle described the computer as a Rorschach test: a device upon which multiple forms can be projected, each of which reveals something about the individual personality of the beholder (Turkle 1984, 20).[25] The characterization of a computer as Rorschach test was consistent with the aspect of constructionism advanced by Seymour Papert, an American pioneer of computers in education, which holds that the child can activate her character and individual style of learning through interaction with the computer as an adaptable, personalized learning tool—a tool that is pliable (within the constraints of the program) in the child's hands. In my comparative study, I situate Turkle's metaphor of "computers as Rorschach" in the particular socio-cultural context in which this metaphor arose. The Rorschach test was a specific type of psychological instrument that operated with particular assumptions about the human and within defined social relationships between the test's administrators and its subjects. Similarly, the idea of the "computer as Rorschach" derives from a particular

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[25] In "Image of Self" (1990) Peter Galison explains in detail how the ambiguous inkblot of the Rorschach takes on a definite form in light of the subject's self-realization through the act of perception and verbalization.

understanding of the human relationship to computers, and hence has implications for how the computer should be employed in education.

In France and the Soviet Union, where there was less attention to the computer as an intellectual technology of the individual, the "computer as Rorschach" metaphor was not prevalent. Instead, Jean-Jacques Servan-Schreiber, the leader of a French computer literacy project advanced the notion of the computer as a tool of decolonization while the leader of the Soviet projects, Andrei Ershov, used the metaphor of the jockey and horse as well as the Biblical Trinity (comprised of programmer, program, and computer) to describe the computer programmer. These metaphors, and the different traditions of thinking the human on which they rested, influenced the ways in which computers were used in education. Thinking the human as I use that idea here spans the psychological approaches in the United States to more macro-social political approaches in France, to the superficially competitive (horse racing) and yet still deeply internal (soul-oriented Trinity) approaches in the Soviet Union. These variations in the way that ideas of the human and of citizenship were articulated through computer literacy programs in the three countries enrich our understanding of the social history of the computing age.

Cross-national comparison across three countries with varied political, social, and intellectual contexts helps to reveal meta-phenomena, such as allegiance to particular sociotechnical imaginaries, that may either go unnoticed when studying only one cultural context or be taken as a given instead of as the product of a particular time and place. To take one particularly relevant example: some histories of computing written by American scholars emphasize how mainframe computers developed in the "Closed World" of the Cold War. The problem with such studies is that the historians have tended to hold a static image of the Soviet Union, centering on Cold War bipolarity. Paul Edwards (1996), for example considers Marxism to be an "ideology" that he factors into his definition of discourse, as if ideology is monolithic. Yet, a closer reading of the engineering and cultural climate within the Soviet Union suggests that multiple allegiances, conflicting philosophies, and diverse engineering solutions were mobilized to deal with computing challenges, just as there were reciprocal (and varied) perspectives on computing and citizenship in the United States.

On the opposite end of the spectrum from "Closed World" histories about mainframe computers are popular recent accounts of personal computing that focus on the PC's revolutionary nature, arguing that PCs have brought about a uniformly "open world" (see, for example, Friedman 2005). Just like the Closed World histories of mainframe computers, works that praise the PC's contribution to an "open" global world neglect the cultural particularities that have contributed to different experiences with and expectations for the computer. Both types of histories are the result of writing from the vantage point of a single culture that results in a false one-country-versus-the-rest-of-the-world dynamic. Thus, the "rest" of the world appears either as the determinate cause of internal events (as in the Closed World accounts) or, inversely, as the bare, open slate upon which the experiences of one country are projected.

The comparative method, applied in this particular moment of transition from mainframe computers reserved for experts to personal tools, even playthings, of the general public and of children, allows me to go beyond the national contexts of literacy programs to say something about the characteristics of computer literacy that the national imaginaries have in common. Comparison allows each case to highlight something present or absent in the other cases. By these means, the researcher can escape the silo of the nation state, highlight distinctiveness, and locate sources and implications more accurately. This methodology, layered on top of a world in which there is already a circulation of people, ideas, and artifacts, fills out the global projection of particularity. Thus, we see people who are constituted both by the traditions and values of their own local selves (rooted in particular national cultures) and by the new knowledge of the computer that they consider to have in common with others beyond their own nation.

In sum, the STS lens of constitutionalism, the framework of sociotechnical imaginaries, and the method of cross-national comparison provide the theoretical and methodological pillars of this dissertation. These frameworks and methods have also informed how I defined the scope of an ambitious three-nation case study and selected the empirical material with which to examine it. My empirical sources consist in the first place of unpublished archival documents (project proposals, correspondence, grant applications) of the three pioneers of the programs in the three nations: Seymour Papert in the United States, Jean-Jacques Servan-Schreiber in France, and Andrei Ershov in the Soviet Union. I also examined a wide range of secondary sources: curricula, textbooks, software programs, and hardware design; transcripts of governmental hearings and political speeches; contemporary magazine, newspaper, and television articles and broadcasts, and films and novels from general culture, expressing views about public knowledge of the computer. Finally, I read articles and books by other writers on these educational programs and on the early history of personal computing more generally. To my knowledge, no one has ever brought this empirical material together, never comparatively, and not with the goal of understanding the constitution of the human in a computerized world.

Some of the individuals who are central to my study, their programs (e.g. *Informatique pour tous*), and technologies (e.g. LOGO programming language) that I analyze have been extensively written about in histories of the use of technology in education and histories of computing.[26] As noted, however, these works tend to focus on events within a single country and are primarily interested in chronicling the development of a technology or its application to education. The puzzle of how humans changed as computers went from large machines accessible only to experts with special knowledge and authorization to necessary implements for everyone in modern societies--and even objects of child's play-- remains outside the scope of these studies.

Some scholars have addressed aspects of the computer "going public," yet have not formulated their questions in terms of the constitutions of the human subject and hence have looked at different material to address the topic. Historians of computing have documented the invention of the personal computer, the process of computerization of society, and the introduction of computers into public life. Some of their work focuses on the design of the computer's physical components, such as the invention of the transistor and the miniaturized circuit (Riordan and Hoddeson 1997) the design of lay-appropriate interfaces (Bardini 2000) as primary reasons for the computer's wide public uptake. Others focus on the role played by the computer industry in its search for new

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[26] On Papert's LOGO, see Cynthia Solomon (1986), Robert Taylor (1980), Bill Ferster (2014). On French *culture informatique* programs, see Jean-Pierre Dufoyer (1988), Georges-Louis Baron and Eric Bruillard (1996), Michelle Harrari (2000) On Ershov's second literacy projects, see Ksenia Tatartchenko's dissertation (Tatarchenko 2013; and forthcoming), Gregory Afinogenov (2013).

markets (Hertzfeld 2005). Many describe the individual inventiveness and entrepreneurial spirit of a few computer pioneers who pursued radical and frequently misunderstood visions (Freiberger and Swaine 1984; Waldrop 2002; Markoff 2005; Isaacson 2014). The stories of these pioneers and of the professional circles of computer programmers is frequently pitted against "ordinary people" or the computer uninitiated lay public (Campbell-Kelly 1996). In most of these narratives, a few (usually male) pioneers deliver shiny, ready-made devices and programs to the eagerly awaiting masses. Although I too follow the work of a small number of male visionaries, my attention to the collective imaginaries to which they contributed, but which also shaped them, helps to embed these individuals' agency in larger social structures. Thus, I examine how the visions of the pioneers were articulated in relation to and together with their ideas of the child, the public, and the citizen that their programs intended both to serve and form. The imaginaries framework also draws attention to the ways in which these visions were resisted and contested.

From the history of computing literature, the recent work of Joy Rankin (2015) comes closest to the questions and subject matter of this dissertation. In her dissertation, Rankin examines the history of computer time-sharing systems used in select American schools and universities in the 1960s and 1970s in order to answer the question "How did computing become quotidian?" Rankin argues that the origins of the personal computing culture lie in the rich educational uses of computers, where students and their teachers were "more than users" but rather creative innovators of user-friendly computing systems. In various parts of her dissertation, Rankin mentions that the people who invented the programming language BASIC and the computing system PLATO believed that their work contributed to new forms of community building and offered opportunities for the "expansion of democracy" (Rankin 2015, 19). Rankin does not, however, investigate what democracy meant for the pioneers or how it connected to knowledge of the computers. Although she says her actors believed university students could and should learn programming, she does not pursue why they thought this knowledge would be important. Going beyond Rankin's work, I investigate the ways in which pioneers of computers in education articulated ideas of computer users together with ideas about democracy. I argue that to answer the question "How did computing become quotidian?" we need to examine the sociotechnical imaginaries of the computer literate person that offer insights into what computing was imagined to be good for, *why* people should know it, and what they should know about it.

Sherry Turkle's early and influential study of how computers are evocative "objects to think with" showed how computers transformed the way that people, especially children, think about themselves, and how people are drawn to this technology. From the side of reception, her work explains how computers became so widely used by the general public because of what they offered and how they developed human psychology (Turkle 1984). These studies rightly point to the myriad intertwined causes--individual and collective, public and private, push and pull--that led to the transformation of the computer from an expert tool of the few to "moving into" households, schools, and workplaces, as announced by *Time*'s 1983 Person of the Year issue.

Unlocking the human with the computer

Children were the primary subjects of these programs. The focus on children introduces special considerations pertaining to the role of childhood within each society, commonly held assumptions about children's needs, abilities, and vulnerabilities, and visions of children's play.[27] Ideas of children as "the future" and as especially in need of becoming computer literate and at the same time as most capable (in contrast to adults) of doing so "naturally" were present to different extents in the three countries. Given this attention to children and the privileged place that child's play occupied in each society, it is particularly striking that the emancipatory unlocking and fulfilling capacity of the computer could best be achieved, the pioneers in all three countries believed, through a playful relationship to the computer. Play with computers as part of computer literacy programs took many forms and could be categorized according to the four characteristics of play identified by French sociologist Roger Caillois (1961): competition, chance, mimicry (role playing, simulation), or even at the limit, vertigo, an out-of-body sense-experience of the kind produced by rapid spinning or ecstatic dancing. Play, it was believed, would enable the computer to become seamlessly a part of the human self, so that interaction with the computer could yield the maximum envisioned satisfaction and benefit. I use the term "interplay" to describe relationship with the computer characterized by play (as opposed to use) and one in which both sides (the person and the computer) mutually influence one another.

[27] On the configuration of the child as user and player of computer games today and the relationship of this play to learning, see Grimes (Grimes 2015).

Different imaginaries of the computer "literate" or "cultured" person in different countries led to the production of different styles of interplay and different types of human-computer hybrids. It is helpful to think of each human-computer hybrid as a type of "cyborg." "Cyborg" is a term used to describe an animal or human organism that has *internalized* a technology in order to *adapt* better to a new environment (Clynes and Kline 1960). The term was coined in 1960 by Clynes and Kline, who were concerned with making it possible for human beings to go to space (Kline 2009).[28] Clynes and Kline conceived the main problem of human space flight to be an incompatibility between the human body and the environment. Their innovation was to adapt the body to the environment instead of creating an environment hospitable to the body (e.g. the space suit is an example of the latter). They proposed to implant an osmotic pump into the body so that drugs could be pumped into the organism in order to maintain homeostasis. The imaginary of the computer literate human being in all three national cases similarly entailed internalizing the computer in order to enable the individual, and, in turn, make society as a whole, better able to adapt to the envisioned demands of the information age. In each of the countries that I studied, this cyborg took a different form. Specifically, different visions of citizenship in the three countries influenced ideas about the right forms of the human-computer hybrid in the information age.

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[28] In his analysis of the work on and allusions to cyborgs by researchers of cybernetics, Ronald Kline has found that the main cybernetics texts were concerned with *analogies* between humans and machines rather than with the fusion of human and machine that defines the cyborg. Although the difference between making analogies and advocating for fusion are different projects, as Kline describes, they did come together in the case of imaginaries of the computer literate person. Pioneers of computer literacy programs that I study, particularly Papert and Ershov, mobilized the cybernetic analogy between human and machine to advocate for the fusion of human and computer in the form of the computer literate person.

This finding contrasts with most work done on cyborgs, where the cyborg is presented as a universal form of hybridity. For example, Turkle (1996) and Haraway (1985) imply that nature and culture blur in the same ways everywhere and the cyborg combines organism and machine in the same proportions. But there can be different arrangements of human and machine to create the cyborg of the computer era. Is it a human brain in the body of the machine, or vice versa? Are the fingers of the machine attached to the arms of a human? These permutations in the form the cyborg takes are significant because they suggests that, when human-machine hybridizations occur, the whole world will not constituted by the same kind of creature--the neuter cyborg--but rather by people who have incorporated the technologies to different degrees and in different ways. This perspective also deemphasizes the claims about the newfound freedoms of the anonymous "technological polis" (Haraway 1985) inhabited by cyborgs. Instead, it draws attention to the tensions and relationships among human beings who form a new kind of global collective by virtue of the diverse ways that they integrate computer technology into their ways of thinking and their bodily practices.

In the United States, the computer literate person was widely thought to be someone whose cognitive capacity had been enhanced by the computer. In France, it was someone who had become part of a common culture that had thoroughly internalized the computer. In the Soviet Union, it was a person who worked as one with the machine. These different fusions of human and computer grew out of different underlying constitutional orders, that is, different ideas about who human subjects are and how they relate and ought to relate, both to one another and to the collective in the envisioned information age. Are computer literate subjects, for example, predominantly psychologically distinct individuals, participants in a collective with intersubjective properties, or members of a common culture with values that permeate how its members think?

Contemporary discussions about machine translation, artificial intelligence, or computer-assisted instruction frequently take human-computer relations to be adversarial.[29] Concerns about computerization include the spread of automation that makes people superfluous in the classroom or the workplace (i.e., with computers that do the job of the human better than humans themselves).[30] By contrast, a computer literate person as envisioned by the pioneers of the age was to have a "feeling for the mechanism,"[31] a sensitivity to the computer that would enable the human operator to intuit what kinds of tasks or problems the computer could be used to resolve and how best to communicate with it. This communication with the computer, or delegation of functions to it, would lead to a deeper, more fully realized humanity in the user, unlocking both creativity (Cohen-Cole 2009; 2014; Rankin 2015) and in other cases reason (Dick 2015). The internalization of computer technology was thus seen as a route to the fulfillment of potential—of the individual (in the case of the US) or of the collective (in the cases of the Soviet Union and France). That fulfillment was envisioned

[29] This human v. machine rhetoric is still present in contemporary discussions of machine translation and its distant offspring in the form of on-line translation services (e.g. Google Translate). See, for example, (Lewis-kraus 2015).

[30] Concerns about automation were central to the anxieties about computers in all three countries that I study, as I will describe in Chapter 1. Although historian of computing Ron Kline (2009) distinguished concerns about automation from what he defined as cyborgian concerns about the fusion of human and machine, I think that it is helpful to see these concerns together as both expressions of anxiety about the changing relationship between human and machine. I have found in examining expressions of anxieties about computers (e.g. Toffler's *Age of Anxiety*) that it is difficult to distinguish between concerns about humans vs. computers from concerns about humans with computers.

[31] To adapt Evelyn Fox Keller's phrase, "feeling for the organism," to describe Barbara McClintock's relationship to the organisms she studied (Keller 1983).

as leading to emancipation from rigid social structures such as an apparently suffocating educational system (United States) or oppressive citizen-state relations (France).

I trace the formation of human subjectivity with the computer by following sociotechnical imaginaries of computer literacy and culture through the four stages of development identified by Jasanoff (2015): origins in the visions of pioneers, embedding in computer technologies and educational curricula, contestation during local experiments, and extension to the national scale.

In Chapter 2, "Building the Computer Literate Nation," I compare how the imaginaries of computer literacy, *culture informatique,* and second literacy originated in the context of three different political cultures in the late 1960s and the early 1970s. Scholars, thinkers, and practitioners in each country articulated visions of the information society—ideas about how society were being and would be transformed with computerization, and in particular the spread of personal computing. The information society was perceived to different extents as a problem and an opportunity, and I explore how the imaginary of computer literate or cultured person emerged as a solution to social dislocations of the envisioned information society.

In Chapter 3, "Entrepreneurs of the Mind," I introduce three key visionaries—Seymour Papert (United States), Jean-Jacques Servan-Schreiber (France), Andrei Ershov (Soviet Union)—who worked to advance forms of computer literacy or culture against the backdrop of distinctive national imaginaries of the information society and of the computer literate and cultured citizen of that society. I use the biographies of these three pioneers to explain what computer literacy, *culture informatique,* and second literacy meant to each of them, respectively. I show that in each of their visions knowledge of the computer was more than a technical skill; it was a way to transform the human mind, how people know and think and learn, with the computer. In the story of each pioneer, we see how each pioneer's vision grows out of wider background imaginaries and how those imaginaries accommodate or resist the tools, institutions, and pedagogical programs they created to purse their visions.

I turn in Chapter 4, "Playful Experiments with Computers," to examining how the pioneering educators sought to put their visions to practice. They did so in particular by carrying out experiments in which children were simultaneously subjects of the technologies and teaching curricula they developed and objects of study from whom the visionaries sought to learn about the "right" interactions between humans and computers. I show how the visionaries valorized specific elements of play in these experiments and how they used computer play for both teaching and learning about the human-computer relationship. Each experiment was a space apart in which the playful relationships that the pioneers considered to be foundational to computer literacy and culture could unfold.

In Chapter 5, "Return to Rules," I examine the ways the pioneers sought to scale up these experiments to the level of the nation. In extending their visions to the national scale, the pioneers worked with the computer industry and the national education systems in their countries and abroad. The fluid ideals promoted by the pioneers encountered resistance from established institutions, each of which had alternative ideas about the way in which computer technology should form citizens. In the end, national programs to teach computer literacy and culture in each country focused primarily on teaching users of machines as opposed to players who refashioned their identities with the aid of computers in the sense envisioned by the pioneers.

In Chapter 6, “Constitutions of the Human in the Computerized World,” I conclude by suggesting ways in which the twentieth-century imaginaries of the computer literate citizen have traveled beyond their points of origin and are connecting to contemporary constitutions of humans in the computerized world.

Chapter 2:
Building the Computer Literate Nation

Starting in the late 1960s, the computer became foundational to the imagination of a new future in the United States, France, and the Soviet Union. In all three countries at approximately the same time, the computer was envisioned as a tool that could transform society by empowering people in particular ways and giving them a new understanding of self and world. In all three cases the route to transformation of the individual and society was to make the computer a part of the general knowledge of the lay public, and of children in particular. In the United States, local and national efforts to introduce computers into education were labeled "computer literacy," in France as "informatics culture" (*culture informatique*) and in the Soviet Union as "second literacy" (вторая грамотность, *vtoraiia gramotnost'*). Each of these national movements, I argue, built on a sociotechnical imaginary (Jasanoff and Kim 2015), a collectively held and institutionally stabilized vision of the future information society and the people who live in it, animated by shared understandings of social life attainable through computers and the public's knowledge of them.

In all three countries the computer was seen as a solution to a sociotechnical crisis that each country appeared to face in light of the emergence of a new society and also as an opportunity to develop and transform its citizenry to be prepared for an envisioned future in which computers would play a central role. Although the specific circumstances in which computer education as a national project took form were different in each nation, in all three cases the development of computer knowledge in the lay public was seen as project of national strategy to address a social problem. In all of the cases the computer was not only an "object to think with," an object through and with which people reflect upon their own ways of thinking (Turkle 1984), but also an object with which to imagine and launch a desirable social order.

In order to serve this function of developing and transforming society, leading actors in the three countries called for all people to be active, "knowledgeable," and competent users of the computer. Advocates frequently turn to the proverb that recommends teaching a man to fish instead of simply giving him a fish to characterize their attitude to computers in education.[32] The "teach a man to fish" approach to computers involved moving away from purely instrumental uses of the computer in teaching to developing some element of knowing the computer (such as programming, or an algorithmic way of thinking) that could become an ever-renewing resource for the advancement of the self and for social development and transformation. However, even though programs in the three nations all endorsed this basic view, what "being knowledgeable" or sufficiently competent in computers meant was different in each case. Uncovering this difference and its significance is one of the main tasks of the present chapter.

The American idea of computer literacy borrowed a technical view of literacy from histories of literacy prevalent at the time. Literacy, and subsequently computer literacy, was seen as an "intellectual technology" that could develop one's cognitive ability to "learn how to learn" and enable the individual to stay abreast of the perceived

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[32] For example, this proverb was printed on the first pages of a promotional booklet for Jean-Jacques Servan-Schreiber's *Centre Mondial Informatique et Ressource Humaine* ("Centre Mondial Informatique et Ressource Humaine Informational Folder, presented by Servan-Schreiber to François Mitterrand" 1982).

rapidly changing information society. To have the knowledge of the computer, or to be computer literate meant incorporating the programmable logic of the microprocessor into one's way of thinking and doing as a cognitive enhancement.

In the French case, knowing the computer was thought of as acquiring a new culture. Becoming acculturated in *informatique* was one special instance of acquiring a broader technical culture (*culture technique*)--a culture that, it was thought, would empower humans by giving them more control over their sociotechnical environments and made it more feasible for them to realize their humanity—and thereby also to become a more effective resource for the state.

In the Soviet case, knowledge of the computer was characterized as a “second literacy.” This idea also drew upon the history of traditional literacy, but unlike in the American case, literacy for the Soviets was not conceived as a technology of the intellect, or a social invention to be applied to the human being. Instead, literacy was perceived as externalizing an innate aspect of the person for whom it was a biological and social destiny. Andrei Ershov, the chief architect of the “second literacy” movement in the Soviet Union, considered the knowledge of programming and of “algorithmic thinking” as an extension and formalization of already natural capacities of the human being. In Ershov’s envisioned future, the person and computer were to partner up together to become productive members of an updated, planned, collective society.

I focus in this chapter on the social, political, and cultural origins of these three imaginaries. Variations among the cases reveal three lines of comparison that were important to the kind of knowledge of the computer that the programs sought to develop in the general public and the kind of citizens of the information age that the programs were designed to form. National attention to computer literacy, *culture informatique,* and second literacy developed in the context of the proclaimed approach of the so-called information society, generally defined as a new age made possible by increasing use of computers by individuals. The first line of comparison comprises the specific ways in which this new age was understood in the United States, France, and Soviet Union, which influenced the kind of public knowledge of the computer that they envisioned as necessary for life in the information age. Computer literacy and culture was seen as a way to adapt the general population to the envisioned demands of life in these information societies. The second line of comparison traces who in society (the state, the school system, the individual) was deemed responsible for leading the adaptation effort. Finally, the third line of comparison comprises the specific way that the computer was supposed to constitute the person in order to make adaptation successful.

Imagining information societies

Curiously, it was the work of Japanese intellectuals in the 1950s that helped popularize the concept of the information society in the United States, France, and the Soviet Union. Indeed, the term originated in conversations among Japan academics (Karvalics 2007).[33] They imagined the information society as a postwar "computopia"—

[33] The first use of the term "information society," or rather its Japanese original *joho shakai* or *johoka shakai,* is attributed to a 1961 conversation between Japanese architect Kisho Kurokawa and historian and anthropologist Tudao Umesao (Karvalics 2007). Throughout the 1960s, various Japanese scholars, including architects, historians, anthropologists, and sociologists, developed and extended the term in numerous works. For example, see the works of sociologist Jiro Kamishima, *Sociology in the Information*

a desirable new social order brought about by computerization and fulfilled through personal computing in which each person would flourish (Masuda 1981). In contrast to a dystopic industrial society ruled by material consumption, the *computopia* was conceived as a new society built on "a general flourishing state of human intellectual creativity" (Masuda 1981, 3). This characterization of the information society as privileging intellectual and creative activity over material consumption became the defining feature of the American and to a lesser degree the French and Soviet visions of the information society.[34]

Despite computer technology's predicted defining role in bringing about the information society, the new society was not imagined as a result of technology's blind advancement but as the fruit of a concentrated "plan" to be carried out by the Japanese government and civil society.[35] The information society according to the Japanese was an unfolding phenomenon that began in years after the end of World War II and was envisioned to reach its full development by the year 2000 (Masuda 1981).[36] The government was responsible for bringing the information society to fruition by helping it

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Society 1964, whose title with the term "information society" was created by the book's editor Michiko Igarashi (Karvalics 2007); Yujiro Hayashi *The Information Society: From Hard to Soft Society* (Johoka Shakai: Hado No Shakai Kara Sofuto no Shakai e) 1969; Yoneji Ma and Konichi Kohyma *Introduction to an Information Society* (Joho Shakai Nyumon) 1968.

[34] This purposeful contrast of the information society with the industrial society was at the core of Masuda's definition and characterization of the new society (for example, his 1980 best-selling book that popularized the term "information society" within Japan and abroad was titled, *The Information Society as Post-Industrial Society*). Despite (or in spite of) defining the information society as the "post-industrial society," Masuda described "the image of the future information society" vis-à-vis the categories and characteristics of industrial society. For example, while industrial society was, according to Masuda, driven by the steam engine, which amplified human physical labor, computer technology would be the driver of the information society and its role was to "substitute and amplify the mental labour of man" (Masuda 1981, 31).

[35] Yoneji Masuda led a team of researchers in 1972 to propose to the Japanese government a plan for bringing about the information society. The report they produced was called "The Plan for Information Society—A national goal toward the year 2000" (Masuda 1981).

[36] In 1980 Masuda still referred to the information society as a "future" society, indicating that in the Japanese imagination it was a society in the process of becoming (29).

complete its fourth and last stage of development, which Masuda called "individual-based computerization" (39)[37]. Having permeated "big science" (stage one), management (stage two) and society (stage three), computerization would reach down to the level of each person (stage four) (36-39). Individual-based computerization meant

> There will be a personal terminal in each household, used to solve day-to-day problems and determine the direction of one's future life. Such computerization will not be carried out by large organizations, but by each individual. *Each person will be the subject who carries out computerization*" (39, original emphasis).

It is precisely this individual-based computerization, later termed "personal computing" in the United States, that would cause "creativity to flourish among people" (Ibid). The idea that the information society is realized through *personal* computing, in particular, became a cornerstone of the understanding of the information society in the United States, France, and the Soviet Union, though what personal computing meant differed in important ways across these nations.

In the Japanese imagination, the computopia would envelop Japan and extend to the rest of the world. The information society was simultaneously a Japanese national project and a global phenomenon. Masuda described a computer information network that grew in size from the local (individual, unconnected computers used in factories, libraries, schools), to the regional-national (time-sharing systems, regional traffic control or emergency systems), to the information society's full realization in the "global space" made possible by communication satellites creating a worldwide "global information utilities" that could be tapped into by individual computer users like international

[37] Masuda expected that this fourth stage would be realized between the years 1975 and 2000 (1980).

telephones (40-42). The development of the information society from big-science to management to society to the individual, and from the local to the national to the global, suggests that, at its fullest expression, the information society would allow individuals to access all information from anywhere seemingly without intermediaries.

The Japanese definition of the information society influenced thinking within the United States, France, and Soviet Union at the same time as scholars in these countries were developing their own nation-specific ways of thinking about this new age and its demands. Scholars in the three countries had different perspectives on the defining elements of the information society: its utopian and dystopian aspects; whether it would disrupt or continue life as usual; what "knowledge" would mean in the new society; whether it would be national or global in reach; whether it would happen on its own or need to be brought about through policy; if it had already arrived or, if not, when it would arrive in the future. Different opinions on each of these questions point to the existence of many imagined information societies instead of one universal society.

United States – An age of anxiety

The idea of "computer literacy" originated in the America of the 1970s, where the computer was seen to have created a problem that it was also perceived as capable of solving. The growing use of computers had led to what Harvard sociologist Daniel Bell called in 1973 the "post-industrial society," defined as a society dominated by the service sector whose main resource was knowledge (Bell 1973) Bell traced the roots of post-industrial society in the United States to the years after the end of World War II. He analyzed elements of post-industriality in America up to the publication of his book and projected how it would develop into the future. Bell saw no difference between his term "post-industrial society" and "information society" (Melin 2004). Both terms diagnosed the same causes and outcomes of social change. Compared with the Japanese definition of "information society," however, Bell and other Americans emphasized the significance of changes in the meaning and quantity of knowledge. Their focus on knowledge, as opposed to on information, was a significant difference. The meaning of knowledge and its relationship to information was undergoing at this time profound changes, in large part because of and with the changing role of computers in society.[38] Visions of personal computers were central to American debates about the meaning and value of knowledge in an information society.[39] And as ideas about what knowledge meant in the information society informed the design of computer literacy programs so, eventually, computer literacy brought into being new conceptions of knowledge.

Bell's characterization of post-industrial society as one based upon the service sector as the primary economic force (as opposed to agriculture or manufacturing) rested upon Austrian-born American economist Fritz Machlup's analysis of the "production and distribution of knowledge" in the United States (Machlup 1962). In order to calculate the

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[38] Computer literacy was centrally implicated in the definition and relationship of knowledge and of information at this time. Some observers of computer literacy in the United States linked directly the perceived transformation to knowledge to the specific shape that the definition of computer literacy took in the United States. For example, in her analysis of the plurality of definitions of computer literacy, Mitchell (1983) suggested that the ambiguity of the use of the term "computer literacy" in the educational context reflected the struggle to integrate computers into existent knowledge structures that had been "turned upside down, inside out, and sideways" by the computer (7). See also Herbert Simon (1971), who said that what it means "to know" underwent a profound change.

[39] For example, see Joseph Weizenbaum, Daniel Bell, and Michael L. Dertouzos debate in Dertouzos and Moses (eds.) *The Computer Age: A Twenty-Year View*, 1979.

percentage of the US gross national product that came from the so-called "knowledge industry," Machlup operationalized knowledge in the most general terms as that which "involved the activity of telling anyone anything" (Ibid.). Between 1900 and 1959, Machlup concluded, the American "knowledge economy" had increased from eleven to thirty-two percent of the US economy (Ibid.). Machlup dedicated a chapter of his book to the production of knowledge with the "information machine," or the electronic computer, and attributed to the presence and use of these machines a large portion of the increase in the production of knowledge that he observed (1962, 295). For Bell, Machlup's analysis of the rise of knowledge production was a sign that a new post-industrial society was coming into being in America. Herbert Simon, the famed artificial intelligence specialist and Nobel laureate economist, argued more radically that developments in information technology not only produced more knowledge but changed the very meaning of the verb "to know" (Simon 1971). According to Simon, knowledge no longer meant having information stored in one's memory but rather having access to information and knowing how to use it. Simon believed that very foundations of public reason—what it means for a society to have knowledge of something—had been altered by the arrival of the information society.[40]

Observed and projected transformations in knowledge went hand-in-hand with perceived speed of societal change. The reason that Simon and others gave for change in

[40] Later definitions of the information society from the 1990s described the change in knowledge in part because of the existence of "cyberspace" as a new, "universal" sphere "inhabited" by knowledge. "Cyberspace is the land of knowledge," wrote Esther Dyson, George Gilder, George Keyworth, and Alvin Toffler in 1996, "and the exploration of that land can be a civilizations truest, highest calling. The opportunity is now before us to empower every person to pursue that calling in his or her own way" (Dyson et al., "Cyberspace and the American Dream," *The Information Society,* 12 (1996): 295-308; reproduced in *The Information Scoiety Reader,* ed. Frank Webster, 2004).

the meaning of knowledge was the speed (acceleration) of the rate at which new information and knowledge could be produced. New concepts such as “information explosion” and “information overload” (Gross 1964; Toffler 1970) described an ever-increasing amount of information that threatened to outpace the human capacity for synthesis and understanding. People had to keep up by learning how to use knowledge in new ways (Simon 1970) or risk what they knew becoming outmoded. Futurist Alvin Toffler identified this aspect of the information society as the one that most filled people with anxiety (Toffler 1970). He described the information society as a state in which many of the norms and habits that people took to be natural no longer applied, leaving people unprepared and stressed.

Toffler famously captured (and projected) this public unease in his 1970 bestseller *Future Shock*. The book sold over five million copies in the United States (Kaste 2010), was translated into many languages and made into a documentary starring Orson Welles as ominous narrator. Its popularity suggests that Toffler’s message of people being overwhelmed by rapid changes in their way of life had struck a cord with broad American audiences in the 1970s.[41] Toffler described Americans as suffering from a computer-induced psychological "malady"—the so-called future shock--a psychological state resulting above all from “too much change in too little time.” Future shock, as Welles explained in the documentary,

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[41] As more evidence of the popularity of Toffler’s diagnosis, in the years immediately following the publication of his book, the book and the phrase were referenced in articles in magazines from *The Bulletin of the Atomic Scientist* or *New York Magazine,* on topics ranging from energy policy to fashion (White 1971; *New York Magazine* 1971). In a 2010 interview, Toffler said that after the publication of *Future Shock* he was visited by Steve Jobs and had a conference with Mikhail Gorbachev to discuss his ideas about the future (Kaste 2010). *Future Shock* developed the argument of Toffler’s 1965 article, “The Future as a Way of Life,” *Horizon,* Summer 1965.

> is a sickness that comes from too much change in too short a time. It's the feeling that nothing is permanent anymore. It's the reaction to changes that happen so fast that we can't absorb them. It's the premature arrival of the future. And for those who are unprepared, its effects can be pretty devastating (Grasshoff 1972).

This social sickness was the result of a perceived misalignment between the habits, skills, and abilities of the general population and the demands put on the economy and human relations by the introduction of new technologies into the fabric of daily life. Toffler and other intellectuals of this time held technology—and in particular information technology—deterministically responsible for the acceleration of social change and associated worries about the *future*, but their accounts concealed an underlying feeling of human inadequacy or lack of readiness in the *present*.

By formulating the problem in terms of a historically unprecedented rate of technological change, Toffler's account skated over the fact that the root of *shock,* as a perceived problem, is not technology but the human incapacity to adapt quickly enough to change. People lack the skills, Toffler claimed, to think adequately about the future: to imagine that future and to be flexible and adaptable to whatever it might bring. Toffler represented people as ossified, stuck in old ways of thinking and being, and unable to embrace the rapidity of technologically generated social change. There was, however, one segment of the human population for whom the ability to imagine the future and adapt to it came easily: children. Toffler presented children as able citizens of the future. The book in this way set up a generation gap between children and adults—in terms of the way that these groups think and act—as the core of the crisis of future shock. The generation gap was the deeply personal consequence of the transformations to knowledge and related acceleration of social change in the information society.

The problem of the generation gap was conveyed in a powerful visual representation at the end of the documentary film based on Toffler's book. The sequence begins with an image of a baby lying on his back in a sea of sand. The baby appears helpless with no adult to take care of him in a barren environment inhospitable to life. The camera pans out showing the endless sand surrounding the unsuspecting infant and fades to a close-up image of an old man's wrinkled face. As the camera zooms back out from his face, we see that the man is sitting on a bench with his back to what looks like a wide beach full of sand where an older child plays in the background. These anxious final images mirror the film's unsettling opening scene in which a young couple strolling through a park resolves, when they approach the camera, into a pair of robots with mechanical eyes. But though both beginning and end of the film are uncomfortable, the source of the discomfort differs. The unsettling feeling at the beginning is finding the figure one originally read as human to be an alien. The anxiety at the end, by contrast, is social and emotional. It represents the helplessness of both generations vis-à-vis one another. The old man looks concerned, but does not seem in any position to help the infant in the sand. The baby seems to be abandoned to his own devices. Since he shows no apparent distress, the film seems to suggest he is all right, but the viewer clearly does not understand how he can be all right in a desert environment without an older person to provide care, guidance, or even basic sustenance for living. The lack of interaction *between* the generations seems most striking. The old man, too, appears to be abandoned, left to his own devices with no connection to the younger ones in the making. Something seems deeply wrong with this image of society--as wrong and shockingly foreign to the viewer as the opening image of the robots, but in a way that identifies no visible danger or culprit, or indeed agent of responsibility.

The final image of the film sums up the book's main thrust: the anxiety of future shock is caused not primarily by alien robots, but by an undermining of the routines of daily lives and relationships through mutual incomprehension that rends the fabric of society. Toffler's thesis is that technological change has infiltrated society and transformed the most fundamental human relationships, making people aliens vis-à-vis each other. It is this inadequacy of human relationships observable already in the present that creates the anxiety expressed in *Future Shock*.

Toffler was not alone in predicting a generational crisis in late 1960s United States and in hinging a larger social problem on that crisis. In *Culture and Commitment* (1970), Margaret Mead described what she called an unprecedented, irreversible "Generation Gap" (with two capital Gs) between the generation that was born and raised before the mid-1940s and its children. The reasons for the Gap were largely technological in her view (she cites the nuclear bomb, TV, satellites, and the computer). These technologies had produced a global community and what she terms a "prefigurative" culture "in which the elders have to learn from the children about experiences which they had never had" (Mead 1978, 13). Members of the younger generation—the same ones who were responsible for staging the student revolts of the late sixties in Europe and the United States—find themselves without role models because their world is so dramatically different from their parents', a world in which a new "prefigurative" relationship between past, present, and future reigns.[42]

Mead's observations about the relationship between the transformation of the relationship between past and present for the parent-child relationship were echoed by educational theorist Neil Postman in his 1982 book, *The Disappearance of Childhood*. Postman observed that interest in sociological and historical studies of childhood surged in the 1960s. Paradoxically, he attributed this rise of attention to childhood to the fact that childhood was actually *disappearing*. Postman argued that average American's conception of childhood in the late twentieth century first came about in the sixteenth century with the invention of the printing press and the rise of broad "social literacy." The printing press created the need to read to be able to participate in the world of knowledge. Childhood thus became a distinct stage of preparation for adulthood through the acquisition of literacy. Postman saw the advent of the electronic media (particularly television) as taking away the need for traditional literacy. Watching television requires no learned skills, so that anyone—children or adult—can gain instant access to all information circulating in society. By removing the entry barrier of literacy for admittance into adulthood, electronic communication erased the distinction between the kinds of knowledge that children and adults have, marking the end of difference between adulthood and childhood. Postman's argument that there was no distinction between children and adults in contemporary life in the 1980s echoed Mead's description of the disappearance of the traditional parent-child roles. Postman's and Mead's arguments

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[42] In prefigurative culture the present is no guide for the future (as it was in "configurative" culture), nor does the future repeat the past, as it did in "postfigurative" culture (Mead 1970).

together suggest a close relationship between childhood, literacy, and perceptions of the future--all of which were also central to the computer literacy movement revving up in the 1970s and attaining full-force by the time Postman's book appeared.

These American social scientists and futurists (Bell, Toffler, Mead, Postman) all identified new information technologies as leading to an information society in which the future was discontinuous from the present. In their view, information technology was seen to transform life multiple times within the course of a single generation, rendering impossible and impractical the relationship, understanding, and transmission of knowledge that traditionally took place between generations. Even for American advocates of information technology, the dawning information age was far from the straightforward "computopia" envisioned by the Japanese. It was an age of anxiety created by information -induced disruption to ways of knowing and being, threatening even the intimate relations of parents and children.[43]

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[43] The transformation of relations among generations could be seen as a change in what French historian François Hartog has called "the regime of historicity," or the experience of time in a given society defined as the articulation of past, present, and future (Hartog 2012). In *Future Shock* Toffler diagnoses a changed relation between the present and the future: the future is coming to the present faster than before. Meanwhile, Mead describes an obsolescence of the past. Taken together, Toffler and Mead's observations converge on the present moment, whose growing importance they subtly link to the rise of the information age. This is consistent with Hartog's argument that in the second half of the twentieth century what he calls *présentisme* (presentism) became the dominant experience of time.

France – A prepared evolution

> *We need to anticipate a world where it will be necessary to change work, to learn new techniques, throughout one's whole life. We are entering an era of learning, where learning will be permanent. It's a remarkable coincidence that* informatique*, which aggravates the problem, also offers us a solution.*
>
> Concluding remarks of the anchor of a French television broadcast during which Seymour Papert appeared as guest ("5ème emission: L'enfant et l'ordinateur" 1982).

In the early 1970s, computers were increasingly moving into French public spaces. These machines emerged from the secured basements of the defense industry and scientific labs to operate the metro, sell transportation and theater tickets, and manage books in the library and registers in local public administrative offices. "Mini" and "micro" computers, also known as personal computers or *ordinateur personnel* and *ordinateur individuel* in French, started appearing in offices and homes. As in American visions of the information society, French thinking too saw definitive parallels between computerization and the new centrality of knowledge. For the French, however, the transformation of knowledge into the most valuable resource had the negative consequence of removing the person from meaningful experience of her reality. The active positioning of computer technology, rendering seemingly passive the human who sat "behind" the metaphorical veil of computing, captured a common sentiment in French society at the time. Reflecting on the economic crisis of the 1970s, Jean Maheu, then the President of the Centre Georges Pompidou, identified as one of its main causes the "veil of digits that interposed itself between spirit and reality" (Maheu 1985, 1).[44] The metaphor of the veil implied that the *informatisation de la société* (informatization of society) had created an obstruction to people's direct experience of the world. Computers were perceived as potent tools for shaping society, but the general public was dangerously powerless to control them. In response to these disruptions, a dominant solution emerged: to use the computer—the very instrument blamed for *informatisation*—to prepare the next generation for the information age.

Alienated by computers

The "veil of digits" can be read as a metaphor for the alienation of the person from meaningful activity and reality. This is the way that French philosopher Jean-François Lyotard understood the problem of the "computer age." In his famous 1979 report "on the condition of knowledge in the most highly developed societies," prepared for the government of Montreal, Lyotard described the growing alienation of persons from the knowledge they produce and use in the information society (Lyotard 1984, xxiii). As knowledge came to be valorized as the main resource of society, Lyotard claimed, it would become just another commodity, valued only for its exchange-value rather than as an end in itself (4-5). Lyotard predicted that in the information society there would be "

[44] This concern about the relationship of computers and computerization to the spirit was a recurrent theme in France. Seymour Papert's best selling book, *Mindstorms* (1980), on the possibilities of computers for education, was translated into French with the title *Jaillissement de l'esprit,* or, litteraly, "Gushing of the Spirit." This more than subtle change of the name—from "mind" to "spirit" and from "storm" to "gushing" or "outpouring"—reflects the difference imaginaries of citizenship in the information society in the two countries that I seek to characterize throughout the dissertation.

> a thorough exteriorization of knowledge with respect to the 'knower,' at whatever point he or she may occupy in the knowledge process. The old principle that the acquisition of knowledge is indissociable from the training (*Bildung*) of minds, or even of individuals, is becoming obsolete and will become ever more so (4).

By becoming encoded in bits and by circulating through global information systems, knowledge, Lyotard predicted, would be "externalized" from the person who produced it. The separation of person from knowledge implied a divorce of the formation of the individual from the learning process. According to Lyotard, the producer of knowledge—the intellectual worker—would become just as alienated from her production as the producer in the Marxist world from the commodities she produced. Lyotard worried that these new forms of alienation and "demoralization" of people in the information society would exacerbate the strains of the late 1960s, when people already felt alienated from society, as evidenced by the 1968 student uprisings of in France, Germany, and other developed countries. European students in particular were protesting against state-run universities and the growing hierarchization and codification of knowledge and power (7-8)). Thinking about the information society as a time and space in which alienation, one of the main problems of industrial society identified by Marx and his followers, would be intensified was congenial to French thought. Alienation was a widely referenced "critical category" in French social analysis in the 1950s and 1960s (Ross 1995), expounded by renowned cultural critics and philosophers such as Henri Lefebvre (Lefebvre 1958), Louis Althusser, Herbert Marcuse, and Jacques Ellul.

Lyotard referred to the events of May 1968 as the result of the growing alienation of members of the so-called Generation X, a term invented in the 1950s by American photographer Robert Capa, who defined it as people born in the late 1940s after the end of World War II.[45] May 1968 has also been portrayed in French accounts as a generational conflict between the students and their parents who witnessed and participated in World War II.[46] In 1979, Lyotard predicted that the people who were students in the late 1960s would experience even more alienation due to the commodification of knowledge in the information society. At around the same time, French Minister of Education Christian Beullac described yet another generational rift, now between Generation X and Generation Y, or people born since the early 1980s.[47] Generation Y, Beullac claimed, was marked by a particular relationship to computer technology. In a lecture titled "For the child, in the beginning is the computer," delivered to a group of inspectors generals (civil servants responsible for inspecting and providing government officials advice about particular public services) Beullac described how children of the 1980s grow up in a "technological environment" (*environnement technologique*) dominated by television and computers. Unlike for their parents (Beullac referred to himself and his audience as "we," the parents), who had "already been armed, already formed" at the time of the arrival of these technologies and so could gradually "absorb the shock and master [their] use," the young generation "has no other world except the technological world":

> They have full access to a diversity of technologies: they press the buttons, hit the keys, manipulate the devices with the same naturalness, even the

[45] Generation X coincides with the "baby boomers." Subsequently, the range of Generation X was extended to everyone born up to 1980.
[46] See, for example, (Rotman and Hamon 1987; Samson 2007).
[47] People of Generation Y, also known as "the Millennials" are continuously described in American and European press as people formed by computer technologies (see, for example, Stout 2015) and referred to as the "digital natives" ("Millennials in Adulthood" 2014).

> same naivety, with which we manipulate our pens and chalk (Beullac 1980, 3).

This ease of the "child of today" with *informatique* reflected what Beullac called a different "mental universe" of the child. He described this "strange" universe ("strange for us, who have drawn from other sources") as one in which "knowledge is in crumbs" and where,

> everything, it seems, is juxtaposed and telescoped: ages, distances, cultures. No guides, no references: everything is equal, everything is the same. In short, an abundance of materials, but no organization or hierarchy, that is to say, all of the elements of a culture without the culture itself (4).

Beullac's description of the disordered mental universe of a child of the 1980s, for whom knowledge is crumbled into little pieces with no reference points or ordering mechanism recalls the alienated and alienating knowledge described by Lyotard and the lack of *a priori* guides described by Mead. By characterizing the child of the 1980s as someone without the structures of culture, Beullac positioned the Ministry of Education as the entity best capable of putting such a culture in place. In France, as in the United States, young people's encounters with computers were imagined to have formative effect on their generation's thinking and being, both within themselves and in relation to other members of society. These characterizations of informatization helped to produce the idea of the information society as a new "technological environment," to borrow Beullac's phrase, that people need to adapt to.

The concern about alienation expressed in the image of a veil of digits interposed between self and world was part of a wider anxiety about the speed and seeming inevitability of technological change and society's urgent need to adapt to it. The speed of social change, driven by technology, was a common theme of French social critics of the second half of the twentieth century. For example, Henri Lefebvre, described rapid French modernization in the two short decades between the Marshall Plan and the end of the 1960s in contrast to the "slow, steady, and 'rational' modernization" of American society (Ross 1995, 4 citing Lefebvre). Comparative literature scholar, Kristin Ross relates how in this period French people described changes in their lives in terms of the sudden appearance of new technologies such as large home appliances and cars in their streets and homes (Ross 1995). The introduction of these objects into daily life dictated new gestures and movements (as depicted, for example, in the films of Jacques Tati) (Ibid.) Jacques Ellul (1977) and Jean-Jacques Servan-Schreiber *Le Défi Mondial* (1980) described similar tempos and consequences of computerization. They expressed a general sentiment that people, and the French in particular, were unprepared for the future society that was being created by a rapid succession of changes driven by technology.

For all the transformative potential that computers had in French visions of the information society, the French state claimed the power to bring this new society into being. This was a central message of the best-selling report on the idea of *informatisation* of society prepared for President Valéry Giscard d'Estaing by finance minister Simon Nora and his junior colleague political advisor and economist, Alain Minc (1978). Like Alvin Toffler's *Future Shock,* the Nora-Minc report was a national best-seller. And like the *Future Shock* documentary, it carried an air of science fiction. Daniel Bell, who authored an introduction to the English language edition, hailed it as a work that had "the impact of a modern Jules Verne story" ("Plateau Nora" 1978). The wide popularity of a state-commissioned tactical report suggests that the phenomenon of *informatisation* fascinated and concerned not only leading politicians but also the general public (Nora and Minc 1980). The report narrated a vision of society's future and priorities in relation to *informatique* technology that was perceived as a matter of public concern.

While conceding the transformative power of computer technologies, Nora and Minc somewhat paradoxically stressed the state's responsibility to harness that power. In fact, it seemed that the more power was attributed to *informatique,* the more it was necessary for the state to control and guide the technology. Nora and Minc made this point firmly: "Telematics [a neologism coined in the book from the combination of telecommunications and informatics]," they wrote, "can facilitate the coming of a new society, but it cannot construct it on its own initiative" (6). Similarly, when Simon Nora was asked in a televised interview "Towards what society is *télématique* leading France? Is it a society that we imagine to have a cold heart of the computer?" he responded,

> It will not lead us anywhere on its own. The right question is whether society will drive its computers, not whether computers will drive society. […] The computer is an efficacious servant. […] If one wants to use the computer to serve a decentralized society, one that is infinitely more humane, relational, convivial, it is certainly the most efficacious tool for doing this ("Plateau Nora" 1978).

Unlike in *Future Shock* documentary, where the question of how society should adapt to the computerized future was left distressingly ambiguous, in France there seemed little question that the state was capable and responsible for ushering into being a new society adapted to the forces of informatics.

Soviet Union – The tame information volcano

French President Valéry Giscard d'Estaing hoped to use the French government's power to teach children *culture informatique* so as to prepare for a smooth transition into an information society rather than "suffer the revolution" of informatization. By contrast, the Soviets envisioned informatization as an evolutionary rather than revolutionary force. For example, in a 1973 book about the growing role of information in society written for a lay audience, engineer Nikolai Petrovich considered the possibility of an "information explosion," an event predicted by a number of Western information theorists when the over-production of information would lead to stagnation in scientific development and possibly even disrupt world order. A cartoon image that accompanied Petrovich's prose showed people running away from a volcano that was spewing out small electronic appliances, books, perforated tape of computer programs, and letters and digits (Petrovich 1973, 186). In his text, however, Petrovich explained that the likelihood of an information explosion was small and that social adaptations, some of which were already underway, would prevent an explosion. He pointed to the slow and steady introduction of computers in the workplace and in the home, the creation of a global network of information transfer using satellites, as well as explicit training of the brain to absorb more information, the emergence of systems for filtering unnecessary information, and the increase in the information-carrying capacity of speech (1973, 199–200). While for Toffler the acceleration of informational processes was bringing about a shock to individuals and society, Petrovich's account suggested the shock would be prevented altogether. The volcano would produce warning tremors, but never erupt (200).[48]

The iconography of the volcano was used to very different effect in seismically active Japan. In his pathbreaking book, *The Information Society as Post-Industrial Society,* Yoneji Masuda used the image of a volcano about to explode as a cover image.[49] What appears to be a stylized Mt. Fuji is shown with a flow chart at its base depicting the process of the "Computer-Communications Revolution and its Societal Impacts." It is as if the flow chart represents a geological transformation of rock into molten lava deep inside the volcano. An explosion seems imminent and yet the skies above the volcano are blue and it does not smoke. Reading the book, one gets the sense that the volcano of the information society will explode, and when it does the transformation of the world will be complete and yet benign.

Similarly, concerns about a possible generation gap or transformation to the fabric of social relations caused by the computerization were largely dismissed in the Soviet Union. The Soviet documentary film, *Game with the Computer,* advertising the launch of the national computer literacy curriculum in 1986, showed in its concluding scenes a

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[48] In his book, *The Information Society as Post-Industrial Society,* that introduced a broad audience around the world to the concept of the information society, Yoneji Masuda also used the image of a volcano in preparation for an explosion as a cover image. The image shows a volcano, which appears to be a stylized Mt. Fuji, with a flow chart superimposed at its base depicting the process of the "Computer-Communications Revolution and its Societal Impacts." This combination gives a sense of an immanent explosion, as if the processes of transformation represented by the flow chart were geological transformations of rock into molten lava deep inside the volcano. The explosion seems immanent and yet the skies above the volcano are blue and it does not smoke. Reading the book, one gets the sense that the information society volcano will explode, but when it does the transformation to the world outside will be complete and yet benign. This example shows how differently the coming of the information society appeared in the Japanese imagination as opposed to the Soviet one, even though they both used the same iconography of the volcano and alluded to a society-transforming explosion.

[49] This image is used on the cover to the English edition published by the World Future Society (Masuda 1981).

grandmother worried about how knowledge of the computer will transform her relationship with her grandson. The narrator reassures her that this is a necessary development, that computers are actually not scary and knowledge of the computer would not fundamentally change people's humanity and specifically their ability to relate to one another (*Igra S Komp'iuterom* 1986).[50] This ending was markedly different from the ending of the film of *Future Shock*. The American film depicted anxiety about changes to fundamental human relationships that technology was bringing about whereas the Soviet film denied the foreignness of the computerized future. This difference suggests that imaginaries of the computerized future in the Soviet Union drew on different resources than in the United States, particularly with regard to society's adaptive capacity in times of change.

Tellingly, it was foreign observers who proclaimed a generational gap in relation to the Soviet information society and the gap they saw was not between parents and children but between the generations of Soviet leaders. This, for example, is how two American observers, Richard Judy and Jane Lommel, explained Gorbachev's decision to teach computer literacy in Soviet schools. "Perhaps it was mainly a matter of generations," they wrote:

> The old Soviet leadership understood little of computers and their potential. For them, as for many the world over, computers were an

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[50] Other scenes from the film made the same point. For example, the film opens with an allegedly incorrect science fictional imagination of a man with strained, moist eyes, seemingly a cyborg with a computer behind his metal band. This frightening image of the cyborg is contrasted with an image of beautiful children playing with a "friendly" computer that is "one of us." Popular Soviet films like *The Adventures of Electronic* (Bromberg 1979) reinforced this idea of the computer as one of us by portraying the indistinguishable "double" of the robot and the real boy as they reverse their roles (the robot goes to school in the boy's place and, frequently, appears to be more humane than the boy himself) and, in a strange echo of the Turing Test, no one in their families or communities is able to tell them apart.

> 'enigma wrapped in a mystery.' Information at the propaganda level was concrete; at the level of the bit, byte, and baud, it was an unreal abstraction (Judy and Lommel 1986, 119).

Judy and Lommel attributed the sudden national interest in computer literacy in the Soviet Union to the rise of a new brand of Soviet leaders able to understand the social utility of computers and information. Their insight that in the Soviet Union social change was marked by the ebb and flow of political leaders rather than by technological milestones is consistent with observations of Russian social scientists.[51] This central importance of political leadership for the fate of any technological project in the Soviet Union is another reason for the denial of the possibility of a computer-induced disruption to society.

While Soviet official and academic discussion did not expect relations between adults and children to change as a result of the coming of the information society, this dimension was considered in the more dissident and critical genre of Soviet science fiction. The work of the brothers Boris and Arkadii Strugatsky, both science fiction authors, and of the film maker Andrei Tarkovsky, many of whose films contain elements of science fiction (particularly, *Solaris* (1972), *Stalker* (1979), and *Sacrifice* (1986)), frequently portrayed relations between parents and children as strained by the child's experience of, proximity to or attraction by a technology. For example, in their novel *Ugly Swans* (*Гадкие Лебеди,* written in 1966-67) the Strugatsky brothers portray a genetically mutated population of adults who represent the future human with heightened

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[51] For example, Pastukhov (2015) and Shanin (2005) describe how events organized and dealt primarily by Soviet leaders (like the Cuban Missile Crisis, the Virgin Lands Campaign, the Great Purge, the 22nd Congress of the Party, the Prague Spring) were the primary ones that marked the spirit of society and formed ways of thinking and being of generations of people.

intellectual and moral capacities. These *mokretsy,* as they are called, attract children away from their human parents and educate them in new ways that unleash a violent conflict between them and the human adults. Despite the repulsive appearance of the *mokretsy* and their unapologetic attitude about luring away the children, they are portrayed in the novel as more just and humane than the depraved adult humans (Strugatsky and Strugatsky 1967). Yet, although this plot hinges on the tension between children and their parents created by a technologically-alien being of the future, this and other works by the Strugatsky brothers and Tarkovsky cannot be reduced to anything like the idea of a generation gap produced predominantly by technology. In the context of Soviet techno-scientific optimism, these subtle and complex works of science fiction show that even in the most technologically transformed, futuristic worlds the fate of human beings depends upon the disposition of their souls rather than features of the external environment.

In Soviet representations, the role of space and space technologies like satellites appears to have attracted a disproportionate amount of attention compared to American and French depictions of the information society. Satellites, in general and the first satellite *Sputnik* in particular were frequently evoked as entities made possible by computers that could also facilitate the creation of future global networks of information in the (Petrovich 1973). One textbook for teaching computer literacy developed by Ershov's colleague Genadii Zvenigorodskii (1985)suggested that by becoming computer literate students would expand their capacity to calculate, aspiring to the levels of calculation that were necessary to launch *Sputnik*. References to satellites in Soviet descriptions of the information society alluded to the global scale of the information society.

Despite evoking the global scale, conversations about information society in the Soviet Union usually returned to the national. Zvenigorodskii's use of *Sputnik* to motivate student interest in computer literacy reflects the Soviet Union's predominant focus on a programmable machine. Instead of being thought of as the "brain" of the personal computer as in the United States, the microprocessor in the Soviet Union was conceived as a controller (Judy and Lommel 1986, 111). By learning to control the microprocessor, the programmer could facilitate industrial automation, which was the primary benefit of the information society for the communist nation. There was no association of the information society with an "open" society, as we will see was the case in the United States and France.

Different from both the French and American imaginaries, the Soviets envisioned the future society as a smooth progression from the industrial present. An important factor that drove this idea of the information society was the history of cybernetics in the Soviet Union, which strongly influenced the Soviet idea of *informatika* (informatics) that lay at the heart of the concept of information society.

Adapting to information societies

The different imaginations of the future described above help account for the approaches that each nation took to adapting its population for life in the computerized world.

United States – Computer Literacy

Responding to the anxieties induced by the information society, some American observers called to limit the intrusion of information technology (including television and computers) in people's daily lives (Postman 1985; Postman 1982; MacNeil 1995; Noble 1984; Sordello 1984; Stoll 1995).[52] Others, proponents of computer literacy including Bell and Toffler, did not wish to stem the pace of technological change. Rather, their proposed solution was to adapt the human mind with computers, in short, to transform the human being so as to keep up with a quickly changing environment.

Computers, Bell and Toffler believed, could augment the human capacity for thinking to better anticipate what the future might bring and to help people become agile learners in the ever-changing world. What was important in the information society, they and their contemporaries wrote, was "learning how to learn." This would make people "knowledge-able" citizens,[53] who can better process and produce knowledge—the main resource of the information society

Learning to Learn

American analysts understood the problem created by the computer and the solution in terms of individual psychology: transforming the way that people think and learn. "Learning to learn" was a *cognitive* capacity that could be, contemporaries believed, most effectively developed with the help of the computer. In order to develop

[52] For an overview of arguments against computer literacy, see (Attewell 1989).
[53] I borrow the term "knowledge-able" from Sheila Jasanoff (2011a). Jasanoff created this term to describe how everyday people are capable, or able, of knowing. Being capable of knowing or processing knowledge is inseparable from being able to capitalize upon that knowledge and *produce* knowledge., which was the activity that was particularly valued by observers of the information society and the knowledge economy.

"futureness," or the capacity to anticipate the future so as to avoid future shock, Toffler proposed educational measures to develop the "habit of anticipation" of the unknown (Toffler 1970, 420). These strategies for humans, he suggested, should borrow from the world of computers. The problem with current education, Toffler claimed, was that it prized accumulation of "data" in human "memory," whereas in a rapidly changing world "today's 'facts' become tomorrow's 'misinformation'" (414). What was needed was not learning facts or data, but processual thinking that emphasized the ability to "manipulate" the data in different ways.[54] The model of data manipulation, it Toffler's view, was the computer itself, whose programs were what made them powerful. He proposed to model human learning on the "master program"--the program that determines how and when the other computer programs run.[55] "A similar strategy can be used to enhance human adaptability," wrote Toffler, "by instructing students how to learn, unlearn and relearn, a powerful new dimension can be added to education" (414). Toffler argued that teaching

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[54] Toffler's emphasis on learning a process, e.g. manipulation of information, rather than on the learning facts, is consistent with Jamie Cohen-Cole's argument that during the Cold War American public intellectuals identified proessual thinking with virtuous open-mindedness and learning by memorization with the closed-minded communist enemy (Cohen-Cole 2009; Cohen-Cole 2014).

[55] Modeling human learning on the idea of the computer program came at a time of a perceived crisis in number of trained computer programmers, which became known in 1972 as the "software crisis" (Dijkstra 1972; the notion of "software crisis" came about during the NATO conference on software engineering "Software Engineering: Report on a Conference Sponsored by the NATO Science Committee, Garmisch, Germany, 7th to 11th October 1968" 1969). I think that it is more than a coincidence that this wish to form people in the image of computers came at the same time as engineers called for the training of more professional computer programmers. This parallel existed also in the Soviet Union. Andrei Ershov's main concern for the future of computers in the Soviet Union was the lack of high-level master programmers, which Toffler talks about. Like Toffler, he saw the master program as an important step in the evolution of the computer—as that which makes the computer significantly more useful. According to Ershov, the future of computer use in the Soviet Union was restricted as long as there were not enough people who could develop these master programs. For Ershov, educating people to become master computer programmers was a more practical task than for Toffler. For Ershov, they would be trained to service the computers and ensure the computers' utility. Meanwhile, for Toffler the master program was a metaphor for an approach to learning called "learning to learn." But in both cases, the occupation and style of thought that is deemed good for humans is developed vis-à-vis the computer.

children how to be master programmers of their own minds was the way to teach them to "learn how to learn."

"Learn how to learn" was a popular phrase and maxim in American pedagogical circles of the 1960s and 1970s.[56] Toffler cited psychologist Herbert Gerjuoy of the Human Resources Research Organization saying that, "Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn" (1970, 414). Knowing how to learn was a cognitive skill that proponents of the "learning how to learn" approach thought would make the person adaptable to an ever-changing environment by knowing how to effectively integrate quickly expiring information.

Physics professor Arthur Luehrmann sought to address the challenge of "tomorrow's illiterate" with a vision of "computer literacy" that he proposed in 1972 (Luehrmann 1980). Luehrmann argued that the proper implementation of computers in the education system was to incorporate the computer as what he called an "intellectual resource" into one's very way of thinking instead of just using it as a tool to deliver instruction. By coining the term "computer literacy," Luehrmann intended to distinguish the new use of computers he was proposing from their dominant use as technology for "assisting instruction" in the classroom.[57] Computer Assisted Instruction (CAI) was a

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[56] See, for example (*Individualizing Instruction* 1973; Novak 1984; Fisher 1972; Della-Dora et al. 1979; Schwartz 1974). Google Ngram shows a large spike for the phrase "learn to learn" in 1970. Also, the 1970s and early 1980s appear to be a time of high demand for self-development/improvement and learning of all kinds. See, for example, this excerpt from *Venture* magazine from November 1981: "The budding courseware market is only the latest development in America's self-help craze. With how-to books leading the best-seller lists, and seminars and adult education becoming big business, the new courseware producers are cashing in on the country's voracious appetite for educational and self-improvement products" ("Software that teaches: educational courseware is the next big market created by the home computer boom," Venture magazine, November 1981). I discovered a copy of this article in the Mitterrand archives, which suggests that this aspect of American interest in learning also drew attention of the French.
[57] From 1966 to 1970, Luehrmann was a physics professor at Dartmouth College where it is possible that he participated in some of the interactive computing projects on time-sharing systems that took place there

popular approach to using computers in education since the mid-1960s.[58] CAI was invented by Patrick Suppes, a Stanford professor of analytic philosophy who knew computer science and was interested in theories of learning (Suppes 1978). In CAI, Suppes used computers to automate the programmed learning educational method. CAI involved the use of computers for drill-and-practice and testing of various subjects at all levels of education, from primary school reading and arithmetic courses to advanced university-level math and science courses.

This use of computers in the classroom evolved from the practice of programmed learning (R. Taylor 1980), a method of education proposed by behaviorist psychologist B. F. Skinner in the late 1950s. The practice of programmed learning involved breaking up the subject to be learned into small discrete pieces of information and delivering them incrementally to students in a way that allowed them to quickly know whether or not they had understood or learned it. Suppes was excited about this use of computers in education because it offered an "opportunity of studying subject-matter learning in the schools under conditions approximating those that we ordinarily expect in a psychological laboratory" (Suppes 1978, 34). In CAI, computers were used to teach students who were not expected to know anything about them except the minimal skills required to interact with the drill-and-practice program.

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in the 1960s and 1970s. The history and significance of these projects is described in Joy Rankin's dissertation (Rankin 2015).

[58] Suppes developed a few courses in math and logic in CAI for different educational levels. He gave a highly popular logic class at Stanford with the technology and, in 1967, he started a company, "Computer Curriculum Corporation" (CCC) dedicated to producing CAI courses and marketing them to schools across the United States. For this work, Suppes benefitted from the federal resources allotted to implementations of the New Math curriculum (following the launch of Sputnik) and for growing interest in the use of computers in education (Suppes 1978a; 2013).

Luehrmann thought that computers could be put to better use in education if they were thought of less as tools for administering learning and more as "intellectual resources." Computer literacy according to Luehrmann was to be the opposite of everything that CAI stood for. Instead of using the computer as an external technology to aid the process of learning, Luehrmann envisioned it as a cognitive resource to be internalized by the learner. CAI was designed by its chief architect Suppes as a "laboratory" for studying the processes of learning, where the computer was a research instrument for observing the process of learning and the student-user was a research subject. The "literacy" approach by contrast sought to remove these laboratory conditions by instead teaching elements of controlling the computer to the students themselves. Finally, whereas CAI was based upon the idea of a strictly-defined and scientifically-validated curriculum, the literacy approach intended in a sense to eliminate curriculum by becoming a fundamental building block for thinking and doing (Suppes 2013). Luehrmann described CAI as "top-down" as opposed to computer literacy, which was "bottom-up"; and while CAI emphasized "individualized instruction" geared to each child's unique cognitive learning style, Luehrmann's description of computer literacy focused on benefits to society as a whole. Teaching students how to "use" computers in this way, Luehrmann claimed, was like teaching the general public how to read and write.[59] Hence, this way of knowing computers would usher a new kind of literacy.

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[59] Luehrmann chose the term "literacy" strategically to refer to the traditional practice of reading and writing. In fact, he insisted upon what he called the "parable" of traditional literacy for thinking about the future of computers in education. The "moral" of the parable, Leurhmann wrote, is that the impact of computers in education could go one of the same two ways of the impact of reading and writing in education: either computers could be used as tools to deliver instruction (the "assisted instruction" approach) or they could be recognized as "intellectual resources," bringing greater social benefit and transformation (the "literacy" approach) by virtue of being technologies of the mind.

Alphabet as technology

By calling this new knowledge "computer literacy," Luehrmann drew upon a rich discussion of public literacy in postwar America. The central idea that literacy plays a key role in the development of economic and democratic institutions and, in general, leads to greater "civilization," was prevalent in histories of literacy written by American scholars in the 1950s-1970s. These authors called literacy a "revolution"--a democratizing and empowering catalyst of social change--and inquired why this "literacy revolution" took place in the "West," much as political economists at the time asked why the Industrial Revolution began in England.[60] This relationship between the "literacy revolution" and the Industrial Revolution was not accidental. In fact, these histories commonly intertwined the social history of literacy with the technological history of the Industrial Revolution. By writing the history of literacy as also a history of technology, they implied that *the phonetic alphabet is a kind of technology*. For example, Carlo M. Cipolla, called the phonetic alphabet a "technology" that introduced the "Literacy Revolution" in his book *Literacy and Development in the West* (1969), and associated the period of time before widespread literacy (when literacy was still the "monopoly of small élites") with a "pre-industrial" economy where people did not use machines to aid them in production (Cipolla 1969, 101–2).[61] Similarly, Goody called literacy a "technology of the intellect" that was the to social and economic development and the origin of

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[60] See, for example (Landes 1969).

[61] *Literacy and Development in the West*, Carlo M. Cipolla, Penguin Books, Baltimore, MD, 1969. pp. 101-2. Histories of the Industrial Revolution written at this time tried to establish what it was that Great Britain had that enabled it to progress so much. For example, Landes (1969) searched for cultural and technological roots that might be generalized into methods for exerting more power over the world and converting others to them under the pretext that it was for their own benefit.

democratic and scientific values (Goody 1968). This is the perspective on literacy as technology that Luehrmann drew on for his idea of computer literacy.

In US histories of literacy in the 1950s-1970s, all of the advantages of literacy flowed from the basic unit of the so-called technology of the phonetic alphabet. Once a person had mastered such an alphabet, the popular narrative went, it could be used to represent ideas in ways that were easy to communicate, as well as to keep records of thoughts over time. This, in turn, enabled the accumulation and critical review of knowledge, and subsequently led to the positive transformations in life attributed to widespread public literacy.

If the alphabet was a technology of reading and recording, literacy—the knowledge of this alphabet for reading and writing—was seen as a technology of the intellect. This was the way that Jack Goody and his literary critic colleague Ian Watt defined literacy (Goody and Watt 1963). In their definition literacy was not just a traditional tool for the hand, but an instrument for the mind—for thinking and creating. It is likely that Luehrmann was inspired by Goody when he, too, decided to emphasize literacy's utility for the mind by defining literacy as an "intellectual resource." Luehrmann's understanding of literacy as "resource" supported his conviction that it ought to be "given" to all people to use, especially since, like a nonrivalrous good, it is not diminished through sharing.[62]

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[62] There is a similarity between this way of thinking about literacy as an indistinguishable public resource and the description of the "knowledge economy" of the "knowledge society" as an economy based on *abundance* rather than the traditional (industrial) economy of scarcity (see, for example (J. Simon 1981).

Fascination with literacy as an explanation for why some countries became more economically developed than others is reflected in comparative studies at this time. The alphabet and literacy in these accounts were held responsible for the formation of the Western scientific and social order. For example, the first English language accounts of literacy in Iran, India, and Latin America were published in 1958, 1960, and 1966, respectively, and in 1965 UNESCO began publishing its journal *Literacy*. Popular accounts of literacy such as Frank Charles Laubach's *Thirty Years with the Silent Billion: Adventuring in Literacy* (1960), described the growth of public literacy as a linear story of progress. According to Laubach, literacy accounted for the perceived "gap" between the developed West and the developing countries (Laubach 1960). In parallel, Goody and Watt argued that the absence of a phonetic alphabet was an impediment to achieving "widespread" and "public" literacy in India[63] and China (1963). They hoped, in turn, that the technology of the phonetic alphabet could remedy "problems" of literacy in these cultures. Accounts that identified literacy as the key to development also tended to draw sharp distinctions between literate and illiterate societies, with no room for a middle ground or a plurality of literacies.

Identification of literacy with "civilization" and illiteracy with economic and social backwardness complemented accounts in which literacy was associated with democratic and scientific values, while its absence was identified with the roots of anti-scientific attitudes and social disease. A comment by John de Francis, an American linguist and sinologist, cited by Goody, clearly expresses this self-congratulatory attitude:

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[63] Although Indian languages have phonetic alphabets.

> Extremely low literacy, a characteristic of pre-industrial society everywhere, abetted the tendency toward preciosity, antiquarianism, and other forms of literary exclusiveness which characterizes inbred scholarship in general (DeFrancis 1950, 8 cited in Goody 1968, 24).

Here, de Francis associated low levels of literacy with "inbred" scholarship. The opposite of the "literary exclusiveness" that created bad scholarship was a general public that, thanks to being literate, participates in productive scientific activity. This is how Goody described the literate public, who, led by literate craftsmen and amateur scientists, freely "experiments" and "tinkers" armed with the liberating technology of reading and writing (1968).[64] As skilled wielder of the technology of the alphabet the layperson becomes a tinkerer, someone engaged in a playful engineering practice (the significance of the idea of "tinkering" is further explored in Chapter 3). In linking experimenting and tinkering, these authors showed that in their minds literacy was the foundation for scientific as well as social order.

Whether or not Luehrmann explicitly drew upon these works for his formulation of the concept of "computer literacy," there are clear parallels between how he defined literacy (as a technology of the intellect) and the hopes (for individual empowerment and social development) with which he infused the concept. At the heart of all definitions of computer literacy was the belief that, more than a tool to be used, the computer should become a tool for people to live by. Although Luehrmann is credited with defining

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[64] Cipolla also had similar ideas about the link between literacy and scientific enterprise: "The Industrial Revolution was not the product of one or two high priests of science; it was the outcome of the daily down-to-earth experiment and tinkering on the part of a number of literate craftsmen and amateur scientists" (1969, 101–102).

"computer literacy," his word was the first rather than the last when it came to defining what skills, knowledge, and competencies were subsumed under the term.

The activities of American community computer literacy organizations reinforced the imaginary of the computer literate person in the United States as a person whose cognitive qualities had been enhanced with the computer. One such organization, *ComputerTownUSA!*, used LOGO to "[help] each other become informed citizens of today's information society" (Loop, Anton, and Zamora 1983). Many similar independent initiatives sprang up in schools, libraries, and community centers around the United States to prepare citizens in the 1980s. Each had its own definition of "computer literacy" and related ideas about what were the essential skills or knowledge to gain membership in the information society. Despite the differences, they had in common the vision that the computer was an "intellectual technology" to be incorporated into one's ways of thinking and learning rather than merely used as a tool for problem solving. In the sociotechnical imaginaries of computer enhancement, as articulated by Leurhmann and Papert, among others, computers were built into expressions of how people ought to live rather than just delivering educational content. Only through cognitive augmentation with the computer could one constitute the knowledge-able individual imagined as the citizen of the information age.

France – *Culture informatique*

In the conclusion to his report on knowledge in post-industrial society, Lyotard wrote that the way out of the dystopian social and political consequences of alienation by informatization was, “in principle, quite simple: give the public free access to the memory and data banks” (1984, 67). What giving the public free access meant, however, was anything but simple and served as one of the main motivations for the development of *culture informatique*. In practice, forming people with *culture informatique* meant exercising control over *informatique* by the state.

In his reference to the “simple” solution, Lyotard cited the French Data Protection Act, *Loi No. 78-17 du 6 janvier 1978, Loi relative à l’informatique, aux fichiers et aux libertés,* also known as the *loi informatique et libertés*. The law was enacted in response to a public scandal provoked by an article in the French newspaper *Le Monde* about a government project known as *Système automatisé pour les Fichiers Administratifs et le Répertoire des Individus* (SAFARI). As part of SAFARI, the government used an Iris-80 computer, manufactured by the French company *Compangie international pour l’informatique* (CII*)*, to collect and store information about French citizens in a centralized database (Boucher 1974).[65] This program, which the government conducted without public debate or consultation, concretized for the French the threat of digitized central databases. In 1978, under president Valéry Giscard d’Estaing, a law was passed limiting the government’s ability to collect and centrally control information about French citizens. The law in itself, however, was deemed not enough to guarantee liberty, the cornerstone of the French constitution, in the computerized age. As long as only select individuals knew how to operate computers, they could use their technical

[65] In a 1969 television broadcast, the predecessor to the Iris 80 computer, the Iris 50, was referred to as “our quotidian computer” (“notre ordinateur quotidien”). The broadcast included an interview with Philippe Dreyfus, former director of the French Bull computer company and the inventor of the word *informatique,* who said that “it is necessary to form people” or to teach them *informatique* in order to realize the goal of the Iris computer to become truly quotidian (“Notre ordinateur quotidien” 1969).

knowledge to abuse the spirit of the law. Those who controlled the computer were seen as also able to control society. This was one meaning of Lyotard's statement that "In the computer age, the question of knowledge is now more than ever a question of government" (Lyotard 1984, 9). Limiting government control of information and giving the public access to computerized information required training the public to be knowledgeable about computers, about how information is stored in computers, and how one can extract information using the computer. *Culture informatique* became indispensable to ensure the constitutional protections of the law for French citizens.

The *culture informatique* ("informatics culture")[66] movement in France sought to smooth over the perceived social transformations caused by computers, or, in the words of President Valéry Giscard d'Estaing, to make *informatique* not a revolution to be suffered, but an evolution to engage with (Giscard d'Estaing cited in J. C. Simon 1981, 1).[67] The imaginary of *culture informatique* promised to give everyone control over this powerful technology and, in so doing, also to address the concerns about the values of capitalism and centralization of power raised by the student rebellion of May 1968 and exacerbated by the economic troubles of the 1970s. As in the United States, education of the citizen with the computer seemed a way to address an apparently computer-induced problem. Instead of lifting the so-called "veil of digits," *culture informatique* sought to make it possible for everyone to see the world anew through that veil.

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[66] Where *informatique* referred to all of the sciences and techniques related to the production and use of computers (Brulé 2006, 317)

[67] Mitterrand also referred to informatization of society as a "quiet revolution": "Well illuminated, guided by everyone's awareness, stimulated and driven by dialogue between the President and citizens of all ages, this march will lead smoothly, without imprudence and without setbacks, to the 'quiet revolution' of 1989" (Mitterrand 1982b).

Informatique and its culture

Culture informatique[68] was to be based upon French language and tradition although also go beyond these in important ways that were explicitly associated with enabling people to participate in an increasingly computerized future society. The development of this "culture" involved not only teaching programming and specific skills for using the computer, but, as with the American concept of "computer literacy," also constituting a foundational knowledge base and worldview for generations going forward. In this sense, the French *culture informatique* was the idea and phenomenon most comparable to the phenomenon designated by term "computer literacy" in the United States. But the French view of this new knowledge as being about "informatics" instead of "computers" and comprising a "culture" instead of individual "literacy" is telling in relation to the parallel American and Soviet imaginaries.

The word *informatique* expresses an idea of computing that is far from neutral and is uniquely French. The word was coined by an industrialist named Philippe Dreyfus, director of the *Centre de calcul électronique de Bull*, in 1962 (Le Diberder 2001). Dreyfus created the word from a contraction of "information" and "automatique" while he was looking to name a new computing organization, which became the *Société d'informatique appliquée* (SIA). The *Académie Française* formally accepted the term into the French language in 1967 defining it as the science of the treatment of information (Ibid.). The new term replaced a number of awkward and diverse computing terms such

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[68] Although I have not found who coined the term and when exactly it was coined, the earliest uses of "culture informatique" that I discovered date to 1971 in a book by Jacques Perriault, *Éléments pour un dialogue avec l'informaticien* (Perriault 1971, 215).

as *calcul électronique*, *traitement des données par traduction* (translation of the English "data processing") and *science des ordinateurs* (an echo of the English "computer science") (Ibid.). Diberder argues that the new word quickly became powerful and mainstream because it was "more general, shorter, and more elegant" than the alternatives. *Informatique* became so well established in French that it is one of the few computer terms that is not regularly overtaken in French by English terms (as is the case, for example, with the French word *logiciel* frequently supplanted by the English "software" or the use of English "chips" instead of French *puces*). *Informatique* itself inspired other contractions, such as the term *télématique* coined Nora and Minc in their 1978 report from a combination of *télécommunication* and *informatique*; and in the same report the term became the root of a process that the authors labeled as *informatisation*. Dreyfus' term *informatique* helped to normalize the new science of the treatment of information because its ending in "tique" is the same as the ending of established scientific disciplines, like *mathématiques, botanique,* or *optique*.

This history of the term is significant for a comparison of the idea of *culture informatique* with *computer literacy*. Unlike the computer in computer literacy, which refers to the machine or artifact, *informatique* in *culture informatique* is polysemic, that is, it has a multiplicity of meanings, all of which form part of the culture. For example, as a translation of computer science, *informatique* emphasizes much more the "stuff that computers manipulate" than the "processes of manipulation themselves" (Knuth 1996, 3). This difference, according to American computer scientist and mathematician Donald Knuth, made American researchers reluctant to embrace the French term, suggesting that there is a difference in what French and American researchers think is the heart of the field of computer science. Unlike computer science, *informatique* is not only a field of study or a discipline; it refers also to computer hardware, software, and the uses to which they are put. Ivan Illich, a preeminent social observer and critic of the twentieth century, insightfully described the uniqueness of this French term. "Only the French language," he wrote,

> knows the term 'informatique'. In no other language does a single word englobe the device, the program, the technician and all the way through to the utopias of the user. To translate this term in German or English, I would say: '*Informatique* is the use of the computer in a state governed by the Napoleonic Code.' Only you [the French] could distinguish *informatique* from the spirit, like you distinguish love from marriage and civil society from political society" (Illich 1980).

By proposing that *informatique* can only be defined in the context of French political culture Illich underscored the uniqueness of this concept. Like the French civil code established under Napoleon in 1804, which, in the wake of the French Revolution created a simplified legal system that influenced the civil codes of nations in Europe, Africa, and the Middle East conquered by France, *informatique* was a modern-day ordering instrument for society. Illich's characterization of *informatique* recognized that in a world ordered by *informatique* a new political subject emerges, along with new modes of governance, while still underscoring the influence of the old constitutional order. *Culture informatique* was the medium by which the French public would be acculturated to this new ordering instrument that, like the term *informatique* itself, joined in one totalizing system everything from hardware to software, their uses, and the utopia that informatics could produce.

A new culture

Besides the difference between computers and *informatique*, there is also a notable difference between the ideas of literacy and culture. The term *alphabétisation*, "literacy" in French, was not commonly used to refer to the knowledge of and about computers. Although the French phenomenon of developing *culture informatique* is comparable to the American phenomenon of *computer literacy*, the French insistence on culture and American attention to literacy are not merely terminological differences but are significant for *what* these programs envisaged. In my repeated attempts to inquire about the use of *alphabétisation* in relation to *informatique,* my interviewees never attached much importance to this term (Perriault 2012a; Baudé 2012).

One distinctive feature of the French approach came from the fact that, instead of drawing upon a technical and progressive history of public literacy as in the American case, the *culture informatique* movement drew on the broader French tradition of *culture technique*. This was a mid-twentieth-century movement inspired by the work of anthropologist/archaeologist André Leroi-Gourhan and philosopher Gilbert Simondon. It focused on the development of a proper relationship of people to the technical objects in their milieu. The movement encouraged people to come to know those technical objects rather than just use them passively as black boxes. For Leroi-Gourhan, who studied the history of human evolution (e.g., of the human hand) in parallel with the history of tools, tools were what concretized human thinking and enabled works by humans to be produced. He called for a move away from traditional humanism that puts the creator, the idea, and speech before action, making, and materiality. In a preface to a book on *culture technique* published by the *Centre de Recherche sur la Culture Technique*, Leroi-

Gourhan wrote that “A work [of art] is the function of technique, thought is translated by the strokes [gestures] of painting, engraving, or sculpting, which are at the command of creative thinking” (Leroi-Gourhan, Perriault, and de Noblet 1981, 7).

The idea of *culture technique* emerged from Leroi-Gourhan and Simondon's understanding of the human being as someone who becomes human through the process of creating and relating to tools. In other words, they saw technology not just as an external tool for human use, but as essential for humans to be fully human. Thus, Simondon said that culture in *culture technique* is not simply “knowledge” but an “ethical relation” (*relation éthique*) with the object, a sentiment of respect and love for the technical object (Guchet 2013). For both Simondon and Leroi-Gourhan, the call for the importance and recognition of the *culture technique* was part of the re-definition of humanism (Guchet 2010). Thus, the movement saw this kind of knowledge of technical artifacts to be indispensable to being a fully realized human being because they understood the human being as someone who really becomes human through the process of creating and relating to tools.

Jacques Perriault, a French communications scientist, was instrumental in forging the link between *culture technique* and the new concept of *culture informatique*. Perriault was a long-time member of the *Centre de Recherche sur la Culture Technique*. As director of the French office of Modern Education Technology (*Office français de technique modern de l’éducation*), Perriault was an early participant in the use of computing in French education. Already in the years 1962-1964 he described a lot of interest and diverse projects in educational uses of computers and information technology

(Perriault 2012a). A personal friend of Seymour Papert, Perriault was one of the main advocates of LOGO in France. Through a project called *enfant à la pratique actif de l'informatique* (a project of the Centre Nationale de Recherche Scientifique), he worked to promote the use of LOGO in French schools by organizing conferences and information sessions.[69] His approach to computers in education in France and his preference for LOGO were inspired by his studies of other technologies in the classroom, particularly television, and audiovisual equipment such as photo cameras (1977; 1978). In those studies, Perriault worked out ideas about the child as an active user of technology, who transformed the technology into a tool of self-expression and exploration rather than using it in a pre-defined manner (see, for example, *La logique de l'usage* 1989). Consistent with the spirit of *culture technique,* Perriault sought to promote the idea of the child as active technology user.[70] For Perriault, to be technically cultured at the end of the 20th century meant to have this kind of relationship with computers (Perriault 2012b). His use of the term *culture informatique* in 1971 was one of the earliest. *Culture informatique* became a more widely discussed concept than *culture technique*. It also became the focus of developments in French education and more general public efforts to form people with computers.

May 1968 and the push for computers in education

The May 1968 student protests were an important series of events that provided both practical impetus and vision to the *culture informatique* movement. The protests

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[69] Perriault also helped to translate (syntactic translation) LOGO into French.
[70] See, for example, Perriault et al. report for the Éducation National, La formation de l'enfant téléspectateur actif (1978).

pointed to deep-seated problems of French society and politics. Studies of the protests conducted by the recently-created Center for Educational Research and Innovation (CERI) of the Organization for Cooperation and Development (OECD) identified three major reasons for the discontent (Papadopoulos 1968). The first was that students felt uncertain about the goals of the French society beyond the satisfaction of material needs. The CERI report suggested that there was a lack of a meaningful vision for a future society that could inspire the students and that the student generation wished to participate in deciding this future, both for their universities and for society as a whole. Second, students were anxious about their professional future and their careers, especially those in disciplines not directly applicable to the labor market. And third, the report concluded that students were frequently critical and sometimes outright rejected internal organizational structures, both inside and outside the university, as well as the contents and methods of the educational system (Papadopoulos 1968; Papadopoulos 1994, 71). Taken together, these concerns reflect a general frustration with the organization of society and government that made it difficult for students to participate in envisioning and making a meaningful future in France. The development of computer education and the active teaching of *informatique* were conceived to help address these concerns about future visions and social order revealed by the protests.

As more and more people used the concept of *culture informatique* through the 1970s and 1980s and as programs were launched to develop this culture in French society, the practical meaning of *culture informatique* diverged from the more theoretical and academic concept of *culture technique*. Perriault's frustrations with the manner in which the French state and other individuals went about developing *culture informatique* are indicative of this divergence of the two concepts.

The first formal French efforts to teach *informatique* began in 1970, following a meeting about the role of computers in education organized by CERI. This was CERI's first meeting since its founding in 1967 and CERI's history is intimately tied up with rising social unrest about the state of education in France.[71] CERI's growing importance between 1967 and 1971 was fuelled by hopes of addressing some of the frustrations about education revealed by the protests (Papadopoulos 1994). In pursuit of this mission, CERI's first project was to explore the prospects for introducing computers into education. This fact suggests, I argue, a link between the problems of social order revealed by the protests and the use of computers in education as a solution to these challenges. Computers in secondary education (middle and high school level) were presented at the March 1970 CERI conference ("Computer Science in Secondary Education") as a way to resolve some of the tensions in European society revealed by the protests (Khan and Gass 1970). One of the general conclusions of the meeting was that introducing a computer science course in general education "has become a practical issue of considerable importance" (109). To this end, CERI appointed a committee that would develop recommendations on what kind of content to teach, what computing medium to

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[71] CERI's principal architect, Michael Harris (at the time, the adjunct Secretary General of the OECD), was inspired by his work with the Ford Foundation (which considered education to be important to economic and social development and for international relations) to start a branch of the OECD focused on education (Papadopoulos 1994, 24). Harris was also inspired by OECD's first educational program begun in 1958, whose role was to examine the education methods and results of member countries at all levels from basic education to secondary and technical education and to help the countries address their problems. Harris recognized the need for a program like PST, but also saw that the resources PST had received were not enough to sustain the program. He decided to launch CERI with funding secured from the Ford Foundation. CERI launched on the results of the 1964 study of education in member countries, which was published in a popular report in 1965. In 1967, the OECD council approved CERI for two years, which were subsequently extended as member states saw increasing benefits from CERI's activities between 1967 and 1971 (Papadopoulos 1994).

use to teach it and how best to train teachers for this new course of study (110). Following the meeting, France launched a strong national effort to bring computer education into French schools.

The French began by building the first software for educational purposes and training teachers to use computers in the classroom. In the summer of 1970, the French government (funded in part by the French computer industry) launched what became known as the *formation lourde*, or the "heavy training" of schoolteachers within French computing companies during the course of one year. Developed at around the same time as the concept of *culture informatique* was emerging, this approach to the formation of teachers and subsequent formation of children in secondary schools with computers seemed far from the ideals of *culture technique*. Teachers were placed with one of three computer companies operating in France: IBM, CII, and Honeywell-Bull. Ninety teachers were trained in the first year. A technocratic, top-down approach to training teachers by computing experts, *formation lourde* ran from 1971 to 1976, with approximately 500 teachers trained in this way in total (Baudé 2012).

Fifteen years later, in 1985, after a sequence of experiments in computers and education that involved more and more computers, teachers, and students at each iteration, the French Ministry of Education launched the *Informatique pour tous* (IPT) program (1985-1989). IPT was a nation-wide program designed to educate all French school children with and about *informatique*. It was a central project of the French state in the development of *culture informatique* and represented a culmination of decades of effort by the French government, and specifically the Education Ministry, to introduce *informatique* into schools, beginning with *formation lourde*. Behind the *Informatique pour tous* program is arguably the most explicit *sensibilisation* effort of the French state, spanning the presidencies of Valéry Giscard d'Estaing and François Mitterrand and the different sociotechnical imaginaries of *informatique* that they represented. The original vision for this program was to require every child in the national education system beginning with the 1985-86 school year to "use *informatique*." Jacques Attali argued that that the computer should be considered and financed like any other school provision (e.g., textbook, notebook) (Attali 1983, 2–3). The goal of IPT was to equip all French schools with micro-computers and introduce all children to *informatique* as well as to help to develop the French computing industry (I will address the relationship between these two normative and economic goals in the following chapters). This goal was pursued together with projects to open school *ateliers de l'informatique* to members of the community and to train hundreds of thousands of teachers about how to use and teach with computers (Fabius 1985, 25). The IPT program reveals the extensive involvement of the French state and its educational institutions in the development of *culture informatique,* at times, as contemporaries have argued (Perriault 2012b), against the very imaginary of decentralization that *culture informatique* initially conjured up.

Despite this, the roots of *culture informatique* in *culture technique* gave important direction to the French imaginary of the computer knowledgeable citizen that set it apart from that of the United States and the Soviet Union. This dramatically different origin from that of computer literacy in the United States had practical consequence for what *culture informatique* became and for how it was taught and learned. Both concepts challenged the boundary between the human, defined in the dominant Western humanistic tradition as non-technological, and technology. Yet, the direction from which the boundary was crossed was different. In the US case the new computer literacy fulfilled the popular historical view of public literacy as a technology, whereas in the French case technology was incorporated into the domain of culture. Computer literacy needed to be learned because it was a new and indispensable tool for the mind, while *culture informatique* was deemed indispensable because it was a new form of culture that drew all French people into its embrace.

In this context, one of the techniques for implementing *culture informatique* became *sensibilisation*, or making people sensitive to the computer. Making sensible or attuned to the technology involved more than knowing or being able to use, but rather learning to *be* or *live* with. As one French television show participating in the *sensibilisation* effort put it: the goal of *culture informatique* was to show how computers could be used to "dream and build lives with" ("Marchand de ville" 1982). This idea was not only used in public, but was echoed by the French computing industry and by teachers developing a pedagogy of *informatique*. For example, a participant at a Paris conference *Informatique et enseignement* in 1983 recalled how another participant, a computer industry official, said that "what is needed is more than know-how [*savoir faire*], it is knowledge of how to be [*savoir être*], a knowledge of how to learn [*savoir apprendre*] and how to adapt oneself [*savoir s'adapter*]" ("Actes Du Colloque National, 'Informatique et Enseignement,' Paris 21 et 22 Novembre 1983" 1983). The same participant continued with another citation about what *informatique* is: "better than a tool, it's an auxiliary, a way of being [*l'auxiliaire être*]." *Informatique* in these practical conversations about *informatique* in education was infused with the grandness of being an auxiliary, or supplement, to being and *culture informatique* thus took on the meaning of being more than skills, but knowing how to learn, to adapt, and to be.

Together with its attitudes towards the relationship of humanism and technology, *culture informatique* also imbibed from *culture technique* its normative vision for a decentralized social order. Intimate knowledge of the workings of technical artifacts, followers of the *culture technique* movement believed, would cure social alienation, reduce the subordination of people to experts, and help lead to a more decentralized society (Leroi-Gourhan, Perriault, and de Noblet 1981). Concern about alienation in the *Manifeste* for the *culture technique* suggests a Marxist spin on valuing the technician and worker over the "man of ideas."[72] For example, in the preface to the *Manifeste*, Leroi-Gourhan denounced the forces in society that praise abstract speech and argumentation over the concrete skills and abilities of the artisan and technician. In Leroi-Gourhan's view, the development of *culture technique* could be a remedy to the perceived growing alienation of humans from their environment (Ibid., 7). By empowering people vis-à-vis the technical objects in their lives, proponents of *culture technique* believed they could bring into being a more distributed and egalitarian social order.

The leaders of the *culture informatique* movement, particularly during the presidency of Mitterrand (1981-1995) and the rule of the French socialists, articulated similar goals of realizing each person as a fulfilled and socially engaged (instead of alienated) human being and citizen. Like *culture technique,* which promised to be a way

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[72] This is also supported by the fact that the *Manifeste* was full of images of people working and playing with technical objects. The diversity of examples it drew upon suggests the breadth of the concept.

to give control over technologies to people, *culture informatique* was presented by many members and supporters of Mitterrand's socialist government as the only way to build a just and democratic society in a world where such technologies existed. *Culture informatique* was a kind of antidote to the perceived negative effects of computerization of society and it was the French government's duty to ensure that this happened by supporting *culture informatique* programs.

A tool at the human scale – Mitterrand, autogestion, and informatique

For Mitterrand, the development of *culture informatique* was more than a solution to the crisis of the 1970s—it was an opportunity to build a particular self-managing (*autogestionnaire*) society, which he and his socialist government considered as an ideal. Mitterrand saw public knowledge of computers to be an indispensable condition in order to make this happen. Under Mitterrand, France developed diverse *culture informatique* projects. Most important of these were the creation of a public computer center called the *Centre Mondial Informatique et Ressource Humaine* (World Computing and Human Resource Center) (1981-1986) and the national education initiative *Informatique pour tous* (Informatics for All) (1985-1989) that was accompanied by an array of educational public television programming. These diverse projects formed a loose network of differently mediated ways to allow people to envision and practice changed relationships and interactions (e.g., between teacher and student in the classroom, and between citizens and government). These interactions, the leaders of the projects believed, would extend beyond the interaction of person with computer and beyond the walls of the classroom into general culture, contributing to the creation of a self-managing society composed of a computer-aware public.

Mitterrand hoped that these varied efforts to make the general public computer-aware would help to build a new *autogestionnaire* society, that, in his vision, would help to alleviate social inequality and empower citizens vis-à-vis the state. The idea of *autogestion* dates back to the writings of social critics in the 19th century, including Karl Marx (Gollonges 2010). Traditionally, self-management *(autogestion)* was a socialist vision of the workplace, in which the workers are partners instead of employees. In an *autogestionnaire* organization, workers would be simultaneously managers and decision makers, not merely acting on others' orders. *Autogestion* was an ideal of a number of French socialists in the second half of the twentieth century, especially following the student uprisings of May 1968. The experience of the LIP watch and clock factory in Besançon, where workers maintained a regime of self-management for a year between 1973 and 1974 after workers' protests shut the factory down, is emblematic of *autogestion* in practice in France.

Mitterrand, however, believed that *autogestion* ought to extend beyond the workplace to society at large. He envisioned *autogestion* as the foundation of a stronger democracy. The main aspects of an *autogestionnaire* society that Mitterrand emphasized were decentralization of the economy,[73] interdependence of members on one another,

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[73] Decentralized economic planning was opposed by democratic socialists to the kind of centralized economic planning characteristic of the Soviet Union. Economic decentralization in practice means that decision-making about how much to produce is given to economic agents dispersed in different parts of the economic system. Despite the term "decentralization" it is nevertheless a form of economic planning, as distinct from free market economics where, at least in theory, no planning takes place but the economy is administered through the "invisible hand" of the market. Outside of France, the use of computer systems to

individual initiative, and transparency among the different layers of government (Mitterrand 1977). He believed that distribution of decision-making power to more local authorities would give citizens a greater sense of ownership and participation in society. His vision contained an important tension—almost contradiction—between interdependence and individualism. And he put a lot of faith in the possibility of *informatique* to resolve it. Linking individuals and regions with computers could enable the distribution of authority and decision making while at the same time giving the government a better picture of what was going on in each corner of France. By re-arranging relations among individual citizens and the government, *autogestion* proposed a transformation to the experience of belonging to the imagined community of the French nation-state.

In a 1977 speech, while still the First Secretary of the French Socialist Party before his election as President, Mitterrand laid out his understanding of the social significance of *informatique* (Mitterrand 1977). He viewed *informatique* as a double-edged sword. He was concerned about the dangers to civil liberties posed by the concentration of power by businesses that collect information (multinationals "in front of which States, especially ours, is expected to abdicate" (Ibid., 1). *Informatique* was too important and too dangerous to leave to the *laissez-faire* of capitalist markets. If left up to the markets, he argued, the vast amounts of information produced, stored, and analyzed by individual businesses as well as the state could be abused. He was also

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create a decentralized economy was the aspiration of Salvador Allende's government in the Project Cybersyn (described by Medina 2011) and also a failed dream of the Soviets (Gerovitch 2002; also see discussion of Soviet experience in relation to the Chilean in Medina 2011, 63).

worried about the fragmentation of work and the alienation of workers from their labor, which he saw to be the result of automation of the workplace with computers.[74] At the same time, he believed that given proper political control *informatique* could be used to build a more just and democratic society than previously possible. The only way to avoid the dangers and secure the benefits of *informatique,* Mitterrand argued, was for the socialist government to take control of *informatique* by using it for the interests of the socialist state.

In order for *informatique* to become the foundation of an *autogestionnaire* society, Mitterrand argued, it had to be subordinated to politics. He called for the need to "remove *informatique* from science fiction scenarios, to enable it to enter, as all social phenomena, into the field of thought and political action" (1977, 1). Members of Mitterrand's government argued that the proper management of computer technology to ensure that it be in the service of democracy required an "audacious" and "long term" view characteristic of the socialists. For example, the French Minister of Research and Industry, Jean-Pierre Chevènement, presented capitalists, in contrast to the socialists, to be too easily swayed by the "short term logic of profit," which could result in technological choices that would not be in the interest of democracy or social good (Chevènement 1982). The "long view" espoused by the socialists, on the other hand, entailed being "ambitious" and thinking imaginatively about how *informatique* could serve the interests of the people (Ibid). Subordinating *informatique* to politics in practice

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[74] Mitterrand gave the example of a spring 1974 strike by bank workers, which he attributed to the "Taylorism-style" insertion of *informatique* into the workplace (Mitterrand 1977). In the United States only overtly lefty scholars like David Noble (1983) sounded this theme.

also meant the flipside of letting *informatique* determine the important questions that society had to respond to.

The ills of *informatique* had to be overcome by more *informatique,* albeit one that was properly managed. The *autogestionnaire* society would ensure that information was managed in a decentralized manner, which would avoid its abuse and support the functioning of *autogestion* at the levels of business as well as the state. According to Mitterrand, the protection of collective liberties that the socialist government pledged to uphold was inseparable from an even greater diffusion of *informatique* into society. The deployment of more of the technology and practices of *informatique* would support the protection of liberties by providing

> access to business accounts for unions; better information about prices and technical specifications of products for consumers; creation of databases with data on the law, social and fiscal legislation, housing, etc. for the citizen; knowledge of revenues, patrimony, financial transactions for the state (Mitterrand 1977, 2).

With the knowledge of *informatique,* Mitterrand envisioned French citizens being able to keep an eye on the state's and private sector's activities, thereby preventing or being able to hold the state accountable for any abuse of power.

Mitterrand's idea of *autogestion* depended upon his vision of what *informatique* would be in the hands of the general public. When thinking about realizing *autogestion* with the help of *informatique*, Mitterrand and other French politicians and leaders sympathetic to the general spirit of *autogestion* imagined it to be a social system for effective information management. "Only an *autogestionnaire* society," said Mitterrand,

> giving workers themselves the responsibility to manage their own affairs, can resist the escalation of information that is necessary in the centralized world to master social processes. The *autogestionnaire* society will give

> the greatest responsibility to the basic social units in the workplace as well as in daily life. This will not lead to the renunciation of *informatique* but will orient its progress towards miniaturization [of machines] and simplification of languages, in order to make of it a tool at the human scale (Mitterrand 1977, 2).

A citizenry knowledgeable in *informatique* was in Mitterrand's vision an antidote to the abuse of power with which technology tempted authorities. He called for "collective mastery" of *informatique* through knowledge: "To control, one must first know. Here, as elsewhere, power resides first of all in knowledge" (Ibid., 4). Knowledge of the technology by the public would lead to its control by the public and would, in turn, shape the tools to make them into tools "at the human scale." In Mitterrand's vision, the *autogestionnaire* social order would be coproduced with the particular human-scale idea of *informatique*.

From Mitterrand's vision of an *autogestionnaire* society achieved through *informatique* we can see the centrality of the French state in managing the coming of the information society. Unlike in the United States, where becoming adapted to the seemingly inevitable information society was predominantly the responsibility of schools and individuals, in France the state, with the future of French society at stake (for better or for worse) and with the President himself personally involved, took the responsibility to prepare the citizenry for the *société informatisé*. What did the Mitterrand government consider to be the right form of preparation? In other words, what did being acculturated in or sensitive to *informatique* mean in practice?

École parallele: computer sensibilisation by television

An imaginative and informal effort to build computer-sensibility in France involved the use of national television programs. *Sensibilisation* in these programs comprised three goals: 1) a multiplicative pedagogical effect, 2) promotion of the commercial interests of the French computing industry, 3) a public illustration of the government's commitment to this "activity of the future" (i.e. *informatique*) (Ibid.). Referred to as *école parallele,* literaly "parallel school" because they supplemented and accompanied the Ministry of Education's in-classroom efforts, these television programs aimed at a wide range of audiences (but many targeted children in particular) to make the general public more computer-aware. Two national French television channels, TF1 and A2, ran weekly programs beginning in the fall of 1983 (timed to begin when children went back to school) and another one-hour long program developed with the help of the CMI, began on FR3 in the fall of 1984 (Salles 1983).[75] One of the programs' aims was to promote the domestic computer industry by demonstrating the strength and capabilities of French-made computers (Menage 1983). The wide use of the term *sensibiliser* used to describe the function of these programs was frequently coupled with *nouveau langages*, or "new languages" of *informatique* that needed to be conveyed to the general public.

The content of these programs varied. Some focused on interviews with prominent French leaders of *informatique*. Others gave examples of the use of *informatique* in everyday life or demonstrated activities of *informatique* hobby clubs.

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[75] A BBC project served as a model for these French programs (Sautter 1983).

Still others were imaginative and poetic, striving to inspire the public's imagination about what *informatique* could be used for. For example, the goal for of one episode of the *Micropuce* series called “Marchand de ville” (“Merchant of Cities”) intended for children, was to show how computers could be used beyond number crunching—how they could be tools “to dream and build lives with” (“Marchand de ville” 1982). This imaginative narrative neither presented facts about the use of computers in society nor taught viewers any computer skills. Instead, with new age music and the graphics of the 1981 version of the video game *Space Raiders,* the episode stimulated curiosity and wonder about the computer.

The episode showed three boys, aged ten—one white, one black, one Arab—walking among rubble in a war-like environment. The boys are homeless vagabonds. As they walk along broken fences they sing a song that appears to be an intangible remnant from a past world of which everything else has been destroyed. At night they stumble across a storefront with a light inside and a sign overhead that reads: *Marchand de ville* (Merchant of Cities). Curious, they enter and find inside a man who resembles a cross between a kind magician and a cyberculture hippie with wild curly hair and a colorful sweater. The merchant welcomes the boys and shows them the computer at the heart of the shop. He tells the children that the computer stores the memory of cities from around the world and has the power to transport people to them. Each of the boys tells the merchant where they wish to live and are happily transported there. The white boy goes to Nantes, the black boy to New York, and the Arab boy to Tunisia.

What the episode implies resonated with observations made by American social scientists about childhood and society at this time. It showed a post-apocalyptic world, similar to the world of *Future Shock,* ravaged by some unknown conflict in which children must find a new home, and they do so with the help of a computer. Though the film showed children, in it true childhood seemed impossible. The children appeared as autonomous little adults. At around the same time that this episode appeared in France, American cultural critic Neil Postman (1982) published his book about the end of childhood. Postman, as we saw, argued that the decrease in the need for literacy due to television had created a loss of the distinction between adults and children. In the world of the film there were no resources for the children to learn from except those recorded in the memory of and only accessible with the help of the computer. The computer's memory contained images of cities of the world, in which Paris was represented by a painting showing the Eiffel Tower by Marc Chagall and Moscow by a constructivist image. The children had no adult guides or role models. The figure of the Merchant, the only adult in the film, contained the same tension between control and independence found in Mitterrand's notion of decentralization. The Merchant was at once the paternalistic purveyor of futures for the children at the same time as he was just a passive executor of the technological transaction between the child and the machine. The lack of adults as models who can teach the child about the kind of path to take for the future is reminiscent of anthropologist Margaret Mead's critique of the Generation Gap (1978) and the final scenes of the American documentary based on Alvin Toffler's *Future Shock* (Grasshoff 1972).

This theme of children being left on their own in a world of *informatique* because they were pioneers and natives of the *société informatisée* was echoed in other *sensibilisation* programs. For example, in one news-hour program at the start of the 1982 year, Mitterrand sat in his countryside home (on vacation during the winter holidays) and commented on the unfolding news. One of the episodes he commented on showed a girl, with her mother at her side, playing a tune on the piano and then listening to the computer she had apparently programmed playing the same tune back to her. Mitterrand said that this was an example of the girl teaching her mother. "She knows things that her mother does not know," he said, "She is acquiring a new form of communicating, a new civilizational form" (Mitterrand 1982a). This kind of deference to children's knowledge of *informatique* coexisted with the contradictory wish to impart to children a *culture informatique* developed by the expert-adults in the Ministry of Education (see, for example, Beullac 1980) and the computing industry.

In an unlivable and unhospitable world of "Marchand de ville" the computer (instead of a human being) offered the only promise of a viable future. By sending both colored boys out of France, however, the new order that the Merchant facilitated with the computer was an act of racial purification. Individuals, connected up with supposedly their own idealized visions, were no longer bereft. Yet, their visions of belonging and their lives in the post-apocalyptic order were defined for them by the disturbing imagination of the state. Given the TV programs' definition of *sensibilisation* to include the promotion of French computer market, this aspect of the computer solution that viewers were invited to imagine was particularly tragic.

This episode of *Micropuce,* and the French television programs about *informatique* more generally, revealed yet another dimension of *sensibilisation* as intended by the French government. These programs encouraged the viewer to consider more broadly how their world could be transformed by the widespread presence of *informatique*. They were enticed with “new vocabulary” from the *informatique* world, but mastering it or learning programming was not the goal. Instead, the programs called upon the viewer—children and the general public—to creatively imagine how to apply this technology to their everyday lives. The *société informatisée* future that they were invited to imagine, however, was paved with deep-rooted values such as the commitment to French-made hardware and software and ideals about the right social order.

A new culture from above

The project of *sensibilisation*—learning to apply *informatique* to one's life—was a cultural project of sense and meaning-making. It was intended to transform the seemingly senseless, obstructing, and foreign “veil of digits” described by Centre Georges Pompidou president Jean Maheu into a palpable thing, or something that could be felt as having sense and purpose for the everyday French person. An exhibit at the *Les Immatériaux* exhibition organized by Jean-François Lyotard at the Centre Pompidou from March 28 – July 25, 1985 as part of the diverse cultural *sensiblisation* efforts illustrated how the *sensibilisation* programs attempted to make this happen.

The exhibit was of a computer that automatically generated unique sonnets at the audience's press of a button. The computer was programmed with the rules for making a sonnet and it drew upon a database of words from broken up sonnets of Raymond

Queneau, a French poet who was a member of the literary movement called Oulipo (*ouvrir la literature potentielle*). Members of Oulipo experimented with the capacity of language to hold and generate new meaning and some of them had interest in the possibility of using *informatique* for new forms of literary expression. For example, prominent Oulipo poet, Georges Perec, was a friend of Jacques Perriault with whom he discussed the opportunities of *informatique* for literature (Perriault 2012b). In the exhibit, the computer "written" sonnet was signed with the exact date and time (to the second!) of when it was produced—such was the whim of the "author," who placed a lot of emphasis on the exact (random) moment that produced this particular, once-in-a-lifetime arrangement of words in the form of a sonnet (Jeanbreau 1985). In addition to being part of the *sensibilisation* effort and serving as a literary experiment for the Oulipo, the exhibit was also used as an example of how *informatique* could be used in French schools to teach literature—as a lesson in how humans and computers can come together to create new meaning (Ibid.).[76]

This exhibit demonstrated the possibility of using computers to make new kinds of sense on different levels. First, as a computer-aided art form it demonstrated words being treated as modules to construct new meanings. Words could be recycled, taken out of their original context and re-assembled again, like bricks reused from an old building in a new one. This modular, flexible approach to language was one that, according to one French teacher, children learned when they played with moving the robotic turtle in

[76] *Informatique* projects with and for literature were particularly interesting for some schoolteachers because there were relatively few applications of *informatique* for the humanities. The majority of *informatique* software and applications were created for mathematics, sciences, and even social sciences like economics and history (see, for example "Informatique pour tous: Catalogue des logiciels" 1985).

LOGO ("SICOB/Ordinateurs et Enfants" 1984). Second, as an application of computer technology to literature, it was an example of how *informatique* could be introduced into humanities disciplines. To this end, this exhibit was cited in a report on the role of *informatique* in education by the French ministry of education, the *Éducation Nationale* as an idea for how computers can be applied to literary education. Finally, this exhibit was an answer to how the *Les Immatériaux* exhibition sought to help to transform the obstruction of the "veil of digits" into a screen of new meaning for people's lives, in the concrete, enjoyable, and playful form of a new sonnet. However, like the sonnet, assembled at a click of a button by the computer algorithm with no possible intervention from the museum-goer, the exhibit also illustrated how French efforts to inculcate *culture informatique* or make people sensible to the new technology happened in opaque, expert-designed ways whose inner workings were neither transparent to nor modifiable by ordinary users.

The hand of the French state in developing *culture informatique* through *Informatique pour tous* program, the Centre Mondial Informatique, and the structured *sensibilisation* programming a fundamental tension between a desire to use *informatique* to retain control over society while at the same time giving greater independence to citizens. Underlying Servan-Schreiber and Mitterrand's imaginary of *culture informatique* was a foundational idea about the human being and her ideal relationship to society as a *ressource humaine,* or an instrument of strategic aid to the state as well as for self-fulfillment in non-instrumental ways. Servan-Schreiber and Mitterrand believed that this idea of the human subject at once beholden to the state and to the self could be developed by *informatique*. In the prevailing imaginary of *culture informatique,* the new computer culture would help the individual find her own self-expression while at the same time even more strongly bind her to the state and its dominant culture.

Soviet Union – Second literacy

As in the United States and France, computers in the Soviet Union were also seen as having created a situation that required people to change. However, the need to change was a lot less ominous than in *Future Shock*, and the change needed was conceived at the level of society as a whole, as in France, rather than in the psychology of each individual independently, as in America. Andrei Ershov, a mathematician and computer scientist who was the leader of the field of computers in education in the Soviet Union, worried that, given the rate of development of computers, there would not be enough programmers to take advantage of the computers' potential (Ershov 1972). Ershov proposed "computer literacy," or "second literacy," as he called it in an influential keynote talk (Ershov 1981a), as a solution, first using this concept in the early 1970s (Tatarchenko forthcoming).

Beginning on September 1, 1986, the first day of the 1986-87 academic year, all schools in the Soviet Union were supposed to teach programming (*Pravda* 1984; *Komsomolskaya Pravda* 1984). At the foundation of the reform was Ershov and his colleagues' idea of *informatika* (informatics) and the decades-long work on developing "second literacy" curriculum and technologies. The text of the reform communicated that the Soviet government recognized, for the first time in history, computer machinery as one of the most important provisions of teaching in general education (Ershov 1987, 39). The formation of every future citizen of the Soviet Union would now be shaped by the powers attributed to computers and programming to define how a person thinks and relates to herself and society. Mikhail Gorbachev's educational reform came at a time of growing instability in the Soviet Union. As part of the *perestroika* plan, this reform was one among a number of policies that Gorbachev made to try to transform the ailing institutions of the state into more viable and open ones to ensure that the Soviet Union would have a future. A major impetus for the reform, as described by Ershov and as perceived by foreign observers, was to help the Soviet Union catch up to the levels of public computer knowledge in the West (Longworth 1986; Judy and Lommel 1986). At the same time as the Soviet national program to develop computer literacy served to bring Soviet society closer to American society in ways that could be measured by quantity, price, or power of the computer technology, the program was oriented to a vision of the information society that was distinct from the American or French.[77]

Cybernetics for education

The national decision to introduce a computers and programming course of study into every Soviet classroom traces back to the early 1960s and two subsequent decades of preparatory work, experimentation, and advocacy. In the late 1950s the Soviet Union was

[77] Numerous accounts of Soviet computing describe a Soviet "computer lag"—a state of being perpetually behind the West in availability, quantity, price, and power of computer technology, particularly with regards to micro or personal computers (see, for example, Graham's comments in Longworth 1986; as well as Afinogenov 2013). The lag narrative assumes that the Soviets modeled their visions of the future of computers in society upon the West. I argue, in contrast, that because the visions of the future of computers (what kind are needed, who should use them, what they should be used for) were inseparable from visions of social order, the Soviet idea of the information society was distinct from the vision of the information society in the United States and in France. Observing developments to teach computer literacy nationally in the Soviet Union, Judy and Lommel came to the same conclusion. It "would be difficult to exaggerate," they wrote, the "difference in visions of the information age" of the Soviet Union and the United States (1986, 111).

in crisis, having suffered famine and facing doubt in the capacity of the Communist Party to maintain a centrally planned economy. Joseph Stalin died in 1953 and was replaced by Nikita Khrushev, a leader who pursued a more tolerant rule that began to make known the violence that Stalin had supported and which had constituted life in the Soviet Union up to that point. In this environment of change, Khrushev's government felt the need to reinvigorate the Communist promise with new, less authoritarian and violent, substance—to re-imagine the future of the Soviet Union (Vaiil' and Genis 1998). This need for a new imagination was inseparable from addressing practical challenges, such as how to run a centrally planned economy without once again succumbing to widespread famine. The young science of cybernetics, with its promise to make societies legible and more productive through information, was perceived to provide a solution to both of these challenges.

Cybernetics, the science of control in natural and social systems (Wiener 1948), was originally banned in the Soviet Union under the guise that it was a "capitalistic" science (Graham 1971; Gerovitch 2002). It was reinstated in 1958 and, in part in counter-reaction to the ban and because of the way in which any science needed to be consistent with Party ideology, cybernetics found a broad reception in the Soviet Union and was applied to a wide range of disciplines and areas of human endeavor (Graham 1971). After the founding of the Scientific Council on Cybernetics, headed by Academician A. I. Berg, Soviet scientists studied the application of cybernetics to fields from agriculture to physics (Graham 1971; see, for example the diversity of applications in Berg's multi-volume publication *Kibernetiku na sluzhbu kommunizmu, Cybernetics in the Service of Communism* Berg 1961). Practically, cybernetics revived the possibility of a centrally planned economy in the Soviet Union (Graham 1971: 329). Yet, more than any specific application, cybernetics in the Soviet Union was remarkable for its totalizing quality[78]—how different aspects of governance and institutions were re-imagined in light of cybernetic insights (Mindell, Segal, and Gerovitch 2003).[79] While visiting the Soviet Union in 1960, historian of science Loren Graham observed that cybernetics in the Soviet Union was understood significantly more broadly than in the United States (Caldwell and Graham 1964).

One key area of wider application of cybernetics was in education. Cybernetics was both an independently popular course of study, with students urged to major in cybernetics, as well as a method with which to re-think education, for example through "cybernetic boarding schools" like one established in Moscow by the Academy of Pedagogical Sciences of the Russian Republic to prepare children from an early age for careers in cybernetic programming" (Graham 1971: 330). Applications of cybernetics to experiment with structure of education consisted of programmed learning and teaching machines. In these applications, the student and teaching machine were considered as one system through which information flowed, and whose flow could be modulated depending on the "feedback" from the student learning. This way of thinking about the human-machine relationship and the process of learning resembled the behaviorist foundations of Patrick Suppes' Computer Assisted Instruction (CAI) in the late 1950s in the United States, as well as of the 1970s approach to *informatique* in schools in France

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[78] Similar, in this respect, to the French attitude to *informatique*.
[79] Eden Medina argues in her book *Cybernetic Revolutionaries* that cybernetic also served as the foundation for a similar kind of governmental and institutional re-imagination in Salvador Allende's Chile (2011).

(which Jacques Baudé described to be largely about CAI (Baudé 2013).[80] Although these efforts to apply cybernetics to education through programmed learning and teaching machines served as important stepping-stones in the history of computers in education to the work of Ershov and his team, they deliberately distinguished their calls for "second literacy" from the programmed learning model (as Luehrmann and Papert did in relation to CAI) (Pervin 2014). Furthermore, the time came to apply computers to education at the national scale, it was not programmed learning, but the "literacy" approach that was deemed the answer to the needs of forming Soviet children for the future.[81]

The government recognition of cybernetics and computing as areas of research that could help revive the communist project is evident in the creation of a new scientific research center in Siberia, the Novosibirsk Akademgorodok. Under Khrushev, Akademgorodok was to be a model for Soviet science and science at the service of the Soviet state (Josephson 1997; Tatarchenko 2013). Its mission was to practice new kinds of partnerships between academia, industry, and education that would help to revive the vision of social progress through science and technology (Josephson 1997; Graham 1993a; Holloway 1994).[82] Both the first Chairman of the Siberian division of science in

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[80] An even better parallel between the application of cybernetics to education in the Soviet Union and in France is the work of Louis Couffignal, who was a French mathematician and cybernetics pioneer who studied the application of cybernetics to pedagogy in the 1950s. For more on Couffignal, see (Mounier-Kuhn 2010; Le Roux 2009; Le Roux 2010).

[81] Ershov reflected upon the history of computers in education in a 1987 address "School Informatics in the USSR: from Literacy to Culture" at the *2nd International Conference Children in the Information Age*. He described how the use of computers for "programmed teaching" was not able to evolve into what he called the "universal conception of general education," causing interest in this program to decline in the 1970s (Ershov 1987, 37).

[82] Akademgorodok included what Josephson calls "organizational innovations" that "fostered a symbiotic relationship between science, education, and industry, something that failed to materialize elsewhere in the postwar USSR" (1997, xvi).

the Soviet Union, Mikhail Lavrentev, who oversaw the construction of the Akademgorodok, and his successor, Gurii Marchuk (later president of the Soviet Academy of Sciences) were mathematicians who specialized in mathematical methods and modeling and helped to develop their application in computing (Josephson 1997, xxi). Thus, computers (though not personal computers) were at the heart of the Akademgorodok from its start: "In Akademgorodok computers and mathematics were at the center of Lavrentev's vision. They would be the key to, and the symbol of, a scientific utopia where interdisciplinary education, research, and production came together" (Josephson 1997, 124). It was there, at the newly founded Computer Center of the Akademgorodok, that Ershov would develop his ideas of computer literacy and attempt to implement them beyond the boundaries of Akademgorodok to all of the Soviet Union.

Computer literacy, according to Ershov

To become "computer literate" for Ershov meant to learn how to program and think “algorithmically,” or to be able to plan one's actions in order to achieve a particular goal. Because he put a technical and professional activity at its center, Ershov's definition appears more narrow than the one in use in the United States and France. What programming meant to Ershov, however, as we will see in Chapter 2, was significantly more than the skill of writing computer programs. It was developing a way of thinking that Ershov saw as inextricably linked to an action-oriented and forward-looking way of life—skills that he perceived to be essential to contemporary society. “The second literacy,” as Ershov called computer literacy, “is not only the knowledge of how to write commands for machines, but also the formation of a decisive and foresighted human being" (Ershov 1981a, 4). For Ershov, the value of being computer literate extended beyond utilitarian skill to being an essential human virtue that would fulfill the human evolutionary progress.

The use of the metaphor of "literacy" entailed for Ershov, as for his American counterparts, a particular interpretation of the history of literacy and an interpretation of the significance of literacy in people's lives. Although Ershov discussed the history of literacy at the seemingly universal scale of "human civilization," his interpretation drew upon ideas and experiences of literacy particular to the Soviet Union. Ershov defined literacy as "the ability of a person to understand and express knowledge in textual form" (1981a, 2).[83] More than its role for any one individual, however, Ershov emphasized literacy as a social and historical force at the level of transforming "human civilization" as a whole. Like Arthur Luehrmann's account of the history of literacy, Ershov's writing also presented a sweeping history of the development of public literacy as a general phenomenon around the world rather than the experience of a particular nation. Ershov divided history into three "eras": the period before the advent of general literacy, the period of general literacy, and the period of the "second literacy" of programming (1981a, 5). In each era, he tied the absence or presence of literacy to the relationship between abstract thought or knowledge and human action. Literacy, he asserted, helped to separate knowledge from action. With the advent of mass literacy, the book as a

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[83] Ershov himself was a prolific writer and reader and these qualities were, as Ksenia Tatarchenko has argued, foundational to the influence he was able to exert within the Soviet Union and abroad (Tatarchenko 2013; forthcoming). Tatartchenko described Ershov as someone who conducted a "republic of letters" (forthcoming). He was also a poet and translator of his own and others' poems, which contain insights about his world-view (his values, ideas about beauty and the human) and the place of mathematics in it.

reservoir of knowledge came to stand between human thought and action. This change in the relationship between knowledge and action paralleled a transformation in the relationship between teachers and students or experts and the lay people. In Ershov's interpretation of the history of literacy, literacy was an essential tool of individual and social transformation: individual in the way that people experience truth and the world and social in the way that they relate to one another and in their capacity for action.

Ershov's interpretation of literacy's significance drew upon its role in the early 20th century in the Soviet Union. Ershov described literacy as a "common good," echoing the way literacy was presented in the mass literacy *Likbez* (ликвидация безграмотности, literally "liquidation of illiteracy") campaigns conducted in the Soviet Union in the 1920s, where literacy was defined as a "natural right" of all people, and therefore everyone needed to be literate (Clark 2000).[84] The naturalness of literacy to the human being was part of the general communist ideology that everyone is the same, that everyone can progress, and that everyone can come to know skills that are so basic they can be considered innate. Consistent with this naturalizing view, Ershov described literacy to be

> the expression of an organic capacity of the human being, i.e. the capacity that has been prepared by the organization of his nervous system and a part of [присущей] the person in all her social functions: in communication with others, in labor, in the observation [созерцании] of nature and in the struggle with her [nature] (1981a, 1-2).

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[84] For an overview of the public literacy campaigns in the Soviet Union and Tsarist Russia see Ben Eklof (2008). A discussion of the social implications of the LikBez movement is in Sheila Fitzpatrick (1979).

The characterization of the person as biologically and neurologically wired for literacy (and hence also for programming) made the practice of such an activity, in Ershov's view, both an individual and a social necessity.

Programming as the Second Literacy

Ershov saw the human to be always-already programming. "We live in a world of programs and are continuously programming, without realizing it" (1981a,10), Ershov said in a 1981 keynote at a UNESCO conference on computers in education. His UNESCO talk was accompanied by illustrations drawn by Mikhail Zlatkovskii. One of them depicted the Earth enveloped in perforated paper of printed-out computer programs, representing "the world of programs." The perforated paper also looked like giant band-aids, suggesting that programming held the world together or could be a solution to the world's problems.

When Ershov spoke about programming as the "second literacy," he referred to the meaning of "second" in two ways: first, as a "second nature" in which programming, like literacy, comes naturally to the human being, fulfilling "a new harmony of the human mind" (1981a, 2); and second, as an inevitable progression that historically follows the "first" literacy. Programs, Ershov continued, are part of human biology (he gave examples of "genetic programs" and predictable human behavior) and human society (from morning routines to national planning).[85] Thus, Ershov saw learning programming as an extension of what is already natural and familiar to the human being. "Second

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[85] Zlatkovskii's illustration to Ershov's 1981 UNESCO speech included an image depicting a man digging through the biological programs that he was made up of (Ershov 1981).

literacy" was a kind of "second nature." This dual idea of programming as second nature and natural historical progression was consistent with the general Soviet idea that literacy is a natural right and a product of the dialectic of revolutionary and evolutionary change that brought it into being.[86] Ershov viewed programming as human destiny, both because human agency actively brought it about (through revolutionary decrees or history-transforming inventions like the printing press and the computer) and because it was the natural evolutionary unfolding of biology and society.

Learning to program as part of general education would make programming, a “natural essence,” the “thought-out achievement of the human being” (Ershov 1981a, 11). By formalizing this implicit ability, it would give all people the ability to master their own nature by acquiring the programmers' traits of "decisiveness and foresight," which, in Erhsov's perspective were foundational to a well-functioning society.[87] “Social problems of the century” like absenteeism and passivity were, according to Ershov, problems caused by the traditional literacy mindset and represented a *lack* of programming-action. He claimed that the ability to “generate a program of action and execute it” (1981a, 10) was the key to “form an active life position” and the cure to these contemporary social ills.

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[86] The ideas that social change takes place through a natural evolution, identified with Marx and Engel’s theory of dialectical materialism, and that it also requires one group of people to actively, by revolution, overthrow another (Marx’s historical materialism) were combined in the Soviet Union in the state doctrine of dialectical and historical materialism, as expounded by Joseph Stalin in *Dialectical and Historical Materialism* (1938).

[87] This point in Ershov’s talk was accompanied by an illustration by Zlatkovskii of a man steering himself through strings attached to his shoulders, thereby suggesting that he was at the same time the puppeteer and puppet and illustrating “self-goverence” or the taking of oneself under one’s own control. This image is visually linked to one in which the “strings” emanating from a man's body are programs. Taken together and in the context of Ershov's text, the man learns to control himself by acting upon the programs that are a part of him.

In contrast to the American understanding of computer literacy as augmentation of the individual mind, Ershov's computer literacy sought to make the person a partner of the machine. The human-computer partnership was illustrated by a telling image from the cover of a key text where Ershov and his colleagues outlined the general education programming curriculum. The image, showing a school girl and anthropomorphized computer sitting side by side at a desk, illustrates the symmetry between the human and computer that Ershov perceived to be already there and which he worked to develop further with the general education curriculum for the teaching of second literacy that he designed. The girl raises her hand in the way that children were taught to do in the Soviet schools in response to a teacher's question, suggesting that with the computer at her side, she knows the right answer. In Ershov's vision the computer needed people and people needed the computer for each to realize his or her own productivity.

Unlike in the American case, where the information society was perceived as a disruption to life the social fabric of life and contributed to the generation gap, Ershov saw the future society where everyone knew how to program on the same continuum with the programmed society of the present. The information society was the evolution of programmed society to a more advanced state. If the LikBez Soviet literacy campaign of the 1920s had been an important force in founding the Soviet state (Clark 2000), the "second literacy" campaign that called for the introduction of computers into all Soviet schools in the 1985-86 school year would, in Ershov's view, serve to fulfill rather than revolutionize the Soviet state. The project of the "second literacy" echoed the first, drawing upon its socially-transformative vision and carrying forward its long-term project of creating a particular normative social order by technical education of the general population. Although computer literacy was envisioned as a way to prepare the way for a smooth transformation to the information society, the government's decision to introduce computers into the general education curriculum came as part of Gorbachev's *Perestroika* reforms, which led to the revolutionary fall of the Soviet Union[88] and the "opening up" of Soviet society to the world, the very kind of opening that the idea of the information society in the West was inseparable from.

Comparing Information Societies and Strategies of Adaptation

An information society is a sociotechnical imaginary—it is a collectively shared vision of life in the near future, one that has not yet attained full fruition and its coming-into-being is said to depend upon the course of technological development (Jasanoff and Kim 2015). The table below compares the three national programs for teaching children to know and to be with the computer. This comparison shows that there was not one information society, but many co-existing information societies. The American, French, and Soviet ideas of what the information society was and would be were drastically different. This comparison reveals at least three different ways in which the computer was thought of to constitute the human: as cognitive augmentation, as culture, and as partner. The way in which the computer constitutes the human depends upon factors such as: the idea of the future the computer is thought to produce (is the computer

[88] I am not suggesting that second literacy led to the fall or even contributed to the fall of the Soviet Union. In this sense, it is important to separate revolutions in the information society from revolutions in the actual society of the Soviet Union. Historically, however, these two societies did overlap (in complex ways that need to investigated further) and this is why I think it is important to draw attention to the irony of expecting a smooth evolutionary transformation in some hybrid imagination of these two societies and in actuality finding a revolution.

imagined to be socially disruptive or is it imagined to continue or reinforce life as usual?); what adaptation means (is it about psychological change or cultural change?); and who is responsible for adapting (the individual or the state).

Table 1: Comparison of national computer literacy and culture programs

	Program Name	**Relationship between computer and future**	**Who is responsible for preparing for the future**	**Incorporation model**	**Citizen of the information age imaginary**
US	Computer literacy / fluency	Disruptive & anxiety producing	Individual	Cognitive augmentation	Knowledge-able individual
France	*Culture informatique*	Transformative but controllable	State	Culture	Human resource
USSR	Second literacy	Continuous	State	Partnership	Productive member of planned collective

The third column shows the different ways in which the computer was envisioned as acting to bring about the future information society. Thus, in the United States, the computerization of society was seen to bring about an anxiety-producing disruption to life as usual. Meanwhile, in France, the computer's effect on society was seen as transformative, but could—and should be—controlled by the state whose role it was, as Mitterrand stated, to subordinate the technology to politics. Finally, in the Soviet Union, the official message about computerization of the Soviet government (as communicated in the popular press about computerization as well as in films) and of the leaders of the “second literacy” movement was that the future with computers would be a greater fulfillment of what human beings and society already were, and so would not be disruptive.

In the fourth column, we see different ideas about who was responsible for adapting to the computerized world. In the United States, the onus to adapt falls on each individual and on independent institutions like schools; relatedly, there was a plethora of ideas of what computer literacy meant, and as many different programs that said they were training people to be computer literate. In France, we see the state leading a single program of *culture informatique* yet with many different kinds of initiatives that are designed by people who are close to the state (like the CMI by Servan-Schreiber), as well as television programs and museum exhibitions. And in the Soviet Union, we see the state taking the responsibility for forming all members of society with a single program.

The fifth column, headed "incorporation model," represents the way in which the computer technology was *predominantly* seen to become a part of the person. Another way to think of this column is that it represents the way in which the computer constitutes the human. In the United States, the form taken by the human-computer “cyborg” was that of a person with augmented cognitive abilities. In France, the computer was incorporated into the person via a culture. And in the Soviet Union, the computer became a seamless partner of the person because both were seen as always-already programming.

The sixth column displays the imaginary of the citizen of the information age--that collectively held and institutionally stabilized vision of the member of the computerized world that the computer education programs sought to bring about. It is not surprising, that, in each country, the imaginary of the citizen of the information age is very similar to the constitutional idea of the citizen that we might find if we were to study the key constitutional texts of that country. This once again reminds us that normative constitutions matter for the way in which a new technology makes its home in a particular society. In the United States the citizen of the information age was envisioned as a "knowledge-able" individual—as a person capable of producing knowledge, by allowing the computer to constitute her cognitive enhancement, for an information society whose primary substance of value was described to be knowledge. In France, the vision of the citizen of the information age was of the human being as a resource for the state, whose own capacity to be resource-full (abundant in resources) the computer helped to unlock. In the Soviet vision of the citizen of the information age the person with the computer as partner was the new (next-level) member of the planned collective society.

In the following chapter, I will develop further these three models of constitution further by exploring in more depth the significance of this new literacy and culture for its pioneers.

Chapter 3:
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.

Goldstein and Papert, LOGO Proposal 1976-1979, p. 5.

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 in the context of the national imaginaries described in the previous chapter. What did they want to achieve with their respective programs and what was at stake for them in achieving it? My aim is to reveal their motivations and intent in ways not easily observed by focusing on the programs themselves. Instead, I trace the pioneers' education, personal and professional backgrounds, work trajectories, sources of inspiration, and influence. By exploring these biographies, we see more clearly how their backgrounds oriented them to focus on topics of the mind.

The pioneers can be seen as “entrepreneurs of the mind” because they ventured with their programs to transform the foundations of how people think and learn. These programs were not just tools to learn mathematics better or to learn computer skills or programming. They sought to affect structures of the mind, such as aspects of learning and thinking, which could eventually have huge consequences for how people think of themselves and relate to others. A comparative analysis of the three pioneers indicates that, while their understandings of the right way to integrate the computer and the mind differed, they all believed the computer to be a natural complement to the mind. They considered the computer a tool that could extend and enhance the mind, and bring about individual and social fulfillment as a result. Computers, for example, could open up the capacity for more effective learning, emancipating the individual from oppressive social structures, and helping to create a more productive society.

In each case, the national imaginaries of citizenship in the information society gave rise to specific ways in which each pioneer distilled his own vision of the computer literacy and culture and forged tools with which to pursue it. In keeping with the American liberal imaginary of the citizen as a knowledge-able individual, Papert formed his idea of computer fluency (as opposed to literacy) and developed the LOGO programming language the use of which, he believed, would lead to empowerment, and emancipation of individual styles of learning and thinking. The French socialist imaginary of the citizen as a resource for the development of both self and the state supported Servan-Schreiber's notion of *la ressource humaine* and helped justify the Centre Mondial Informatique through which the French state could pursue a totalizing *culture informatique*. Finally, from the Soviet Marxist imaginary of the citizen as a productive member of a planned collective, Ershov distilled his vision of how algorithmic thinking could lead to a virtuous and effective collective and, together with his like-minded colleagues, he developed the pedagogical approach of school informatics with which to form and enable such citizenship.

Seymour Papert

In 1976, as an already seasoned researcher of computers in education, Seymour Papert (1928-) labeled computers as "tools of the mind" that would transform individual and collective psychology and lead to a "revolution" in how we think about human beings (Papert 1977b, 14). Papert's lifetime work indicates his wish to guide this "revolution" towards a synthesis of the human mind with the calculating machine so as to effect improved learning and self-fulfillment.

Papert himself traced his interest in the workings of the human mind and of the mechanisms of learning to his childhood. As a child, Papert was fascinated by gears. In his famous 1980 book on computers in education, *Mindstorms,* Papert recounted how he "fell in love" with gears, which served in his childhood as a cognitive and sensory learning tool. Papert loved to rotate circular objects against one another and then later liked to rotate them in his mind. He liked particularly to think of differential gears because they did not follow simple linear causality. Papert recalled his initial "excitement at discovering that a system could be lawful and completely comprehensible without being rigidly deterministic" (Papert 1980, xviii) This early encounter with gears inspired his interest in mathematics and became the foundation upon which he based his own understanding of how learning works (10). This combined interest in mathematics and learning persisted through Papert's long and productive career. He studied mathematics in college in South Africa (where he was born) and later also in England, earning a second Ph.D. in mathematics from the University of Cambridge in 1959. Math served as the subject of choice for Papert's thinking about learning and in his efforts to reform education with computers (Ibid.). In 1967 he became a professor of applied mathematics and director of the MIT Artificial Intelligence Laboratory (AI Lab). Soon after, he began a project under the auspices of the AI Lab to continue to develop LOGO, a computer language for children. 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 an alternative method of learning in American schools. Having studied with the famed child psychologist Jean Piaget in Geneva, as his long-term friend and collaborator, Papert advanced a theory of learning that he called "constructionism." Developing LOGO was for Papert always a means of developing his own understanding of how learning takes place and helping to improve the function of the mind.

Papert and Jean Piaget

Papert drew inspiration for thinking expansively about his work with computers from his work with the 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 famously concluded that people acquire knowledge by interacting with their environment according to their needs, in a way that he termed "constructivism." 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 theories were tremendously influential in twentieth century psychology, pedagogy, and epistemology and they helped to distinguish the idea of computer literacy from the drill-and-practice use of computers in education.[89]

Papert came to know Piaget when Piaget invited him in 1959 to work in his Center for Genetic Epistemology in Geneva. Papert had completed his Ph.D. in mathematics from Cambridge that same year and Piaget seemed to have liked Papert's dissertation on "Lattices in Logic and Topology." Papert spent six years in Geneva, from 1959-1965, working together with Piaget on the branch of genetic epistemology concerned with the development of mathematical reasoning in children.[90]

Papert's unique way of interpreting the significance of Piaget's thought reflected his own interest in understanding and steering of processes of 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 was Piaget who brought epistemology from out of its home in philosophy and made it a science in its own right (Papert 1965, 2). Papert argued that genetic epistemology was a new scientific approach to the study of knowledge and mind. Not only did Piaget develop this epistemological science, but he 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

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[89] Drill-and-practice use of computers in education was based on the behaviorist understanding of human psychology and learning, according to which a person is rewarded for desirable behavior and punished for non-desirable behavior. B. F. Skinner showed that by using rewards and punishments a subject could over time learn to perform only the desirable behavior. These reward and punishment structures were embedded in the design of drill-and-practice software. For example, when a person answered a question correctly, they were rewarded with points or more difficult questions and when they answered a question incorrectly, the program would subtract points or keep repeating questions of the same difficulty or type.

[90] Piaget published his first major study of this process in *A Child's Conception of Number* in1941.

study of control and communication in animals and machines that took off in the post-World War II environment of the United States (Ibid.).

Papert argued that constructivist theory had 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 such as learning. He 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" (Papert 1965, 2). 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.[91] 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 through which the information moved—human biology/neural networks v. computer/electrical wiring—was different. According to Papert, these 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

[91] 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, which are distinct from the era of thinking about the mind as an information-processing machine.

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 MIT AI Lab beginning in 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: 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 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'" (Papert 1977b, 14). He was concerned, however, that anxiety 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 influence (either positively or negatively) individual and collective psychology. This position was supported by Papert's fellow MIT colleague, philosopher Hubert L. Dreyfus. In a September 1967 article titled "Why Computers Must Have Bodies in Order to Be Intelligent," Dreyfus based a critique of computer's inherent limitations on an argument that a robotic arm could not even move fast enough to play Ping-Pong (Dreyfus 1967). In a lively critique of Dreyfus, Papert argued that his generation must come to grips with 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' (Papert 1968, 3 original emphasis).

Instead of proving to people like Dreyfus why their pessimistic perspective on the computer's future capabilities were false, Papert said he preferred "to probe the problems we all have in integrating man and machine into a coherent system of thought" (Papert 1968, 4). In an early suggestion for a project, Papert set the tone for the kind of work he would pursue with LOGO: to show not only that human beings and computers could co-exist but that they could in fact benefit one another.

While searching for practical ways to "integrate" humans and machines in 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"), was closely related to Piaget's "constructivism" (with a "V"). Both theories emphasized the role of active making, or construction, of knowledge by the individual (Ackermann 2001). An important difference between the two theories arose, however, as a result of Papert's work with children and computers. This difference related to 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, considered concrete thinking not as a stage but as 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 the Piagetian stages: abstract thinking could become concrete thinking, as well as vice versa (1977b, 14). Interaction with computational objects, he argued, prompted a general "revaluation of the concrete," which he claimed had larger ramifications than just in learning (Epistemological pluralism 162).

Constructionism, I argue, was Papert's answer to the challenge he articulated in his critique of Dreyfus: how to successfully integrate "man and machine into a coherent system of thought." 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 further work. For instance, LOGO was designed to reinforce the supposed naturalness of "concrete thinking." In what 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 promoted 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. His grand vision of LOGO as a tool with which to transform the processes of human learning and thinking led to his being recognized as LOGO's chief developer and proponent. In particular, Papert's ideas about what the language could do to human thinking were unprecedented, although LOGO researchers before Papert joined the project were already thinking about computer languages in education in ways that were novel at the time,.

The LOGO project began without a 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, as a project to design a new programming language for education.[92] The Educational Technology Department (ETD) had been formed two years earlier, in 1965, by Wallace Feurzeig. ETD's founding 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. Now it shifted attention to investigating *programming languages as educational environments*. This change reflected a greater shift away from "top down" drill-and-practice-type projects, which saw the computer as a tool to facilitate learning of already-existent educational content, toward new frameworks of computer literacy in which the computer was envisioned as a tool that would 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 2011). 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

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[92] BBN's location in Cambridge, MA, is not incidental. Walter Rosenblith, biophysicist and Institute Professor at MIT described BBN as a consulting company for acoustics in architecture 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 (Rosenblith 2000 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.

middle school mathematics classrooms in the Boston area in 1965-66 and found to be an effective tool for learning mathematics (Ibid).

The success of the constructivist approach in demonstrating demand for a robust computer language for an educational purpose and the national priority given to developing American mathematics and science education in the post-Sputnik era combined to create the parameters for ETD's second project: another computer language for children that would become LOGO. With 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 had studied and collaborated with Jean Piaget, the world's authority on constructivism. That same year Papert 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 learning, constructivism, mathematics, and computers. Papert joined Feurzeig and a team of ETD engineers and educators, including Daniel Bobrow, Richard Grant, and Cynthia Solomon.[93] Together, these 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 (Feurzeig and Papert 1969, 291).

[93] The same year that Papert joined the MIT mathematics faculty as professor and became the director of MIT's AI Lab.

Here was a language conceived for young children who were not expected to become mathematicians, programmers, or other computer specialists. The criteria explicitly turned away from specialized preparation and programming conventions that were seen as "interfering" with the primary goal of communicating mathematical concepts. The requirements emphasized "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 very name, "LOGO," suggested that this programming language could express ideas and thoughts in its words.[94] Feurzeig selected this name as an explicit reference to the Greek *λογοσ* (logos), "the word or form which expresses a thought; also the thought itself" (Ibid., citing Webster-Merriam Dictionary, 1923). The use of word rather than number commands (e.g., "Forward," "Left") also had an instrumental purpose consistent with the criteria, i.e., requiring little preparation to master. Word commands were considered easier to understand and learn both for children and adults (Feurzeig and Papert 1969). These criteria, the language's name, and its constructivist underpinnings set LOGO 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 teaching mathematics) and small-scale project. Papert developed LOGO's functional specifications while Bobrow made the first implementation in LISP (a high-level programming language) on a Scientific Data

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[94] 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 2 for a discussion of this in the context of the relation between traditional literacy and computer literacy.

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 (Feurzeig and Papert 1968). This first test revealed that the language was not immediately appropriate for the younger (10 year old) children whom it targeted for and that it was still largely thought of in relation to mathematics education and in terms of strategic military interests (Feurzeig 2011). In the 1967-68 year, the ETD group created an expanded version of LOGO that was implemented by Charles R. Morgan on the DEC PDP-1, the first computer in which the designers focused on user interaction ("DEC PDP-1 Collection" 2015). From September 1968 through November 1969, the National Science Foundation (NSF) supported the first intensive program of experimental teaching of LOGO-based mathematics in elementary and secondary schools (Feurzeig and Papert 1969). 1969 also saw the first experimental use of LOGO with children under ten. The classroom work was carried out at the Emerson School in Newton, MA (Ibid., 293). This second version of LOGO had now expanded to younger children under the auspices of the NSF instead of the Office for Naval Research; however, it still had a relatively instrumental application to teaching mathematics. Papert and his colleagues recognized the potential of LOGO to play a more expansive and transformative role in education. This vision in large part motivated the decision to move work on LOGO to the environment of the AI Lab at MIT, where Papert was director. At MIT the theoretical and practical development of LOGO would continue for over twenty years and it would become, according to Papert, the source of transformation to how people learn.

From literacy to fluency

In bringing LOGO to MIT, Papert hoped that it would be possible to use the language to build a "totally different learning environment" as compared to the learning environment of American public schools at the time. His experiences with Piaget led Papert to articulate this grand goal for education—and for the formation of the human being. The new learning environment would be one that began neither with the problems of existing school systems nor from a technology that could provide a solution, but from a vision of what constitutes good learning (Papert 1976). Papert's vision of good learning came from his understanding of the workings of the human mind as illuminated by constructivism and from his work with the LOGO project, which applied constructivist theories to education with computers.

Papert saw education in American schools as deeply problematic. One culprit was society's dependence on—and the organization of schools around—traditional literacy. Like Luehrmann's, Papert's vision of computers in education involved an interpretation of the history of literacy. In his view, however, literacy was not the source of civilization and development as much as it was a problem that had led to what he perceived as the current impasse in learning. The alphabet, in Papert's view, was not a technology and literacy was not an intellectual technology. Instead of taking literacy as a ready-made notion that simply needed to be disseminated in the world (as did the histories of literacy discussed in the previous chapter), Papert problematized the idea itself. He sought to distinguish between literacy as the knowledge of how to read and write, which he termed "letteracy," and literacy as the possession of general culture (Papert 1993). He found in the falling together of "letteracy" and "literacy" the basic source of the problem with contemporary education, and with the use of computers education in particular.

According to Papert, literacy imposes a kind of "mediation" on the human experience of the world and, more specifically, on the learning process. He complained of the particular mediation that was created between the human being and her pursuit of knowledge in the traditional school system based on the knowledge of reading and writing. In traditional schools, in which reading and writing were the normal mode of accessing knowledge, the child lost the "immediate" experience of learning that babies seem to possess—directly through the senses.[95] Papert distinguished three "stages" of the development in the relationship between the individual and knowledge: the "immediate" learning of a baby, the linguistically mediated learning of school children, and the immediate learning of adults who had mastered language to the extent that it was now natural to them and they could go on to access knowledge and explore playfully and creatively (Papert 1993; Seymour and Freire late 1980s). Papert believed that the majority of people never made it to the third phase. They remained dependent upon "letteracy" to mediate their relationship to the world. This mediation suppressed a diversity of learning styles and constrained people's freedom of learning and experiencing the world.

Papert believed that computer literacy, as it came to be institutionalized in American programs of the 1970s and 1980s contributed to the problems with American

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[95] Describing how babies learn, Papert wrote: "Babies begin to build their knowledge by exploration of everything they can see and touch." As they grow, children transition to more mediated ways of learning—through using language to either ask an adult or by reading books written by others. Then, "by the time they move into school, mediated acquisition has become the dominant form" (Papert 1993).

education.[96] Computer literacy was being taught as a new "letteracy." According to Papert, these programs were too rigid and unimaginative in their conception of both the child and the computer. From his grounding in constructivism, Papert critiqued the fact that these programs usually considered both children and computers as "objectively given" (Papert 1988, 4). They implied a set of skills that the child had to master so as to interact in a pre-defined manner and place in society. The idea of computer literacy catered to and fed into the traditional school system, the same system that taught children in a way that, as Papert argued, in most cases destroyed the intellectual spark and capacity for "immediate" learning that each person was born with. At the same time that it locked in this particular vision of the child, the "Educational Establishment" also adopted an unimaginative perspective on what the computer could be for human beings (Papert 1993). The computer in the school was a tool, Papert argued, that tended to reinforce the traditional pedagogical approaches instead of reimagining what learning ought to be and could be with the computer (Ibid.).

While Papert was openly critical of the computer literacy movement, he shared Arthur Luehrmann's original sense of computer literacy as an intellectual technology for adaptation to the information age.[97] Similarly to Luehrmann, Papert considered the

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[96] For descriptions of these programs, see for example (Barbour 1984; Cheng and Stevens 1985; Bialo and Erickson 1985).

[97] It may surprise some readers that I focus on the work of Seymour Papert in a study of computer literacy. Papert vocally decried computer literacy and never used the term to describe his own work. However, multiple examples from Papert's own writing as well as that of Arthur Luehrmann, point to a foundational similarity of their projects. For example, in a 1977 address in front of Congress, Papert described the need for knowledge about computers as one of the "3R's" (reading, writing, and arithmetic) and as a "basic skill" and he talked about, like Luehrmann, how "the presence of the computer and people's skill in using it will deeply change the way everything else is learned" (Papert in US House of Representative 1978, 259). In the same Hearing, Luehrmann distinguished his call for computer literacy from CAI or Computer

computer to be an intellectual tool that one should incorporate into oneself to adapt to—and take advantage of—an environment in which the computer would have a growing presence.[98] At the same time, he imagined the human-computer relationship in more individualized and creative terms than was implied by the idea of literacy. Papert believed that computers could fundamentally transform the way that people learned—that they could make learning at any age as “natural” and “immediate” as the way that a baby learns (Papert 1980). While Papert maintained this aspect of Luehrmann's original vision for “computer literacy,” he preferred to speak about his programs as developing computer “fluency” rather than literacy.[99] Papert purposefully chose the idea of fluency—a term implying a capacity to create new linguistic constructs as well as to read set texts—to distinguish his perspective on computers in education from the institutionalized literacy approach.

Management of Instruction (CMI) and allied himself with Papert’s project, which he refered to indirectly as the testimony of the other witnesses that the Congressional Committee had heard before him (Luehrmann: "... a kid can be taught to use the computer, and that the process of using the computer is different for the kid than the process of being taught by the computer. It seems to me that it is this second activity, the teaching of the kid to use the computer, which is at issue today. That is what the witnesses here have stressed today. There is something important about people learning how to interact with machines. That is the point here" (318)). When Congressman Swanson asks him to clarify his project in relation to Papert’s, Luehrmann confirms that they are working towards the same underlying goals. (Swanson: "Won't students actually learn how to program the computer as they go through the type of training routine advocated by Dr. Papert? Luehrmann: Let me clear that up. I was not trying to distinguish my testimony from Professor Papert's. [...] Swanson: “So you use the broad term computer literacy to include everything we have talked about today?” Luehrmann: “Yes; that's the point. (320)).

[98] Papert believed in the inevitability of the development of computer technologies, from artificial intelligence to the introduction of computers in daily life (see, for example, Papert's criticism of Dreyfus' thesis that AI will not advance). Throughout his work, he took the approach of welcoming and embracing these developments and he was very positive about the changes they could bring—should people be willing to incorporate them into life in the right manner. Papert lays out his vision for what this manner is in his proposal for the Humanistic Computer Center (Papert 1977b).

[99] Despite Papert's lack of association with the mainstream of the computer literacy movement, or rather his critique of the values and goals of this movement, his success and fame seems to derive in part from the general context of computer literacy to which his ideas were perceived to belong. For example, the numerous NSF grants Papert received for the research and development of his approach to computers in education fell into categories focused on public support of math and science education that computer literacy and other computer education projects (e.g. CAI) drew upon.

"Fluency" for Papert was an expansive notion that included not only being intimately familiar with using the computer but also developing an ease of learning any subject matter with the help of the computer. Papert's favorite example of a fluent learning experience was that of a child who learns a foreign language by living in the culture in which it is spoken. He believed that all of learning ought to just as "natural": to proceed unforced from the child's needs to live in a particular environment. Papert described computers as "universal Proteus" tools[100] that can be used to create any environment from which the child could draw knowledge resources. The computer in his vision could provide for learning fluency in any subject matter, facilitating general learning because of its "mathetic" potential, a term derived from the Greek word *mathesis,* meaning science or learning. With the use of computers, people could "short circuit" the need to learn how to read and write (Seymour and Freire late 1980s, Part I). In doing so, people would once again be able to access and build knowledge "immediately," or without mediation.[101] They could "maintain their curiosity and a sense of their own intellectual power that they had when they were born" (Papert "The Future of School" Part 1). By removing the need for linguistic mediation, computers could, according to Papert become the ultimate tool for helping people to learn how to learn.

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[100] 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. This idea is consistent with the American vision of the information society as a society of constant, rapid (even accelerating) change for which the preparation is learning to be adaptable by learning how to learn.
[101] "Immediacy" is of course a relative notion. The computer is a form of mediation between self and world as much as traditional knowledge of reading and writing is. What was "immediate," "natural," and "playful" for Papert was guided by particular parameters that I will explore in detail in Chapter 4 when I look at how Papert's visions were implemented in specific hardware, software, and educational programs. For now it suffices to say that what was "natural" for Papert seems to have implied mathematical or engineering way of doing things, although Papert understood that math may not be everyone's "natural" language or way of thinking (Papert 1980).

While the computer was an artificial tool, Papert saw in it the potential to make learning more "natural"-- a concept he frequently used uncritically and always with a positive valence. The person fluent with computers was, according to Papert's vision, a person whose cognitive functions had been enhanced in a natural way with the computer. Not only would the computer make all kinds of learning natural, but learning to use the computer itself could also become natural, mentally an even physically, according to Papert. He sought to create hardware and software that would allow the user to access the resources of the computer without knowledge of formal programming or abstract ways of thinking. Papert aspired to make learning the computer an intuitive exploration, a social and collaborative activity that engaged the user's body, and a matter of playful "tinkering"--a process and manner of interaction that could altogether avoid the need for traditional literacy (and its perceived constraints, such as the disciplines of traditional schooling that supported it).

Thus, for Papert the computer represented the empowerment of human beings and emancipation of styles of learning and thinking (Papert 1980; Harel et al. 1991; Papert 1993). Papert saw his quest to develop the computer as a tool for fluent learning as sharing goals with other branches of critical scholarship, such as feminist theory, African studies, and sociology of scientific knowledge (SSK). All were committed to demonstrating and defending a diversity of ways of thinking and to resisting the potentially flattening power of purely abstract thinking (Turkle and Papert 1991).

While these allies—from feminist studies, African studies, and SSK—waged their battles for diversity of thought and epistemic recognition for different social groups (women, Africans, dissident scientists), Papert focused on altering the foundational relationship between children and adults. His vision for the use of computers in education would address the crisis constituted by the gap of understanding between generations by using the computer to make learning natural and thus preserving the original curiosity and capacity for learning in very young children. With the computer all learning could be natural and *mathetic*, and by learning with and in the computer environment people could maintain throughout their life the amazing learning capacity and curiosity of the very young. The computer would preserve the "intellectual spark" which everyone is born with ("Obsolete Skill Set" 1993). In Papert's vision, computers could erase rather than exacerbate the distance between children and adults. Children could be like adults by learning to think about how they learn (thus becoming "child epistemologists"); and adults with the computer could remain like children by retaining the capacity for "immediate" and playful learning (the value and significance of playfulness are discussed in Chapter 4).

Implicit in this vision of "immediate" access to knowledge was the idea that the computer would become an integral part of the self. In this way Papert's vision for computers in education was also, as for Luehrmann, a vision of embodiment of the computer as a cognitive enhancement. Papert's idea of developing "fluency" supported the cybernetic incorporation of the computer by the child or any user. Like Leurhmann, who termed the computer an "intellectual resource," Papert, too, viewed the computer as a "tool of the mind" (Papert and Goldstein 1976) and contrasted this aspect of computers with older tools, which he described as tools of the hand. To be properly employed, this tool had to become a part of the human being. Papert designed his computer in education programs to reflect this belief. For example, LOGO taught children to program not for the knowledge of programming itself, but to facilitate learning more generally, and the use of the LOGO Turtle, a robotic or virtual object that children could program in LOGO to draw on a piece of paper or on the computer screen, encouraged the "playing out" of the role of the robot and blurring the boundary between the computer and the child.

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

The creation of the "totally different learning environment" Papert foresaw required, first, an environment it could call home. In 1969, the year before Papert officially brought LOGO to MIT, he began plans to build the Children's Learning Lab.[102] The Lab would be housed on the first floor of a building across from the MIT campus called Technology Square, perhaps an imagined opposite pole to Harvard Square a stop down the subway line. This Square was already headquarters to the AI Lab (on the top floor) and a number of other prominent computer researchers (*MIT News* 2004). 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 a computer language for children was central to both understanding and influencing the human mind.

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

[102] Records about the building of the Lab at the MIT Archives date from 1969-1974.

research" and "learning experiments" with elementary school children (Papert and Goldstein 1976). Children and their 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 simultaneously a site of development and improvement of the LOGO language and software, based on feedback from teachers and students, and 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 so-called emergent AI, which depended on the design of *computers* that were capable of learning.[103] 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 human beings learn and to apply these lessons to the designs of machines. Even before LOGO arrived at MIT, then, its planned location in the AI Laboratory reflected Papert's grand ambition for 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 constructionist principles at the foundation of the computer language and to design

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[103] On Papert's definition of "emergent AI" see his article on the two AI's in *Daedalus*. Papert's colleague Marvin Minsky was interested in the dual project of advancing artificial intelligence and understanding the process by which human beings learn by creating computers that learn (known today as research in "machine learning") and specifically the challenge of making a "child computer," or a computer that mimicked a child's as opposed to an adult's form of reasoning, see Minsky on the creation of a "child computer."

the language and accompanying hardware so as to influence human thinking and learning. In their work 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 learn *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 contained the right kinds of resources for the child to draw upon for learning. The idea of a microworld came from constructivism, which emphasized the importance of the "world" or surroundings of the child, from which the child draws resources for learning (Piaget 1970). The real world of the school in which structured learning usually took place, Papert argued, did not always contain the proper resources for learning, but in the computerized microworld all of the appropriate resources could be provided.

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 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 by rote, while for adult specialists these subjects are fun, dynamic, and intertwined in complex ways with other aspects of life. These subjects *must* have beeen denatured, Papert thought, in order to be taught in the traditional way in school because the school relies on 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 as students of all ages can learn to dance in a samba school—Papert's preferred example of a successful and good model of learning (see, for example, Papert 1980, 178). This comparison implied that Papert considered the school to be an impoverished world for learning, while the computer microworld could be limitlessly rich in learning resources and, implicitly, more similar to the real world in which unstructured learning takes place.

What made the computer "dynamic" in Papert's eyes was that it was a kind of "Proteus tool," an ever-adaptable technology that, through the flexibility of the microworld, could be molded to the learning needs and style of expression of each child. LOGO microworlds, however, did not mold to any *a priori* needs or styles, 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. In Chapter 4, I describe in detail the ways in which these artifacts and content informed children's activities and interactions. In the remainder of this section, I want to introduce two of the most important aspects of LOGO that were used to generate 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, it is essential to see them in the context of Papert's theory of "constructionism." This is a theory of knowledge that posits that people learn by making things with objects. The LOGO Turtle and Turtle Geometry were tools that both enabled Papert to formulate the theory of constructionism and allowed Papert and colleagues to 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. Rather, constructivist insights that children learn abstract thinking through the engagement with concrete objects in their environment prompted the idea of creating a “computational object” to facilitate the child's learning, exploration, and creation with the programming language. As this computational object, the LOGO Turtle re-defined the relationship between the child and the computer. The computer and the programming language became not the object of the child’s interaction but the mediator between the child and the Turtle robot.

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 with the help of consultant Mike Paterson (Feurzeig 2011). 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,” also took this form. Those creatures were landmark creations of machines capable of learning. Now, the LOGO Turtle was another turtle cousin designed to help children to learn but also to give researchers insight into child learning. The LOGO Turtle thus joined a long lineage of devices for exploring the workings of the human mind through technology.

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 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 cursor-like 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 LOGO Turtle, whether a physical robot or a virtual representation, was central to the MIT LOGO Group's work in transforming the way that children learned. 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” (Papert and Goldstein 1976). During the first wave of LOGO research at MIT (1973-1976), Papert and his colleagues focused on developing objects and content for use in teaching to support the ability of LOGO to generate rich and flexible microworlds.[104] They created what they called “real

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[104] Papert and his colleagues referred to their research in terms of these “waves,” which are designated by two rounds of NSF funding for LOGO research, 1973-1976 and 1976-1979 (Papert and Goldstein 1976)..

mathematics" (as opposed to a "denatured" version) 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 constituted "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. 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' (Papert 1976, 4).

For the purposes of learning, the microworld enlivened the subject that was taught in it, making it much more "real" than if it had been taught in an "artificial" or "denatured" way with pencil and paper in the traditional schoolroom. Learning in the microworld of the computer (as opposed to the world of the school), with computer-mediated computational objects like the robotic Turtle and with a new form of geometry would come, in Papert's vision, closer to the nature of human learning.

LOGO, in Papert's vision, would allow the user to realize her full natural potential as a learner and as a knowing being. The technology allowed users to realize their humanity, while social institutions like the school and literacy restricted this ability. LOGO brought to fruition, amplified, and extended the natural potential of the mind. This vision was especially striking in Papert's notion of the computer as an "informational prosthetics" for the handicapped. "Informational prosthetics," Papert explained to Congress at the Hearing on Computers and the Learning Society,

> means that with the computer this person can learn, this person who is being completely isolated and dependent can manipulate information and can do any job in the world which primarily involves manipulation of information. Like your job [a Congressman's job] primarily is manipulation of information, or that of a writer or musician or scientists (US House of Representative 1978, 285).

The concept of the computer as informational prosthetic depended on a view of intellectual and creative work as work that "primarily is manipulation of information." This understanding of work was consistent with the postulate that the manipulation of information is the main economic activity in the information society. With the computer as an informational prosthetic the previously handicapped person could take part in her society. Papert's main point in making this statement was to convey to the congressmen that the Education for all Handicapped Children Act passed in 1975, which declared education to be a constitutional right of all children in the United States, including the handicapped, and which mandated that states should provide appropriate education for children of all abilities, had failed to be carried out in a "real human sense" (286). The reason, Papert claimed, was that the law defined what counted as "appropriate education" without taking into consideration the capacity of computer technology to serve as an informational prosthetic. The law made it a constitutional obligation of states to meet the person at the level of their educational needs, however handicapped, but with the informational prosthetic of the computer, *any* person's educational handicap could effectively be eliminated. Papert recommended that the legislation be changed "in order to make what is legal become more matched to what is real." Congressman Scheuer, who had called together the hearing, agreed (US House of Representative 1978, 286). Papert's testimony reflected his vision that the computer could reveal each person's true potential in a way that well-intentioned lawmakers underestimated—revealing all of us to be equally "handicapped" and yet in principle equally able.

Papert shared this vision of the relationship between the personal computer and the mind with other American personal computer advocates and designers, notably Steve Jobs of Apple Computer. In answering an interview question, "What is a personal computer?" Jobs replied that the computer is a tool for amplifying human intelligence. He explained how tools like a bicycle have in the past increased the efficiency of human locomotion in a way that made the human twice as efficient in traversing distances as the most efficient animal, while without the bicycle a human being was significantly less efficient than many animals. The improved efficiency of the person on a bicycle, Jobs said,

> illustrates man's ability as a tool maker. When man created the bicycle, he created a tool that amplified an inherent ability. That's why I like to compare the personal computer to the bicycle. The Apple personal computer is a 21st century bicycle if you will, because it's a tool that can amplify a certain part of our inherent intelligence. There's a special relationship that develops between one person and one computer that ultimately improvise productivity on a personal level" (Jobs 1981).

Jobs' vision of the personal computer as the 21st century tool for amplifying an inherent capacity of the human being (intelligence) was consistent with Papert's. To work as a tool that amplified intelligence, the computer had to be designed in particular ways. According to Papert, not any programming language would be able to perform this function; for Jobs, it was the *Apple* personal computer in particular that was the ideal instrument of intelligence amplification. Both Papert's LOGO and the interface of Jobs' Apple computer shared a commitment to "object-oriented programming" whose theoretical basis was concrete, as opposed to abstract, thinking. In an article describing concrete thinking, Papert and his long-time collaborator Sherry Turkle referred to Apple computer's "iconic style"—its design that features icons as screen objects that users manipulate (as opposed to interacting with IBM personal computers by typing instruction)—as an example of privileging the concrete style of thought (Turkle and Papert 1991). For Papert and Jobs object-oriented programming was what enabled the computer to become like a bicycle—a tool that most people, even children, could quickly learn. Both the hardware and the software artifacts they designed reflected the idea that constructionism is the nature of human learning, and they promoted concrete-thinking through the distribution of these artifacts through computer literacy programs.

Thus, the educational power of Turtle Geometry as conceived by Papert was intended to be much more than just a way to teach mathematics. It was to serve as a 21st century tool of the mind, at once reflecting the mind's structures and amplifying them. The personal computer, supplied with object-oriented programs, was a natural tool in Papert's mind because being a tool-maker was part of the very definition of being human. If, according to Papert and Goldstein, the computer revolution required a revision of the definition of human, then what would this new definition be? If the definition took humans to be "tool-using animals," then how would the "tools of the mind" factor into defintions of human-ness? The history of Papert's work, especially his search for a system of thought to 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 by not only by giving insight into the process of human learning and thinking, but also serving as a way of constructing that mind. The LOGO group's work was designed ultimately to ensure that, by mastering the right language at the right age, humans of the future would be mentally adapted to live with and use computers for their own self-fulfillment and for the good of society.

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 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 believe that general computer literacy would enable France to reclaim its economic and political strength. Despite his different background, concerns, and manner of pursuing public computer literacy, Servan-Schreiber like Papert believed that computers would help to develop the mind of the French citizen, fulfilling that person's sense of self and increasing her contribution to society.

These ideas about computers enhancing people's minds to meet 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 nation's social, political, economic context. It was the idea of people as bearers of certain capabilities of the mind (skills, faculties, knowledge) that serve as resources for themselves 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 et Ressource Humaine* (World Computing and Human Resource Center, CMI). The Center was to introduce people to computers. Instead of developing a children's computer language as a way to influence human cognition, Servan-Schreiber founded the CMI, which, during its brief lifetime would venture to realize the vision of the *la ressource humaine* by bringing together under one roof children, the French public, international computer researchers, and different kinds of computing equipment and software. In this section, I show how Servan-Schreiber planned to transform the human mind with *culture informatique* by tracing the role of the computer in developing *la ressource humaine* from its conceptual origins before the CMI through the Center's active life.

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 under the presidential mandate of forming the French citizen with the computer. In the intervening decades we can see how issues such as colonization and social improvement that concerned Servan-Schreiber served as the foundation for the ways in which he began to think about the role of computers in emancipating individuals in French society and generating social well-being. His vision of the computer-human relationship, in other words, was political to the core, but in a way that reflected a historical moment of crisis for his nation in the world, as he saw it.

Servan-Schreiber began actively to 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 supplement soon became popular enough to take off as an independent publication. It attracted a generation of young executives who had lived through the aftermath of the French Liberation. These readers were dissatisfied with France's embroilment in colonial wars, which they perceived to be of another age; distrustful of ideology, they wished to be governed by skilled, practical individuals (*L'Express* 2006, 2). They shared Servan-Schreiber' conviction that France must grant its colonies independence and so flocked to *L'Express* and to 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 individual minds.

His own experiences in the Algerian war prompted him to think about the plight of colonized peoples. Perhaps as punishment by the government for his strong criticism of the war (2006, 3), 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 in *l'Express,* highlighted how people's opportunities for personal and social growth were limited because of imposition of the colonial power.

In two successive publications, *Le Défi américain* (*The American Challenge*, 1967) and *Le Défi mondial* (*The Global Challenge*, 1980), Servan-Schreiber articulated two ideas that would later find crystallization in his concept of *la ressource humaine*. The first was the need to transform French society through a particular kind of managerial education of its citizens; and the second was how knowledge of computers and computerization were 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 in 1967 organized his experiences, observations, and ideas in an important book titled, *Le Défi américain*.[105] Here, Servan-Schreiber presented the first major elaboration of the concept of *la ressource humaine* (without yet

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[105] The title of Servan-Schreiber' book echoed that of his father, *L'Exèmple américain* (*The American Example,* 1917).

using the term itself) that would influence his ideas for computer literacy as a national agenda for France. *Le Défi américain* argued that the United States was outpacing France not only economically, but, more importantly, in cultural and social terms. Servan-Schreiber describes the "challenge" presented to France by the Unied States 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" (Servan-Schreiber cited in Schlesinger Jr. 1969, xiii). 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 was primarily built upon not "hard" traditional industry and capital, but on a particular kind of "soft" knowledge[106]: the knowledge of effective organization and management. The answer to this challenge, Servan-Schreiber said, lay not in prohibiting of American investment (J.-J. Servan-Schreiber 1967, 30) and, above all, not in nationalizing French industry (42), but in education (80). He advocated reforms in general, technical, and, especially, managerial education in France (81). Servan-Schreiber identified France as lacking a particular aspect of a human resource: the resource for effectively managing business organizations and society, and what was required to regain French 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 (possibly even to this

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[106] Joseph Nye's concept of "soft power," or power that attracts and co-opts rather than coerces, is based on the same distinction (see Nye 1990).

day) and has been translated into fifteen languages. This success, combined with the large and vivacious personality of the author, set him up for direct involvement in the future of French politics.[107]

In 1980, armed with 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 redirected 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 *Défi américain* appeared thirteen years later as a technical challenge in the *Défi mondial*. In the former, the "war" against France was being waged largely with "creative imagination and organizational talent" (Schlesinger Jr. 1969, xiii). The computer was one source of American imagination and organizational talent, but it was not in itself the instrument of the economic and cultural war. By 1980, Servan-Schreiber described American and Japanese superiority in terms of the advanced state of computerization (*informatisation*) of their societies. Their successful computerization was a direct threat to France. Only by mastering *informatique* could France hope to be able to compete with the rest of the world. Servan-Schreiber advised his readers not to resist computerization but instead to embrace its benefits. He presented

[107] 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 prominent role in shaping the European response to the American challenge" (Schlesinger Jr. 1969, 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 the loss (*L'Express* 2006).

the computer as a threat when it was in the hands of the foreigner and a means of defense when it was in one's own. He saw the ability of the population to take advantage of the increasing computerization of society as the key to helping France keep up with the rest of the world (especially with the United States and Japan) in terms of the economy and so be positioned to retain its cultural sovereignty and influence.

By tracing the evolution of Servan-Schreiber's publications, we see how what began as his concern for colonized peoples elsewhere gradually developed into concern about the viability 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 began work on the development of *culture informatique* in France, he articulated another link between colonization and *culture informatique:* being cultured in *informatique* was 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 in this particular type of human resource. His next step was to develop a solution to correct this deficit. His entrepreneurial idea was to make a center in Paris where people could 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 deficit as having political and economic consequences, his solution was to create a space where French citizens and foreign visitors had an open invitation to come to explore the technology in a less structured manner, instead of focusing, for example, 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.

Mitterrand asked Servan-Schreiber to research the possibility of a Center that would focus on mastering *informatique* so as to make of it an instrument of a new kind of economic and social development (Mitterrand 1981). In a public letter, Mitterrand asked Servan-Schreiber to offer recommendations about how to set up such a center, which Mitterrand referred to in a narrower way as a “center of technological observation” (Mitterrand 1981, 20). The president laid out the goals as follows:

- collect information about global developments in micro-electronics for the medium and long-run;
- 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 (20-21).

Under the guise of “technological observation,” which suggested an experimental space for observing citizens' interaction with the computer, Mitterrand, with Servan-Schreiber's encouragement, called in essence for a laboratory for actively forming the citizen with the computer.

In response to Mitterrand's commission, Servan-Schreiber proposed the plan for the *Centre Mondial Informatique et la Ressource Humaine*. Notably, then, the concept of *la ressource humaine* was first crystallized in a formal plan to create a center to introduce computers into society. There was a fundamental tie between the naming of the concept and the proposal for a public computing center to form French citizens' minds with the computer. Servan-Schreiber identified *la ressource humaine* as the primary object for the government to pay attention to and to develop as a top national priority (Jean-Jacques Servan-Schreiber 1981, 4).[108] "This revolutionary science," i.e. computerization, wrote 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 (Jean-Jacques Servan-Schreiber 1981, 23).

In this passage, Servan-Schreiber identified human faculties to be limited and not yet fully achieved. They could only be fully realized, he argued, with the help of the computer. Servan-Schreiber argued that the mastery of *informatique* would bring not only economic advantage to France but also social progress in the guise of newly developed human faculties, specifically towards new kinds of activities and greater creativity (Ibid.).[109] 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, jobs would use the human capacity to "feel, imagine, and communicate." The

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[108] 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.

[109] Ibid,, Servan-Schreiber proposed that with an *informatique* cultured general population the informatization of society could make possible both economic and social progress, while these two had until now been contradictory..

new economy would use these human resources to create new growth, both economic and social.

The concept of *la ressource humaine* was interchangeable in Servan-Schreiber's writings with the idea of "human faculties." This link reveals more about how Servan-Schreiber thought about the human being as resource. It suggests that what was most important in his understanding of the human being was the mind. The specific virtue of computerization for Servan-Schreiber was that it allowed the development of personal faculties: the more it supported the individualization of education, of knowledge acquisition, of action, the better it would enable the use of each person's singular capabilities (J. J. Servan-Schreiber 1980, 393).

The concept of faculties dates back to the *Déclaration des droits de l'homme et du citoyen* and to seventeenth and eighteenth century philosophy.[110] The word "faculty" comes from the Latin *facultat* meaning power, ability, opportunity, and also resources and wealth (OED). The mind's faculties, which included one's will, together with memory, imagination and understanding, were at the same time universal attributes of human nature and personal attributes. The individual was considered the owner of one's faculties. It was the individual who controlled these attributes and could manage them (e.g squander or grow) as one liked. Although the individual possessed the faculties, they were also of interest to the nation-state. Thus, in Servan-Schreiber's vision of *la ressource humaine,* each person is a "resource" for the nation-state.

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[110] For instance, Francis Bacon's classification of the human mind's faculties provided a theoretical basis for Diderot's and d'Alembert's *Encyclopédie* (see Discours préliminaire).

Servan-Schreiber was not alone in thinking and speaking about the person as a resource of the state in the early 1980s. That idea was popularized by Julian Simon in his 1981 book, *The Ultimate Resource*. Simon developed his notion of human resources against the thesis advanced in the famous 1972 report, *Limits to Growth* (Meadows et al. 1974), that exponential population growth would outpace the availability of food and natural resources creating scarcity and global collapse. Instead, Simon claimed that the human being and more specifically human inventiveness and creativity were the "ultimate" inextinguishable resource that would always find ways out of a situation of scarcity, instead generating abundance (J. Simon 1981). Simon's argument crucially depended on the logic of the information society, in which knowledge and information were seen as the individual's and the nation's greatest assets. In contrast to decreasing physical resource, resources of knowledge and information, produced by and residing in the human mind, were everywhere seen to be increasing.

Servan-Schreiber's popularization of the term *ressource humaine* in French invested it with added meaning. The word *ressource* is French in origin, meaning "help or aid" ("Resource," n.d. in Oxford English Dictionary). In French as well as English it is most commonly used to refer to objects such as money, food or tools. Another meaning of *ressource* in French, however, is a personal attribute and capability that can help or sustain a person in adverse circumstances ("Resource," n.d.). The notion of *ressource humaine* as used by Servan-Schreiber combines these two key elements of the etymology and meaning of the term: resource is something that aids (in this case, the state) in a time of difficulty and this helping force is an attribute or capability of a human being.

Servan-Schreiber considered the computer to be the ideal tool for mining the human resource. He believed that a one-on-one relationship with the computer would help realize the natural abilities and talents of each person, thereby making the person both more fulfilled and a more valuable resource to the state. The reason that the computer was uniquely positioned to develop and deploy these faculties in Servan-Schreiber's understanding, was that, unlike other technologies, it was 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" (Rapport to Mitterrand, 24). Servan-Schreiber' conception of the human (found already in his 1967 book, *Le Défi américain*) was of someone who possesses *faculties*, and he conceived of the CMI as a place for the further development and deployment of those human faculties with the computer.

Life of the Center: A "window open onto the human resource"

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

With the personal support of François Mitterrand, Servan-Schreiber opened the Center in a wealthy central 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 be visited by approximately 40,000 people per year. From the outside of the building, the glass façade of the Hall looked like a *vitrine* (display case) of a store. Servan-Schreiber himself described it as "the first window generously open onto the human resource" ("Micro-université informatique: Le Hall du Centre" "Centre Mondial Informatique et Ressource Humaine Informational Folder, presented by Servan-Schreiber to François Mitterrand" 1982, 2). Inside the Hall, all kinds of computers and software were available for people to come experiment and play with. On the second floor was the center for research and development and the offices of CMI's scientific advisors. The social experimental space below was linked to research and experiment with the technology, as well as with "social experiments" to study human interactions with computers organized by the CMI in different regions of France, in the former French colonies, and in developing nations around the world. Thus, the CMI was a model of work on future products as well as a show-floor for experimentation with these products by the curious public.

The CMI was presented by the French and international press, as well as by its participants, as a move towards the realization of the Socialists' goals for *informatique*. It was part of the socialist strategy for adapting the French to the vision of the information society.[111] It was a utopian vision, hoping simultaneously to promote the French computing industry, attract foreign computer scientists to France, stimulate French international economic competitiveness, develop and educate the French population, help to relieve unemployment, and make France the center of research on the social side of

[111] The French newspaper *Le Monde,* in an announcement of the opening of the CMI described it as a way of "accommodating mentalities to an entirely new world" of *informatization,* and described its project of "familiarizing each person, beginning with the young, with the technologies of the future" as a way of "allowing to better regulate the problems of adaptation" to the information society (*Le Monde* 1981).

computing. One article written soon after CMI's opening proclaimed its goal as being to ensure that “knowledge be accessible to everyone, that the thought of the world not be structured one day by computer memory” (J. 1981). The author hoped that the CMI would help to democratize knowledge and free it from technical constraints. The author’s implicit expectation that the CMI would help to make knowledge more “humane” recalled Mitterrand's statement that appropriation of *informatique* by an *autogestionnaire* society would make computers into tools “at the human scale.” By bringing computers “down” to the “human scale” the socialists believed that they would avoid abuses of power that could result from computers being at the “scale” of the corporation or the state.

The Center would achieve this by focusing on developing *la ressource humaine,* which it pursued not by delivering structured learning of computer skills or of programming, but instead by providing a place to *experience* the computer. The Center was never explicitly concerned with computers in education, nor 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 Center’s project to introduce computers into the 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," or the all-permeating *culture informatique*. Although Servan-Schreiber himself never explicitly discussed 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.

The CMI was not so much for learning computers as for "learning how to learn" with the computer. It focused more on the sharpening and improvement of a person's skills 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, an alleged 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" (CMI Informational Folder 1982). Kuan-Tzu's famous statement resonated strongly with Servan-Schreiber's thought. It not only figured on the CMI folder, but also as an epigraph to his 1967 *Le Défi américain*.[112] The quotation summarized how Servan-Schreiber viewed the role of the computer in the development of *la ressource humaine*: learning how to use the computer was supposed to serve the person in a multitude of ways. Servan-Schreiber envisioned the computer to be not a tool for a narrow, pre-defined task, but for open-ended, imaginative development of the mind's faculties. One example that Servan-Schreiber gave of how this happens resembled Papert's thought about computers. Servan-Schreiber contrasted how learning to speak comes naturally to a child while learning to write and read do not.[113] This was not because of the biological structure of the brain, said Servan-Schreiber, but because of a

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[112] It was still present in the 1969 English translation, *The American Challenge,* Atheneum (New York).
[113] Likely, Servan-Schreiber borrowed this view from Papert, whose books he undoubtedly read before inviting him to be the Scientific Director of the CMI.

cultural environment that is not favorable to reading and writing. With the help of the computer, whose keyboard was an essential component, the child would learn to read and write effortlessly (while pursuing another task, interesting and meaningful to her). But learning to read and write was, according to Servan-Schreiber, only a convenient example: by working with the computer the child would foremost "learned-to-learn"—developing a capacity that would serve her for the rest of her life (CMI Informational Folder 1982, 28).

Instead of offering explicit computer training, the CMI provided the visitor, more subtly, the first formative lessons in *culture informatique* by curating in particular ways the initial encounter with the computer. Being exposed to the R&D, being able to test the latest *informatique* developments, being able to have one-on-one use of the computer, were themselves already a kind of education 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 (see Chapter 4 for a more detailed discussion). 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 with the industry and experts through intermediaries such as CMI researchers and Hall staff. This carefully curated technological awareness reflected a fundamental tension in Servan-Schreiber's understanding of the human being as a *resource*, standing between the emancipatory and the subjectifying meanings of this concept.

Servan-Schreiber believed that to successfully develop a person's faculties with the computer required one-on-one interaction between human and computer. This one-to-one ratio was for Servan-Schreiber just as important as, or perhaps even more important than, the software with which one interacted, and this idea influenced the physical arrangement of the center. Servan-Schreiber made 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 (Jean-Jacques Servan-Schreiber 1981, 29).

The idea of the computer as a “personal tool,” customizable to the needs of each person, reflected Servan-Schreiber' understanding of the computer as “personal and universal.”[114] The computer was uniquely able to develop the human faculties because of this apparent universality.

Even though it was based in a central Parisian location, the Center sought to impart to the visitor 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, to serve the socialist goals of the nation, and also to be a *world* initiative. The official goal of the CMI was to be, from its central Parisian

[114] “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 (1981, 29).

location, an *international* ("world") center for computing. In addition to French engineers and computer scientists, the CMI counted in its leadership an Austrian economist and American engineers (most notably, Seymour Papert, Nicholas Negroponte, Alan Kay, Raj Reddy).[115] 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 (see, for example, Servan-Schreiber 1981).

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 the indifference of the developed countries to the plight of the people living in the periphery. The realization of this problem since the 1970s required developed countries like France and the United States to address this problem by starting, at the "planetary scale," a "large [process] of knowledge transfer, of know-well, of know-more"(Mitterrand 1984b). Mitterrand emphasized the idea of knowledge (rather than technology or money) as the essential and valuable resource to such a degree that he even developed two new knowledge-related terms – "know-well" and "know-more" – which positively qualified and embellished knowledge, and which could be activated through the acquisition of *culture informatique*.

Servan-Schreiber and Mitterrand were building upon the global political imaginary derived from the universalisms of Marxist theories of production and

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[115] There was significant fluctuation of membership, particularly from abroad, so all of these people were involved only for a limited time in the CMI.

revolution to develop their own imaginaries of the computer world. For example, Servan-Schreiber stood firmly by Mitterrand's internationalist outlook. 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 (Servan-Schreiber 1981, 31). In his 1980 book *Le Défi mondial,* Servan-Schreiber argued that, without improvement in *la ressource humaine* throughout the world, no improvement could take place in France. The challenge, in his 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 technology transfer: "It is no longer about implanting machines, but about training human beings" (Ibid., 31-2). This international vision shared by Mitterrand and Servan-Schreiber involved making the "Third World" a "partner" in computer research:

> 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' (Ibid., 32).

Mitterrand's and Servan-Schreiber 's ideas about the CMI as well as those expressed in Servan-Schreiber's earlier books described a world in which in order for France to do well other, less developed nations also had to do well. The computer, they imagined, could be the source of the tide that would lift all boats if all people acquired the *culture informatique*. 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.[116] This internationalism attracted foreign scientists to CMI[117] and it sought to create the CMI as an exportable model that could be transferred to other countries to form their own citizens as human resources.[118] The CMI imparted to its visitor the feeling of participating in a global project, suggesting that the mind informed by the computer could become a valuable resource of global applicability.

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[116] In his report to Mitterrand about the CMI, Servan-Schreiber cited 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," which consisted of European (Karl Schiller, Samuel Pisar, Peter Huggler), Japanese (Doko, Nahajima, Iwata), Arab (Ali Khalifa Al Saba, Abdulatif Al Hamad, Zaki Yamani), and African (Leopold Senghor, Hogbe-Nlend) scholars and politicians as well as scientists. Servan-Schreiber brought these leaders together in Paris to discuss a "global" approach to the reality of the world that was "suddenly agglomerated, radically different, and totally submerged by the information revolution" (Servan-Schreiber 1981, 5). The group's focus was to consider together three issues that Servan-Schreiber identified to be inextricably linked but which had up to then been studied and treated separately: "the crisis of the industrial world, the misery of the underdeveloped countries, and the mastery of the scientific revolution" (24).

[117] International participants in the CMI project, such as Seymour Papert, Terry Winograd, Fernando Flores, Nicholas Negroponte, and Alan Kay, were also drawn to the socialist political project of the CMI. For example, in his speech at the opening of the CMI, Papert described his work with computers as devoted to making the computer into an instrument with the help of which people can acquire knowledge in new ways. The main task of working with computers, said Papert, is "no longer only about a science of machines, but about a science that touches on fundamental questions in the human sciences, about epistemology, and about politics" (Papert 1981). This kind of "humanistic," socially-oriented, and allegedly global (emphasized by the fact that the center had "World" in its name) work with computers was, according to Papert, only openly supported by the French socialist government. In an interview with a French newspaper, Libération, Papert described how he had come to realize that research at MIT funded by the United States Defense department "is not neutral." "France," said Papert, "is currently the only country that takes seriously its moral responsibilities [towards its citizens], while the United States in inclined towards conservatism" by the structure of its research-funding and educational system. Papert aligned himself with France, in his interest to use computers for "social progress" (Levy-Willard 1981). Other American researchers that participated in the CMI, such as Stanford computer scientist Terry Winograd, shared Papert's view. In the same Libération interview, Winograd described himself as part of a "technological ghetto" in the United States, "without opening onto the real world." "If I participate in this Parisian center," says Winograd, "it is to advance the research that can serve Senegal as well as India, not just the market or defense in the United States." Winograd was quoted as saying that the American government would never invest in a project like the CMI, preferring to invest in games rather than in socially-beneficial programs such as educational computer programs (Levy-Willard 1981).

[118] Also, important political leaders who visited 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)" (Jean-Jacques Servan-Schreiber 1981, 16).

Despite the importance 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(Mitterrand 1984b, 44).[119] This double responsibility of the CMI towards “each and every man and woman on the planet” and towards “the French people” created a tension on both 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 recalled how during the Revolution French people were able perceptively to capitalize on the revolutionary moment for human advantages (Mitterrand 1984a). The CMI took on the complex identity of being, at one and the same time, for each individual person, a French idea and “project,” and a project in the interests 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 applicable and necessary around the world.

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 (“Centre Mondial Informatique” 1982). Servan-Schreiber saw the “same struggle” for individual freedom and autonomy at stake in the decolonization of Algeria through war and in the decolonization of the French

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[119] The characterization of the CMI as a “French project” was emphasized in the original and echoed by Servan-Schreiber, even as he quit the CMI see his final letter to Mitterrand announcing that he is quitting, titled "Un projet français," (1985).

through computerization. He 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, the presence of the computer *revealed* the extent to which people were "colonized."

This colonization-over-the-self, Servan-Schreiber argued, restricted the French people's autonomy to create their own destiny and to build their own lives and careers. 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 (echoing the rhetoric of the arms-less "war" from *Le Défi américain* and of the "deployment" of faculties from *Le Défi mondial*), led through the acculturation of all the French, and especially of the youth, with *informatique*. 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 was not only socially right, but natural. His idea extended beyond the particular case of France (though he took 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, citizen for example would also need to be technologically decolonized in this way. Servan-Schreiber frequently stated that computerization would only achieve its full potential if it took place together with globalization, or the spread of computerization throughout the world (see, for example, *Le Défi mondial*).

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, suggested, as Servan-Schreiber frequently stated, 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,* a technical culture. Though they used the term *culture informatique* frequently, neither Servan-Schreiber nor Mitterrand ever to my knowledge explicitly defined the term.[120] They omitted any reference to the technicity of the concept when they imagined it as becoming a part of the fabric of daily life.

The idea of *la ressource humaine,* which the CMI project both developed and depended on, posited the human being *of* the computer, whose full potential as at once an

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[120] For an example of Mitterrand's use, see "Une idée fixe," a comment by François Mitterrand, à la réunion des 120 Directeurs des Grandes Écoles (1983).

individual, a universal person “of the world” and a citizen of a specific nationality and culture, could only be reached *with and through* the computer. In fact, the very nature of the computer—the history of its production in specific countries, the relation between the hardware and software that makes it run—came to define *la ressource humaine* in this tripartite way. Yet, the idea of *la ressource humaine* had a life of its own seemingly independent of the computer: it was, after all, about the development of the human faculties that had been in existence since at least the eighteenth century, or about the relationship between the individual citizen and the nation-state.

Servan-Schreiber' concept of *la ressource humaine* provides another answer to the enticing and unresolved puzzle that Papert and Goldstein presented: if the use of computers—tools of the mind—is just as transformative for humans as the tools of the hand had been, which prompted the human being to be defined *relative to* the tool, then what should the new definition of human being be in the computer age? Servan-Schreiber might have answered: 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. The Latin name for this new computer-constituted species of the genus “Homo sapiens” could be *homo versutus*—a combination of adroit (as in skillful with the hands, which suggests both the capacity of making tools as well as the swiftness of fingers on keyboards), versatile (adaptable), and ingenious (clever and original).

Papert was an entrepreneur of the mind who used LOGO to form the minds of children according to an understanding of concrete-thinking and constructionism-advancing technology as natural. Servan-Schreiber on the othere hand saw the natural to be a harmony between self-realization and social contribution. He sought to make each person into an entrepreneur of his or her own mind by gaining access to computers and he believed the state would reap the benefits of these entrepreneurs' ventures in self-realization. Just as an entrepreneur develops her organization by managing and growing the company's resources, Servan-Schreiber hoped that *culture informatique* would allow each person to become an effective manager of his or her own faculties and deploy them in the most effective way, for the benefit of the self, the nation, and the world.

Andrei Ershov

Andrei Petrovich Ershov (1931-1988) was a Russian mathematician and computer scientist who was the strongest proponent of the introduction of the general public to computers in the Soviet Union. He had elaborate visions 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 his stated understanding of human nature and child development, which can be broadly characterized as 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, adopted by Gorbachev's government in 1985, emphasized the development of the human via the mind according to the qualities necessary for algorithmic thinking. Ershov termed computer literacy the "second literacy." This definition of the knowledge of computers as "second" literacy echoed the idea of "second nature," i.e., as something that is not *a priori* given and thus must be learned but which comes easily to a person as a habitus, a form of life. This notion characterizes well Ershov's vision of computers as logical, "natural" extensions of human thought and action.

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." The topic of Ershov's dissertation suggested 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 (Tatarchenko 2013).

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[121]). Unlike the Parisian Centre Mondial Informatique, whose

[121] That the Computer Center was formerly part of the Institute of Mathematics is mentioned by Ershov in (Ershov 1966, 18). 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.

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 development of programming languages mainly for quantitative applications.[122] 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 automated.[123] Ershov's early work on simplifying and making more interesting the work of the human-programmer in relation to the computer was an experience that informed his later work with the introduction of computing in schools. His 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 was "programmed learning," was neither a technically-feasible nor desirable path for the role of the computer in education. Instead, he found it much more promising and interesting to pursue the teaching of algorithmic thinking (supported by programming

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[122] 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 4, 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.

[123] Ershov's authority in research on automatic programming was recognized around the world. Ershov published an early book on automatic programming titled, *The programming program for the electronic calculating machine BESM*, which 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, 30. Also David Parnas on history of automatic programming, e.g. D. L. Parnas. "Software Aspects of Strategic Defense Systems." American Scientist. November 1985.

skills) to children, and to apply the informational management capacities of the computer towards creating and transferring pedagogical knowledge throughout the USSR.

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 the population would require to derive from computers the social utility that the machines were imagined to bring. 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.[124] Because of his concern for the future of programming and his personal experience with the training of programmers, Ershov was asked by the Soviet government in March 1970 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 United States in both the production of electronic calculating machines and the training of professional programmers to supply these machines with programs required for them to be useful to society.[125] Social utility, in the Soviet case, was defined in terms of direct application of programs to agricultural, industrial, and managerial tasks.[126] In this brief report, Ershov 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

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[124] In 1970 only seven to eight universities in the Soviet Union trained programmers (Ershov 1970).
[125] 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" (Ershov 1970, 1). The consequence of this calculus was that the “software crisis” was felt even more strongly in the Soviet Union than in the United States.
[126] This definition of social utility is markedly different from the one that Jean-Jacques Servan-Schreiber considered.

that could train students and qualitative innovation in the way that programmers were 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) (Ibid., 2). 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 United States, that he became seriously interested in—and convinced of the feasibility of—computer education more generally.

Algorithmic thinking

One of the stops on Ershov's work visit to the United States in October and November 1970 was the Massachusetts Institute of Technology. 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 cited 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 (Ershov 1972, 505). 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 work of programmers and the programmer's role in society could be amplified to the scale of 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 (Ershov 1972). He drew a parallel between the role of programmers in computing to the role of authors and printers in printing:

> 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 the world's evolution, giving us in this way an unheard of power over nature (Ershov 1972, 504).[127]

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 (Ershov 1972, 504).

In addition to being talented in these diverse, sometimes even contradictory ways (accuracy of a bank clerk and fantasy of a detective author), the programmer had to

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[127] Ershov’s suggestion that computers could be used to predict future scenarios is reminiscent of the kind of knowledge that students were taught by using computer simulations, especially prevalent in France, and is related to teaching 'future-thinking' that some (particularly American) cultural analysts in the 1970s thought was a crucial skill of the person of the information age.

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 to hve extraordinary mental capacity and to work at the "limits of human knowledge" (Ibid.) Encouraged by his meeting with Papert 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 order to produce professional computer programmers as well as a general population of algorithmically thinking people.

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. Ershov wrote of that 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 (Ershov 1972, 505).[128]

Ershov's interpretation of Papert's and Minsky's contribution is interesting because of what it revealed about Ershov's own understanding of human learning, despite drawing seemingly incorrect conclusions about Papert and Minsky's work. Minsky and Papert did not intend to overthrow the role of imitation in learning. In fact, imitation played an

[128] 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. They appear in the uploaded copy of the "Aesthetics and the Human Factor in Programming" 1972 in the Andrei P. Ershov Archive (see Ershov 1972 reference for location in archive).

important part in Papert's pedagogical approach, as evidenced by his efforts to create collaborative learning environments where children were encouraged to interact and draw analogies in thought and movement not only among themselves but also in relation to a robot. Papert and Minsky's work also did not prove that people learn by organizing thought into flow charts. Papert inherited from Piaget the idea that scientific causality, required for such formal tasks as organizing thought into flow charts, is not innate, but constructed little by little through the constructive adaptation of the mind to reality (Piaget 1927; Piaget 1950; Piaget 1970). Ershov's interpretation of Papert and Minsky's work reveals that *for him* algorithmic thinking was a necessary component, even prerequisite, of all learning.[129] The changes that Ershov made to the passage reveal that, originally, he believed that Papert and Minsky warranted an even more technical, computer inspired, vocabulary ("flow chart," "subroutines") to describe the learning process. Despite the differences between Ershov's interpretation of Papert and Minsky's work and how they themselves would have described it, Ershov believed that he had found in Papert and Minksy proof that algorithmic thinking was a full-fledged epistemological theory. This served for Ershov as validation of his value of algorithmic thinking.

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

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[129] In his article on Ershov, Afinogenov described Ershov's personal preoccupation with organizing information, which he also demanded of his colleagues. Ershov logged the date, time, and hour, and place of articles and article drafts and expected that his colleagues do the same (Afinogenov 2013, 565, citing Iu. A. Pervin, "Ershov I Slovo," in Andrei Petrovich Erhov: Uchenyi I chelovek, ed. A. G. Marchuk (Novosibirsk: Rossiiskaia akademiia nauk, Sibirskoe otdelenie, 2006),.These practices may account for Ershov's ideas that organizing and carefully recording information were important to all people's learning and research and also explain the existence of the extensive archive of all of his activities used by many scholars today to tell the histories of Soviet computing and society.

the capacity for thinking 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 (Ershov 1972, 505).

Ershov claimed that learning to program would improve one's intellect. This claim was 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" (Ershov 1972, 504). After his encounter with Papert, Ershov believed that everyone's intellect could 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 could 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 as a means of advancing the normative goal of creating a society of algorithmically thinking people, whom he thought to be fuller human beings and better members of the collective.

Ershov's goal of educating 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

Khrushchev, in conjunction with the goal of “accelerating scientific-technical progress” (“XXII S’ezd Kommunisticheskoi Partii Sovetskogo Soiuza: Stenograficheskii Otchet” 1962, 282). The project of forming this mythical citizen of the Soviet Union, whose role would be to usher in the “creative transformation of the world” (Vaiil’ and Genis 1998, 13), went hand in hand with the project of technoscientific development. The specific qualities of the new person were not spelled out by Khrushchev, leaving the details of forming this new human for others to imagine and pursue. Nevertheless, the announcement recognized explicitly for the first time that the formation of the human being was one of the three principal sites (alongside building the material-technical base and creating new relations of production) of the construction of communism (Ibid., 14). 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 forces that were both bodily (e.g., medical practices and body disciplines) and social (education, social relations and responsibilities) (Ibid.). Ershov's experiments with educating people in the Soviet Union with and through the computer coincided with and indirectly supported this national project.

“School Informatics”: Algorithmic thinking for all

In 1979, Ershov and his colleagues Gennadii Zvenigorodskii and Urii Pervin published a treatise where they laid out their vision for children's education with the computer called, “School Informatics: Conceptions, current state, perspectives.” They defined *informatika* (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 stood for *elektronnaiia vysheslitel'naiia mashina*, or computer, for short]" (Ershov, Zvenigorodskii, and Pervin 1979, 4). Learning *informatika,* according to the authors, was a matter of developing the algorithmic style of thought. Ershov later described this book as a "manifesto" motivated by the authors' years of study of children's interaction with computers and expounding their vision that all people in the Soviet Union needed to develop algorithmic thinking and that all were capable of developing it. "All of the above-mentioned habits and skills [that define algorithmic thinking] have a general cultural, educational, and human value," they wrote, "and are necessary for almost every human being in the contemporary world, independent of his level of education or profession. This is why these habits and skills need to be formed as part of general education (13). In the late 1970s, when they penned this manifesto, the authors' vision was radical because very few people outside of the professional programming community had contact with a computer in the Soviet Union, and so few had a practical need for algorithmic thinking. In part anticipating the reality their visions would encounter, the authors argued for the general utility of algorithmic thinking in Soviet society.

The authors proposed to embed the teaching of this new science of *informatika* in general education, beginning as early as possible, but no later than ninth and tenth grades (the equivalent of the last two years of high school in the United States). Children would be taught a specially adapted branch of the science called "school informatics" (5). When the authors elaborated upon the different aspects (technical, pedagogical/methodological, and organizational) of the introduction of "school informatics," they revealed that for them it was less about teaching programming than it was about helping students to develop a thought style most commonly found among programmers—algorithmic thinking. The authors believed that this thought style, also described as "specific habits [*navyki*] of mental processes," was essential for everyone in the Soviet Union to learn, be they programmers (creators of software) or users of software (9).

As defined by the authors, algorithmic thinking involved:

- the ability to plan out the structure of an action,
- the ability to understand and to build informational structures to describe objects and systems,
- the ability to organize the search for information so as to solve a given problem,
- the ability to clearly and correctly formulate one's thoughts in writing (i.e. writing instructions to a computer),
- the habit of using the computer at the right time to solve problems of any kind, and
- mastery of technical skills to interact with the computer (e.g. typing) (9-12).

In defining the abilities that comprised algorithmic thinking, Ershov and his colleagues put in last place the possession of "hard skills" such as typing. Instead, this style of thought was dominated by disciplining one's thought in approaching problems and proceeding to solve them, and training the habit of using the computer for such problem-solving. In Ershov's, Zvenigorodskii's, and Pervin'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 acting in the world.

Learning to think algorithmically was for Ershov and his colleagues indispensable for life in the contemporary information society as interpreted by the Soviets. Preventing the explosion of the metaphorical information volcano (Petrovich 1973) meant training in people a rigorous capacity for efficiently processing information; and the model for this ability was the computer and the programmer who had a symbiotic relationship with the machine (Zvenigorodskii 1985). Furthermore, one could imagine that algorithmic thinking could be the style of thought of the Soviet Man—that mythical new person whose being was forged together with the Soviet admiration (and hope) for science and technology as aids to society—and whose action-oriented and industrious qualities algorithmic thinking purported to develop.

The approach that Ershov and his colleagues proposed to use to 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 was that these languages contained too much technical detail that would distract the student from the holistic aspects of algorithmic thinking (21). On the opposite extreme, trying to teach school informatics without programming was, in their eyes, the better approach of the two because it could 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 (22). They considered programming an actual computer to be important to develop sound algorithmic thinking, but the programming had to 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. The ideal programming language for instruction, they wrote, should reflect all of the main programming concepts and 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 from natural language so as to clearly signify to the student that this was a special language. The structure of the educational language needed to be able to interface methodologically 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 it 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 (24-25).

A comparison of Ershov and his colleagues' requirements for an educational programming language with those of the BBN group that produced 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, agreed that the language should present these concepts with, as the BBN group put it, “minimal interference from programming conventions” (Feurzeig 2011, 291). 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” (Ershov, Zvenigorodskii, and Pervin 1979, 14)[130] Ershov and his colleagues 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 public with the computer, in the course of inserting the language into the practice of education, both groups moved away from disciplinary concerns towards developing in children a more general “feeling for” the computer.

[130] Ershov and colleagues explained that no single subject—including mathematics--contained enough of a developed conceptual tool kit to communicate the algorithmic thinking ideas, habits, and skills. They cited the work of Vadim M. Monakhov et al., “The formation of algorithmic culture of a school child throught the process of teaching mathematics,” Moscow: Prosveshenie,1978 (Формирование алгоритмийеской культуры школьника при обучении математике. Пособие для учителей) . Authors of that work 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, Zvenigorodskii, and Pervn 1979, 13-14).

Despite these similarities, even despite the fact that Ershov took Papert and Minsky's work as a foundation for his own conviction in the capacity of children to learn algorithmic thinking, what being computer literate meant to Ershov and Papert was different to the extent of seeming contradictory. For Papert, the computer naturalized learning by offering opportunities for concrete thinking, while for Ershov learning algorithmic thinking formalized an apparently innate human inclination to think in a programmed way. It is as if each of the pioneers was dealing with a different mind and a different computer. And this is actually true, for each of the pioneer's ideas of the mind were influenced by his culture and personal history. The computer as "tool" of *that* particular mind took on for each a different shape (i.e., the type of programming language used to interact with the computer) and mission.

Enhancing the natural capacities of the mind

Seymour Papert, Jean-Jacques Servan-Schreiber and Andrei Ershov each in his own way influenced how the computer came to be seen as a "tool of the mind" and was sued to form the minds of children and the general public. Despite differences in their intellectual backgrounds, the stakes and goals of their work, and the socio-cultural contexts in which they lived, all three entrepreneurs of the mind shared the vision that by developing the mind with the computer they could enhance the natural qualities of human thought. Papert, Servan-Schreiber, and Ershov, respectively, identified concrete thinking, "resourcefulness" of human faculties, and algorithmic thinking as innately human qualities—at once specifically national and universal.

These qualities of the mind characterized the human subject at once as a national of one specific country *and* as a universal representative of the "tool using animal" species. Such a person could be extended and developed by becoming computer literate in the diverse ways that these pioneers envisioned. Papert envisioned the personal computer, whose design was informed by constructionism, as a tool for amplifying the human intellect in ways that existing social institutions, such as schools, were incapable of doing. Servan-Schreiber saw the personal computer as the ideal tool for simultaneously maximizing each person's sense of fulfillment and social productivity, thereby ultimately becoming a resource for self, nation, and world. Ershov envisioned that teaching each person to model his or her thought processes on the computer algorithm would result in a more efficient and productive society.

Each pioneer's idea of the relationship between the human mind and the computer emerged in the context of understanding the information society and evolved during the course of his work on the computer literacy programs. This account suggests that the understanding of human as concrete thinking, resourceful, and programming was a result of active work with the computer. The use of the computer to study the processes of learning and thinking, not surprisingly, revealed how apt the computer could be as a tool for extending, more in the sense of externalizing[131] than enhancing, the functions of the mind. The analogy between the mind and the computer became more solidified as a result of the development of computer literacy programs for the general public, that is, by studying processes of learning with and through the computer.

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[131] See, for example, Ernst Kapp's and André Leroi-Gourhan's definition of technology as externalization of human organs.

The mind, however, was not the only site for the computer's work on the human being. In the following chapter I examine how the sociotechnical imaginaries of the computer literate person were embedded in actual technologies, experimental educational curricula and spaces. Through these embeddings, the computer came to constitute not just children’s minds but also their bodies and actions.

Chapter 4:
Experiments in Play

A reporter asks a little girl, about 9 years old: "Are you afraid of working on the computer?"

"No," she answers distractedly and continues to type something on a keyboard, parachuting with her thin index finger over each letter before gently pressing it and pausing to look up at the screen to see if the letter actually appears there.

“Is it a carnivore?” appears on the screen.

“Yes,” types the girl. She's playing a guessing game with the computer. She has an animal in mind and the computer has to discover what this animal is by posing questions to which she must respond "Yes" or "No."

Computer: Is it a domestic animal?

Girl: Yes.

Computer: Is it a dog?

Girl: No.

She had in mind a cat. Polite and always eager to learn though being defeated, the computer asks the girl to please teach it a question that it might use next time to guess correctly. The girl types: “Does it meow?” Satisfied, the computer thanks her for the lesson and asks if she wants to play again.

This scene, shown on national French television, was filmed at the *Salon des industries et du commerce de bureau* (SICOB) exposition in 1970. What had been since its founding in 1950 an expo for French professionals to discuss the latest computer technologies, became in 1970 also a place for child's play.

Children and computer games were welcomed at SICOB for the first time in 1970 because of a new interest in the use of computers to form people knowledgeable in *informatique*. The computer game that the girl played was not intended just for fun; it masked a lesson in computational thinking. As its inventor described to the reporter, this game was designed as "initiation to *informatique*" ("Les Ordinateurs et Les Enfants" 1970). It was intended to build a particular kind of "intellectual rigor" that the designer thought was the "fundamental element to prepare children for their future life in which they would have constant relations with the computer" (Ibid.) "Intellectual rigor" translated, in this game, into the capacity to formulate very precise questions and answers. Precision was simultaneously determined technically—by what the computer accepted as valid inputs, which were only "yes" or "no" answers or a "yes or no type" question—and by the engineer's prior idea that this is what it means to be precise. Playing the game was intended to give the child practice in the computer's "mode of reasoning," a form of thought referred to as "computational thinking," that the game's designer praised as not only the correct (the only!) way to interact with the computer, but also as a virtue in human interactions more generally. The child at SICOB was the subject of the computer game that was supposed to teach her a lesson, or teach her to think like it. She was also an experimental subject, in an experiment designed by the engineer and the national *informatique* programs that determined children should be prepared in this particular way for a future life with computers. It is under these strict and serious conditions that children and games were admitted to SICOB.

Yet, the episode also shows how the child was more than a passive subject learning the computer's mode of reasoning. She seemed to possess some mysterious capacity for interacting with the computer that the engineer—and the public watching the episode on television—found inspiring and wanted for themselves. The girl appeared to have escaped the frame of the narrow lesson constructed for her by the engineer.[132] When she had finished playing the game, the reporter asked her a question:

"Did this teach you something?" the reporter asked.

"Yes," replied the girl obediently.

"Are you sure?"

"Above all, I taught it!" The girl responded, revealing how she truly felt about her interaction with the machine. In her reply the girl demonstrated the fearlessness that she had displayed at the start of the game. She showed how even in a game designed didactically for her to learn the computer's "mode of reasoning," a mode of reasoning deemed important for her future, in a game designed so narrowly that she could only express herself with "yes" or "no" when prompted by the computer, she felt in fact like *she* was the one in control of the learning. Instead of learning from the machine, she had *taught* it.

Children were at once subjects and objects of the French "social experiment" of introducing *informatique* into daily life and forming people with it. The subject role was foregrounded when a reporter remarked on the girl's fearless attitude towards the computer with apparent awe and reverence. "If we [adults] are a little frightened by the possibilities of computers, they captivate our children," he said (“Les Ordinateurs et Les

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[132] Research on children’s interactions with technological artifacts has documented how children “intervene, bypass, and even subvert the discourses and design limitations they encounter in their interactions with technological artifacts” (Grimes 2015, 99). See, for example, Plowman (2004) on how children play with a “smart toy” switched off in order to circumvent its limited functionality. While studying childrens’ use of the photo camera, Jacques Perriault also observed the numerous ways in which children transform and appropriate technologies for their needs (Perriault 1989).

Enfants" 1970). This attitude was the foundation of what the reporter described as the difference between adults and children in front of the computer. The girl's observation that she had taught the computer instead of merely learning from it was not taboo even at a professional and didactic place like SICOB. Rather, it was a demonstration of respect for children and their special relationship to computers that adults were seen to be incapable of.[133] The adults watching the scene applauded the girl's ability to stand the lesson on its head or to "flip," in contemporary jargon, the relationship between teacher and tutee.

In this sense, the girl's interaction with the computer was also an *object* of study for French society. The computer itself, which had learned from the girl, the engineer, the Ministry of Education, which eagerly looked to children to understand their use of computers, and the French public who watched the experiment at SICOB on their television screens -- all were interested in the ease and apparent fearlessness with which this child interacted with the computer.

In this chapter, I analyze how the pioneers of computer literacy and culture in the United States, France, and the Soviet Union went about realizing their visions of making children computer literate by designing experiments with children and computers. The experiments that I investigate include the Brookline LOGO Project in the United States, activities of the *Centre Mondial Informatique* and its Belle de Mai project in France, and the All-Soviet summer school for young programmers organized at the Novosibirsk

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[133] This interest in children's allegedly special relationship to computers is reminiscent of contemporary discussions and studies of children as "digital natives"—children born into autochthonous relationships with computers and the Internet.

Computing Center in the Soviet Union. All three were crucial sites of learning, both for the children being taught and for the pioneers.

The term "experiment" was used to describe all three of these projects. Seymour Papert spoke extensively about the experimental nature of introducing LOGO in American schools (Papert 1980). Jean-Jacques Servan-Schreiber described the introduction of computers into the Belle de Mai neighborhood of Marseille as a "social experiment" (Servan-Schreiber 1983; "Centre Mondial Informatique et Ressource Humaine Informational Folder, presented by Servan-Schreiber to François Mitterrand" 1982, 1; Chappaz and Vignaux 1983b, 2). Andrei Ershov in the Soviet Union described the use of computers in education as an "experiment in the construction of a new society" (Ershov in *Igra S Komp'iuterom* 1986). By calling their projects experiments, the pioneers not only drew attention to the novel and uncharted nature of their undertakings, but also signaled their interest in learning about the *society of human beings and computers together* through their projects.

No two experiments are alike, especially when they are experiments with and about society. The constitutional norms that I identified in the previous chapters to have shaped and been shaped by the visions of what it meant to be computer literate or fluent and to have *culture informatique* or "second literacy" also informed the designs of the experiments under investigation in this chapter. For example, the study of human reasoning was an explicit element of Papert's experiment, which involved teachers working alongside psychologists. In contrast to Papert's and his colleagues' interest in psychological effects of computing, Servan-Schreiber explicitly used the term "social experiment" to describe his projects, thus privileging an interest in the more macro effects of computing on the communal lives of populations. Meanwhile, understanding the human was an indirect, yet key, byproduct of Ershov's experiment, which from the start was allegedly about seeing how the computer could be helpful in "constructing a new society."

As noted, all of these "experiments" were projects in which the child was both the subject and object of the experiment. The child whose behavior and nature came under investigation during the experiment was also the one who was supposed to learn through the experiment.[134] In a computer literacy or culture experiment, the computer and the pedagogical program in which it was embedded were both the instrument for teaching children (like a textbook) and for learning about and from children (like a metaphorical microscope). As subjects of the experiment, children were taught particular procedures to use with computers, ways of thinking and ways of using their bodies in relation to computers that the experiment designers believed would lead them to the development of computer literacy or computer culture. As objects of the experiment, children were seen to have something to teach the experiment designers about human beings and the nature of human interaction with computers. Moreover, children were a source of knowledge about how to build the "right" kinds of computers to facilitate children's' seemingly innate capacity for interacting with the machines.[135]

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[134] This use of computers in education to study human nature was present before computer literacy programs. For example, American pioneer of computer assisted instruction, Patrick Suppes explained how "one of my own strong motivations for becoming involved in computer-assisted instruction was the opportunity it presented of studying subject-matter learning in the schools under conditions approximating those that we ordinarily expect in a psychological laboratory." (Suppes 1978a, 34).
[135] In "The Situation' in the Cold War Behavioral Sciences," Rebecca Lemov describes how human sciences researchers in 1950s United States set up carefully controlled experimental environments that they called "situations" in which they believed that they could observe the natural behavior of their research subjects (2013). To the extent that the experiments in computer literacy and culture that I discuss in this

Different ideas about the relationship between the human being and the technical artifact, as well as different access to technology, can help to account for variations in the centrality of the computer itself within the experiments. For example, physically introducing the computer as a novel artifact into a human community, be it a school or a city neighborhood, was a key move in the American and French experiments, while the computer was rarely present in the Soviet programming experiments and, for much of the experiment, remained an imagined entity.

Despite these differences in experimental design, all three of the cases attributed an important role to games and free play with the computer. For example, although not strictly a computer game, LOGO-based Turtle Geometry used in the Brookline experiment was designed to engage the child in playful activity as a way of teaching her programming and mathematical ways of thinking. In France, computer games such as the guessing game played at SICOB[136] as well as LOGO-based games were available at

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chapter were also interested in observing the "natural" interaction between children and the computer, they can also be considered types of "situations." However, there are important differences between the 1950s situations and these experiments around the world in the 1970s and 1980s. For example, in the computer literacy experiments, the pioneers were particularly interested in the people's interaction with the technology (rather than using technology to study the supposedly purely human behavior, such as interaction of people in small groups). Also, although some experiments in computer literacy took place in specially created laboratories (e.g. the MIT Learning Lab, or the first floor of the CMI), the majority of the experimentation occurred in settings like schools and city neighborhoods, which could not or should not (for the purposes of the experiment) be as tightly controlled as the specially-engineered "situation." These differences suggest an evolution of the means of studying human behavior from the 1950s situation of American social scientists to the 1970s and 1980s experimental research on human subjects. This evolution has been described by Jamie Cohen-Cole in (2014) and by Marcia Holmes (2014). See also Lemov's forthcoming book, *Database of Dreams,* for a look at how experimentation on human subjects gathered momentum in the 1970s as the laboratory became the class, the field, the village, and the city (Lemov 2015).

[136] The guessing game played by the girl at SICOB was developed using the computer language AESOP, an "early interactive query system" created in 1967 for the IBM 1800 computer ("Programming Languages Database" 2015). The game was database-based and used a non-graphical interface and thus had a textual basis. It was a game that did not require the computer to play it and the lessons of the particular style of rigorous thinking that it sought to teach could be learned just as well by playing the game with another person and using paper and pencil. A number of games used in the social experiments described in this

the CMI and in the various public venues in Belle de Mai for children and the general public to use freely. In the Soviet Union, the first textbooks to teach programming to young children developed by Ershov and his team used game-like activities to introduce the child to the basics of communicating with the computer. Ershov's team also viewed the summer camp—a place of immersive learning through a combination of serious activity and fun—as the ideal venue for learning the second literacy.

In all three national cases, researchers encouraged “free play” with computers as part of the experiments. "Free," in the sense of unstructured use of the computer, was frequently related to "playing" with computers or using them for no particular instrumental purpose. Play was an important element of the design of the experiments so that they might serve the dual purpose of teaching ways of interacting with computers *and* allowing observers to learn from children’s seemingly unmediated interaction with them (i.e., what children might do with the computers if merely left alone with them). Of course, interaction with the computer was rarely fully unstructured, as choices of what software and hardware to make available and how to control access to the machines (e.g., how many computers there should be, where to put them physically) determined what "free play" with the computer meant in practice.

Despite the challenge of creating an unstructured interaction between human and computer, the researchers’ *wish* to do so, repeatedly reaffirmed by findings during the course of the experiments that play was necessary for the goal of creating computer literate or cultured citizens, is itself significant. Not only was the game instrumental for

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chapter had this quality. For other games, the computer was essential. I identify the centrality of the computer for playing games used in the experiments--and the centrality of the computer for the experiment as a whole--to be one important dimension for comparing the experiments across the three national cases.

teaching computer skills in an engaging way, but the immersive environment of the game was considered ideal for unlocking the potential of each person. Papert and Ershov believed that while engaged in playing a game with the computer the players could learn about their own modes of reasoning vis-à-vis the machine (significantly, these two pioneering educators explained the mechanism by which self-learning would take place through the game in different ways).

For each experiment I examine in this chapter, three elements emerge as specially important from the comparative research:

1) the organization of the experiment to simultaneously bring about a particular vision of computer literacy, *culture informatique,* or second literacy and to study the child as object of the experiment;

2) the role and type of computer hardware and software used in the experiment;

3) the meaning and use of ideas of game and play in the experiment.

Attention to the role of play in the experiments to form computer literate or cultured citizens reveals lines of ambiguity in what play actually meant in these programs. The original impetus in all three countries to begin with children in forming computer literate and cultured citizens derived from thinking that children do not have the mental limits of adult minds that might inhibit learning, thinking, and being with computers. Starting with children also meant starting with play, because play was understood to be the quintessential activity of the child. The pioneers took children as "players" with the computer as objects of study because of their seemingly natural capacity to interact freely with the machine, with ease and lack of fear. The game involved the children in seemingly self-directed activity in which their interaction with computers could be thought to mirror their natural interests. In this sense, play with the computer was just one more type of computer use.

Yet, in the course of developing their computer literacy and culture programs the pioneers stressed two other aspects of play: interactivity and freedom of interpretation. The organizers of the experiments considered playing games with the computer to be not only a means of teaching computer literacy, but also as the ideal form of engagement with computers. The child as player was also a model for what they hoped the computer literate person would eventually be: capable of freely using the computer for tasks that could not necessarily be foreseen rather than a passive "user" of ready-made software and hardware. Freedom, however, made sense only within some envelope of constraints. By encouraging children and adults to play with computers, the pioneers showed that they valued and sought to encourage “free” action only within limits set by the rules of the game—a structured range of freedom that French sociologist Roger Caillois define as an essential attribute of play (Caillois 1958). This notion of freedom of interpretation or action is what gives meaning to the term “play” in such uses as the *playing* of a specific performer (that performer’s personal style used in interpreting a work) or the *play* of a gear (the range of permissive movement of a machine part)[137] (Caillois 1958, 8). Becoming computer literate or cultured, I argue, meant entering into what I call “interplay,” or playful interaction, with the computer. Interplay with a computer is an interaction in which both sides (the person and the computer) mutually influence one

[137] It is particularly fitting that Caillois uses the example of the gear to describe this sense of play as freedom, because this is precisely the quality of differential gears that so attracted Papert in his childhood and became, as he acknowledged himself, immensely formative for his work on computers in education.

another and it is a relationship characterized by play (as opposed to use) with space allowed for freedom of interpretation.

These experiments show that for the pioneers of computer literacy and culture, playing was not just a form of use[138] but a distinct manner of relating to the technology. Papert's, Servan-Schreiber's and Ershov's experiments to form computer literate or cultured people as players, as opposed to mere instrumental users of the computer, had, I argue, large consequences for the constitution of the human in a computerized world.[139] Interplay with the computer took place in new, experimental and relatively unscripted spaces where people and machines could come together to write anew the rules of the game that would come to define both humans and computers. Such interplay facilitated teaching children as subjects and studying them as objects, while serving to build the ideal relationship between computers and people.

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[138] In her analysis of the way in which playing computer games configures the child, Sara Grimes relies upon the STS framework of "configuring the user" advanced by Akrich (1992), Oudshoorn, Rommes, and Stienstra (2004), and van Oost (2005). Work in this framework considers how technologies are preconfigured in the semiotic sense as designers formulate ideas about the potential future (often idealized) users of their designs (Akrich 1992). Although she is interested in the effects of playing and engagement with computer games, Grimes still works with the conception of the child as a *user.*

[139] Anthropological studies of play generally, such the work of Roger Caillois, and of play with technology in particular, such as Natasha Dow-Schüll (2012), have come to similar conclusions about the uniqueness of the play relation. For Caillois, one of the definitions of play was that it was not a utilitarian activity, and therefore should not be confused with use. Dow-Schüll showed how people who participated in machine gambling did so not for any utilitarian function of winning money, but for the experience and mode of being of self-equilibration with technology, which is more a mode of being in the world with the technology than a mere use of the technology.

United States

> *"When fourth-grade teacher [at the Lamplighter School in Dallas, TX] showed her class how to use the [LOGO] turtle, she thought the students would spend several days drawing lines, rectangles and triangles. After a week of linear explorations, Ms. Leventhal thought her students might then begin to ask about drawing curves or circles. But in the first five minutes someone asked, "Can it draw a circle?" The entire class jumped on the question. Ms. Leventhal told them to try to answer the question themselves. One student stood in the middle of the group while the others tried to find a way to instruct him, one step at a time, to walk in a circle. They quickly agreed the instructions should follow the pattern: one step forward, turn a little to the right; take another step forward, make another small turn to the right, and so on.*
>
> *The only remaining question was, how many times this had to be repeated to produce a complete circle. One student said, 'Oh, lots of times. About a hundred.' Another answered, 'Not a hundred, 360. It takes 360 degrees to make a circle.' They had solved the problem. When they told the turtle to repeat the 'forward one, right one' instructions 360 times, it drew a circle.*
>
> *The class, working together, accomplished in less than one afternoon what Ms. Leventhal thought would take up to two weeks. The phenomenon is so common in Logo settings that it has been named 'blowing the curriculum'"* (Nelson 1981, 16).

This description of a scene of 10-year old children's first interaction with the LOGO programming language and Turtle capture some of the key aspects of a successful interaction with LOGO. Children work together and independently of the teacher; they use their bodies to "play" Turtle in order to develop the strategy for programming it; children make guesses and correct them before accomplishing their goal; in doing so, they "blow the curriculum," or demonstrate how what they are interested in and what they are capable of cannot be adequately addressed by a pre-planned educational program.

Like the game played by the girl at SICOB in France, the game children played with one another and with LOGO in a Texas classroom had also been designed to teach them a new, computer-facilitated way of thinking and reasoning. In both games the children "taught" the computer, but the games and the desired way of thinking that they was supposed to build were markedly different. For instance, the guessing game had a right answer that the computer was trying to converge on. The LOGO game, in contrast, was open-ended: the child could set his or her own goals of the shape to draw. The guessing game was intended to teach the child precision and rigor defined as the ability to pose and answer "yes or no" questions while the LOGO game was designed to teach them how to rely upon their own knowledge and experience to think through a problem. These differences were not accidental, but reflected distinct visions of what it meant to be computer literate and how to achieve this literacy through a combination of technology and pedagogical approach.

Below, I describe in detail the Brookline LOGO project which Papert and his MIT colleagues carried out during the 1977-1978 school year. They launched this project to explore the capacity of the computer to support children's learning and to use the children's interaction with computers to learn about human psychology.

LOGO experiments with learning and learners

Papert and his colleagues frequently described their work with LOGO in schools as "experimental." In fact, they described their entire research program from 1973 onwards as "experimental," whose "output *is* intended to be a set of experimental findings" (Papert and Goldstein 1976, 12 original emphasis). They distinguished this period of experimental-pedagogical work from the three preceding years (they had received National Science Foundation support for their work in both cases, with each increment of work being for three years) as the time when they were developing the technologies and building the concepts to use in the experiments. "During this next three year period, we propose to shift this emphasis," Ira Goldstein, MIT professor of computer science, and Papert wrote, "New conceptual and technological development will continue. But the conduct of well-planned and rigorously controlled experiments will become a central focus" (Ibid., 12). By describing their project as "experimental," Papert and Goldstein sought to draw attention not only to its newness, but also to the way in which their experimental designed used the "computational approach" to yield insights into human psychology.

Even before the Brookline LOGO experiment got underway, the central project of research with LOGO for Papert was to reconceive the relationship between knowledge, computation, and the learner. The first NSF grant for LOGO research explored the possibility of using "programming languages as a conceptual framework for teaching mathematics" (Feurzeig and Papert 1968). This interest emerged from the Bolt Beranek and Newman (BBN) research project led by Wallace Feurzeig, researcher in artificial intelligence. In 1965 Feurzeig led a team of researchers as part of the Educational Technology Department at BBN away from researching how to use computers as tutors in mathematics (the computer assisted instruction, or CAI, approach) to using computers to teach ways of thinking that would be useful for mathematical reasoning (the "literacy" approach). This change of approach, which led to the creation of LOGO as a programming language and "conceptual tool for the student" (Papert and Goldstein 1976, 21), itself already contained the dual goal of teaching ways of thinking and learning and learning about the processes of thinking and learning. The goal of the LOGO projects from their very beginning was to use the new tools of the computer to experiment with the relationship of knowledge to the human being. The projects required "reformulating traditional knowledge in a fashion that takes advantage of the unique characteristics of the computer" (21).

"Reformulating traditional knowledge" meant not only repackaging it into new curricula, but thinking about the relationship between programming and mathematics or biology or physics or the English language in a way that sought to redefine what these fields were as well as how they were taught.[140] For example, Papert and his colleagues found that with the computer "many concepts which previously were thought to be intrinsically too advanced for children became quite elementary and accessible. Such mathematical concepts as formal algebraic structures, recursion, functional application, and algorithms could become "concrete" for the student through the medium of programming" (21). Papert and Goldstein contended that, through programming in LOGO, material that was previously considered to be too challenging for children came within their reach. The use of the computer as a conceptual tool thus brought about changes in what the child was capable of knowing.

Changing the focus from using computers as tutors to using them as conceptual tools also entailed re-thinking the schoolchild in relation to the subjects they were learning. According to Papert and his colleagues, the child's capacity to learn more and better with the computer came in part from the computer's capacity to engage students in "self-directed" learning. In this kind of learning, the child determines what and when to learn as opposed to being a passive recipient of knowledge from a teacher or a computer.

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[140] Papert and his team invented a computational approach to math that the called Turtle Geometry (see Chapter 3). Computational approaches were also devised for teaching physics (Goldstein and Goldstein 1972; Abelson et al. 1974; Cohen 1975), discrete mathematics (Goldstein 1973), music (Bamberger 1974), physical skills (Austin 1974), and biology (Abelson 1974).

"Traditional knowledge" takes on "a personal nature when encountered by the student in the course of a self-directed programming project," wrote Papert and Goldstein (21). The LOGO project thus involved a different way of thinking about the child as learner and student in the institution of the school.

LOGO research came to the MIT Artificial Intelligence lab, it took on yet another experimental dimension. Understanding the human through advanced research into computation and artificial intelligence was a primary interest of the MIT LOGO group. They saw AI not only as an instrument to create intelligent machines but to understand the meaning of intelligence more generally:

> Although there is much practical good that can come of more intelligent machines, the fundamental theoretical goal of the discipline is understanding intelligent processes *independent* of their particular physical realization (Goldstein and Papert 1975, 4).

AI converged with psychology as a methodology to understand cognition and intelligence in *any* instantiation, whether in the computer or in the human mind. Papert and his colleagues were inclined to think of AI as "theoretical psychology" (Ibid., 5, citing Newell 1973) and saw the projects of AI and that of psychology to be linked, each influenced by the other:

> AI draws from psychology a set of basic concerns--understanding language, perception, memory, problem solving. Psychology, in turn, acquires a new framework of computational ideas for expressing cognitive theories. Indeed, a major purpose of psychology becomes the discovery not of the class of programs that could possibly explain a given intelligent behavior (this is the archetypal concern of AI), but rather the *particular program* that a given individual actually possesses" (5, emphasis added).

The consequence of this mutually constitutive interaction between AI and psychology was, according to Papert and his colleagues, the focus of both fields on the "local" and the "particular" ways in which a given person (or intelligence) uses her mind and organizes knowledge. They contrasted this attention to the "particular program" with "global" qualities of thought and "general" knowledge methods. This approach treated intelligence as an emergent phenomenon of particular circumstances and experiences rather than an innate quality a person possesses.[141] The significance of this approach to intelligence for LOGO research was that Papert and his colleagues saw the computer as a tool for developing the capacity of the individual mind to learn better and also considered the computer as a kind of diagnostic or method to understand better the specific ways that any given child learns.

<u>The child epistemologist and the computer Rorschach</u>

"Learning better" for Papert meant being aware of how one thinks and learns. One of the principles behind LOGO's design was to encourage children to think about how they think and be able to "articulate" the way in which they think. This is what Papert called teaching children to be "little epistemologists." "Children learn by doing," Papert said in one research memo, and added, "and by thinking about what they do" (Papert 1971, 4). Papert designed LOGO to "give children better ways and means to think about what they do" with "activities whose structure might allow the child a

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[141] "A very intelligent person might be that way because of specific local features of his knowledge-organizing knowledge rather than because of global qualities of his 'thinking' which, except for the effects of his self-applied knowledge, might be little different from a child's" (Papert 1971, 7 citing Papert and Minsky 1974, 59). Note how this way of thinking about intelligence was different from Andrei Ershov's approach, who treated intelligence more as a quality that emerges from following a procedure.

particularly clear view of his own intellectual activity and so help him achieve a more articulate understanding of 'doing'" (4). Papert believed in and worked towards the use of computers to facilitate this kind of self-reflection of the child about his or her learning. "Computer-controlled devices," he concluded, "excel in this function" of helping children become little epistemologists (4).[142]

The aspiration to make the child into a little epistemologist through interaction with a computer is related to the view of the computer as a Rorschach test promoted by Papert's collaborator, Sherry Turkle. In *The Second Self*, Turkle described the computer as a Rorschach test, a device upon which multiple forms can be projected, each of which reveals something about the individual personality of the beholder (Turkle 1984, 20).[143] The characterization of a computer as Rorschach test is consistent with the aspect of Papert's learning theory of constructionism, which holds that the child can activate her character and individual style of learning through interaction with the computer as an adaptable, personalized learning tool—a tool that is pliable (within the constraints of the program) in the child's hands. Turkle's metaphor of "computers as Rorschach" arises from the particular socio-cultural context of the United States (with its anxious attitudes towards the information society) and the computer and artificial intelligence research environment of MIT in the 1970s and 1980s. The Rorschach test was a specific type of

[142] This wish to make children into "little epistemologists," or self-analyzers of their own ways of thinking is similar to another important trend in American education in the 1960s and early 1970s in making children into "little scientists." Jamie Cohen-Cole described the MACOS project, one popular educational project that explicitly sought to do this. The goal of MACOS (1964-5), an elementary social science curriculum, was to treat students as little social scientists and hoped to make people more scientific, which, Cohen-Cole argues was perceived as a way to also make them more human (Cohen-Cole 2014, 191). The peak of MACOS was in 1972 and it was used as a training device of teachers, so even if teachers didn't use it, they "imbibe[d] its view of learning, the mind, and human nature" (191).

[143] In "Image of Self," a chapter in Daston's *Things That Talk*, Peter Galison explains in detail how the ambiguous ink blot of the Rorshach takes on a definite form in light of the subject's self-realization through the act of perception and verbalization (Galison 1990).

psychological instrument that operates with particular assumptions about the human and within defined social relationships between the test's administrators and its subjects. For example, it is ambiguous (people can draw different conclusions from looking at the same inkblot), has no intrinsic meaning, but rather reveals the meaning-making type and capacity of the subject. By calling computers metaphorical Rorschach's, Turkle suggested that computers can reveal their user's ways of thinking and thus serve them for self-reflection as well as that computers could take on the meaning given to them by their user. These ideas derived from the metaphor of computer as Rorschach were consistent with the dialectic of universal and particular (a universal tool uniquely suited to the needs of any user) present in Papert's characterization of the computer as a "Proteus tool" as well as the vision of the "personal computer." Papert and his colleagues designed LOGO to support this idea of the computer.

This dual goal of Papert and his colleagues for computers in education (to make children into "little epistemologists," that is, analysts of their own ways of knowing, and to allow computers to serve as Rorschach tests, that is, instruments to reveal children's ways of knowing) can be discerned in the design of their experiments. The Brookline LOGO experiment that Papert and his colleagues launched in the school year of 1977-78 laid out this dual goal for computers in education: to allow children themselves (for pedagogical reasons) and adults (for research into the processes of human thinking) to glimpse their thought process through their interaction with LOGO.

The Children's Learning Lab

Given his understanding of artificial intelligence as a kind of "cognitive psychology" that sheds new light upon the workings of the mind, Papert as director of the AI Lab established a direct link between computing research and research on the human mind. Papert and his colleagues proposed to create within the AI Lab a place called the "Children's Learning Lab," which would double as a site where elementary school children and teachers could come to train in LOGO and a place for AI Lab researchers to study the forms of children's learning with computers.[144] The Children's Learning Lab focused on research in three general areas: 1) computer graphics and robotics; 2) locomotor skills; 3) music perception. The areas of research reveal the blurry line between studying the child and studying the child's interaction with the computer. The first area of research was interested in children's interaction with computer graphics and robotics while the second and third areas were traditionally centered on studying the child's cognitive abilities. To support this research, the Lab included a designated room where children could read and view videocassettes and a special "observation room," where the researcher could observe the children's activities from a distance without interfering in them. The Lab, a space measuring sixty by sixty feet, was designed to accommodate sixteen to eighteen elementary school students at a time who would come

[144] One interesting result of this combination of research on AI and children was Marvin Minsky's interest in creating a computer that would be like a child. Minsky believed that making a "child computer" would be a more challenging and interesting task than making a computer modeled on an adult's thinking process because, a child's reasoning, unlike an adult's could not as easily be described by formal rules of logic. According to Minsky, a "child computer" was also more important to the continued development of AI research because, if it could be created, it would have the capacity to be able to learn on its own as children do. The ability to learn was seen as a valuable and mysterious capacity of the human being (and child, in particular) that the development of AI could benefit from at the same time as it could shed a light on the process. Today, research on machine learning is one of the largest and most vibrant areas of computer research, with hundreds of promised applications.

accompanied by their teacher from the nearby Roberts School in Medford, Massachusetts. They would be in the lab for a total of nine "contact-hours" per week ((“Children’s Learning Laboratory, 1969, 1971, 1974,” n.d.).[145] The research programs planned for the Children's Learning Lab occupied approximately the years 1972 - 1976.[146] The Laboratory itself grew out of the LOGO researchers’ desire to have a convenient and controlled, literally "in-house," space in which to develop the LOGO technology and pedagogical concepts.[147] Papert and his team began to implement the technology and concepts they discovered during this earlier phase of research in the "experimental-pedagogical" phase from 1976 forward through the Brookline LOGO project.

The Brookline LOGO experiment

Unlike the activities of the Learning Lab, which took place in a specially created space at MIT, the Brookline LOGO project studied children and computers within the space of a regular school classroom. Papert and Goldstein referred to it as an "operational experiment," which they defined as "well-planned and rigorously controlled" (Goldstein and Paper 1976, 12), using the methods they had developed in the "context of a normal school with a year class over a full year" (12). Goldstein and Papert described the project of the "operational class" in the following way:

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[145] AC 205, Box 138 Folder 9, P74-11 Children's Learning Laboratory, 1969, 1971, 1974 ; see also appendix with layout of the Children's Learning Lab from AC 205, Box 138 Folder 9, P74-11 Children's Learning Laboratory, 1969, 1971, 1974; more details about the Learning Lab and the activities that took place there, Papert et al. *Assessment and Documentation of a Children's Computer Laboratory* (1977a).
[146] Activities of the LOGO Group during this period are described in the 1973 NSF proposal authored by Papert.
[147] I have not been able to determine for certain whether the Children's Learning Lab was actually built. The MIT Archives contain only the plans for building the space and the people who worked with Papert that I spoke to about it describe many projects that involved the study of elementary school children, but do not recall specifically a space called the Children's Learning Laboratory.

> We propose to create, within a school in the Boston area, a LOGO environment sufficiently equipped to allow a normal class to spend approximately half of their school-day in it. The work the children will do in this LOGO environment will be integrated into the rest of their school activities and will cover a substantial part of the subject matter expected of students in that school year. Such an experiment will have to last at least a full year to be as significant as we wish to make it. If we have sufficient resources of people and equipment, we will operate two classes at different levels: one at the junior high school level (8th grade), the other at mid-elementary level (fifth grade) (Goldstein and Papert 1976, 13).

Goldstein and Papert expected that the entire experiment would take three years of work because they needed at least one year of time to prepare for it. The preparation included teacher training, preparing equipment and site, recruiting staff, preparing teaching materials and, last and most important, designating observational and evolutional methods in consultation with a panel of specialists (13). The National Science Foundation had since 1968 been tasked by the President and Congress to provide a leadership role in the use of computing in science and education in the United States (Seidel, Anderson, and Hunter 1982, 3).[148] Papert's team received a grant from NSF in 1977 to develop a plan for evaluating its "total environment" of the LOGO programming language and Turtle in the context of a typical urban elementary school (Papert et al. 1978, 2).

The Brookline LOGO project took place in the Lincoln Elementary School in Brookline, Massachusetts. Four computers equipped with LOGO and Turtle Graphics were installed in the school's classroom. All of the sixth graders in the school had

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[148] In the last decade (from 1971 - 1982), the Science and Engineering Education Directorate of the NSF invested over $70 million in different efforts on computers in science education. Papert and the LOGO Group at MIT were frequent recipients of NSF grants for their work. NSF's involvement in science education more generally came after the launch of Sputnik in 1958. Americans explained Sputnik by "focusing on the inadequacy of American education" (Cohen-Cole, 197). In 1958, the National Defense Education Act (NDEA) was passed in response to Sputnik . NDEA "marked an expansion in public support for national involvement in education" leading the NSF to increase its role in curriculum design (Ravitch 229),.

between twenty and forty hours of "hands-on" experience with the computers and the researchers documented in detail the work of 16 students (Papert et al. 1979). One experienced elementary school teacher from the Lincoln School who also had experience with the development of new educational materials supervised the children's work in the computer classroom (Papert et al. 1979, 1.2).

The project sought to answer a number of questions about the children's interaction with the computer:

- How much can 6th grade children, in a regular school setting, learn about computer programming using a LOGO environment?

- What concomitant skills that are part of the standard school curriculum (mathematics, science, and language) do children learn in the course of their LOGO work?

- What non-standard skills (problem-solving through planning and debugging; use of procedural thinking and computer metaphors, etc.) do children acquire in the course of the LOGO work?

- Does the LOGO experience produce any changes in the child's attitude towards learning or toward himself/herself as a learner, both in general, and in relation to particular subjects (e.g. mathematics)?

- What changes, if any, can be found in the child's attitude towards using computers and towards the role of computers as part of our technological society?

- Could we gather educationally useful data about the students by observing them in their work? (Papert et al. 1978, 3)

One outcome of the project was that it identified a set of programming concepts and skills that were demonstrated to be within the reach of most sixth grade students ((Papert et al. 1979, iii). The project further suggested ways to increase the number of students "proven to be capable of learning to program" using computational environments like LOGO.

A. Organizing the experiment

Three elements of the Brookline LOGO experiment enabled the child to be simultaneously the subject and the object of the study: the deliberate choice of children with different educational abilities; a teaching strategy that left a lot of time and space for the children to select their own activities; and the use of a "dribble file" to study the children's learning process.

The team working on the Brookline LOGO project chose on purpose to work with a range of "average" children as well as with "exceptional" children on both ends of the spectrum of academic achievement. This choice of students with a range of abilities contrasted with a number of previous experiments with computers in education. These earlier projects targeted either "mentally gifted minors" (e.g. work of Adele Goldberg and Alan Kay at Xerox Palo Alto Research Center in 1974, teaching children a language invented by Kay called "Smalltalk") or with mentally disabled children (e.g., many of the projects of Patrick Suppes' group at Stanford focused on the use of computers to improve the learning of disabled children, see (Suppes 1978b). The choice of students with a range of abilities was important for the Brookline LOGO experiment because the researchers were interested in seeing how the computer could be used as a tool to enhance individual learning whatever the learning style or ability a student started with. Diversity mattered because they were testing the possibility of using the computer for and by everyone, irrespective of a student's academic abilities. They were assessing the general capacity of the LOGO environment to make children into "child epistemologists" and to serve as their Rorschach. This choice of a wide-range of students for the experiment corresponded with the researchers' understanding of intelligence as particular to the individual, context-specific, and learned-by-doing, instead of as an objective measure of intrinsic ability; it also furthered their wish to test (or demonstrate) the universal applicability of the computer as a tool to learn with.

The decision how and what to teach to the students during the experiment reflected a similar concern for allowing each child to choose her own way of interacting with the computer. "It was part of the strategy that while the teacher would exert some pressure for the students to achieve the goals we had set for them he would also allow deviations if he felt that a particular student would not respond to the pre-determined goals," Papert and colleagues wrote in the Final Report (Papert et al. 1979, 1.4). This approach also distinguished the Brookline project from other efforts to teach with LOGO. For example, in a LOGO project conducted in Edinburgh, teachers worked from a manual to teach topics in a particular sequence (Papert et al. 1978, 14). The Brookline LOGO experiment's choice of self-directed learning reflected the dominant pedagogical approach of Papert and his colleagues that prized learning through personal exploration and motivation rather than according to a predefined curriculum.

One payoff of this approach to teaching was that it promised to yield insights into the children's own learning process. "This policy [of allowing deviations from pre-planned curriculum] proved to be immensely valuable," the report's authors wrote:

> Significant deviations [from the usual use of the computer] took place in two cases. In each of these the students taught us something very profound about how a computer can be appropriated to the service of an individual's learning needs (Papert et al. 1979, 1.4).

By using a self-directed approach to interacting with the computer, the researchers not only applied a pedagogical strategy that they deemed to reflect the nature of intelligence and the process of learning, but also one that confirmed to them the universal, "protean," utility of the computer and the flexibility with which it could be deployed. Consistent with this view, they discovered (as was their hypothesis) that children did not move through three stages of reasoning—from programming only for the end product (verbal output or graphic design) to "style conscious programming" (making programs that include the correct form using a new concept being studied), to programming to solve problems. Rather, they found students whose predominant model of reasoning was either the first or the third kind, with no obvious evidence of the second[149] (Papert et al. 1978, 14 citing O'Shea 19,). This finding was central to the development of Papert's theory of constructionism, which rejected Piaget's evolutionary argument that people proceed from a concrete to abstract style of thinking in favor of a view that people have different starting and ending points.

A third important element that related the children as subjects and objects of the experiment was the use of a "dribble file," a printed record of the students' work with the computer, to examine the student's learning process. Concerns about how to evaluate the experiment were central to the organizers and explain why they believed the project would require a year's time to set up. In their original NSF proposal asking for funding for the project, Papert and his colleagues described their intention to collaborate with outside evaluators to design specific means of studying the children's interaction. The "dribble file" was an invention of the Brookline experiment in response to a need to find

[149] They interpreted the finding that few students showed the second style of reasoning as further evidence that they did not use a "work-from-a-manual" approach to teach the students, so there was no possibility for students to develop programs of "correct form" that used a new concept being studied (Papert et al. 1978, 14).

a way to keep track of the student's work during the course of the year and to find a concrete way to evaluate the experiment.

Unlike the environment of the Children's Learning Lab, which was part of the MIT AI lab and was designed with an "observation room" from which researchers could observe the children's interaction with computers, the "operational" space of the classroom and the year-long duration of the project made observation difficult. In fact, it changed what "observation" meant altogether.[150] The researchers would not be present in the classroom every day to observe the children but were only present from time to time (Papert et al. 1979, 1.2). They needed a way to track the student's progress over time and see the way that their interaction with the computer developed and what impact it had on their studies. Largely due to the innovation of the "dribble file" to track student's progress and understand their styles of work, the Brookline experiment became known as one of the most thorough experiments in computers in education.[151]

The "dribble file" was a complete printed record of all of the interactions of a child with a computer during a given period of time. The files were the "data" on which the research study on child's learning was based (Papert et al. 1978, 13). The contents of the dribble file was used to illustrate and justify elements of the individual student's work with the computer (described in Final Brookline Report, Part III (Watt 1979)). It was also invaluable for the teacher, who was instructed to make a daily study of each student's

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[150] For a history of observation of children, see (Whiting and Child 1954; Gesell 1974).

[151] The researchers themselves describe their project as unique in these terms and they credit the special "conditions designed to allow us to collect and analyze an unusually large body of data about [the students'] progress" (Papert et al. 1979, iii). They also describe themselves as "We are possibly the first to have set up a well considered definition of programming (that was not dictated by the accident of a particular programming language simply being there) and to have published (for example in this study) a detailed account of how a representative group of students actually fared with it" (Papert et al. 1979, 1.10–1.11).

dribble file as "an invaluable source of information to the teacher as to what each child's working style, methods of problem-solving, strengths and weaknesses really are" (Papert et al. 1978, 13). The teachers then used this information "in planning the individual teaching strategies that are developed for each child as the classes progress" (Ibid). The file was the perfect form of data for researchers interested in child-computer interactions because it was the most direct product of this interaction. It was also authoritative and "spoke" for the child=. It revealed to the teacher and researchers styles of learning that the students themselves were unable to articulate, even though one of the foundational goals of the experiment was to help children to find a way to become articulate about their own thinking. The dribble file was simultaneously data (raw output of the experiment), as well as a teaching tool. A product of the private, one-to-one interaction of the child with the computer that teachers and researchers could mine for undercover modes of reasoning, the dribble file was simultaneously teaching tool and data (raw output of the experiment) about the learning process. It was a technological innovation that imprinted the child's thought process and style of interacting with the computer on a piece of paper. An essential component of the Brookline LOGO experiment, the dribble file linked the child as subject and object of knowledge.

B. The computer in the experiment

The computer played a central role in the Brookline LOGO social experiment. Unlike in the Soviet case, where, as I will show, the computer itself was secondary, the Brookline LOGO experiment would have been inconceivable without the computer. First, the computer generated the data (in the form of the dribble file) that the researchers used as well as provided feedback to the teachers about what and how the students were learning. Second, the children's one-to-one interaction with computers was precisely the type of human-computer relationship that researchers were investigating. As part of the design of their project, the researchers ensured that students would work in classes of four, "so that there was always a one-to-one ratio of students to computers" (Papert et al. 1979, 1.3). "We believe," they wrote, "that the ratio of students to computers is essential to the results we obtained and will be typical of the computer-rich world of the near future" (Ibid). "Hands-on" interaction with the computer constituted *the* kinds of interaction that the researchers were interested in and about which they made their observations.

Each of the four computers in the experiment featured LOGO and LOGO-based Turtle Geometry, a software environment for building geometric shapes on the screen. Thanks to this virtual "creature" that effectively combined "playfulness and technicity,[152] the children learned programming, geometry, and how to think about their own forms of learning. Students used commands in LOGO language to move a cursor on the screen that represented a "turtle." The name for the cursor derived from the earlier instantiations of Turtle Geometry in which the children, through the computer, had manipulated in three-dimensional space an actual robotic turtle that would draw with a pen on large sheets of paper on the floor. In the Brookline experiment, the turtle "lived" on the screen. Children did not distinguish whether they were interacting with the computer or the turtle—both formed a seamless entity that they accessed through one of the four

[152] Papert used this characterization of "playfulness and technicity" to describe Nicholas Negroponte's Architecture Machine Environment, which he considered to be a “prime model" (Papert 1977b, 18).

computers in the special classroom. Each of the computers was linked to the others so that a student who had "taught" the turtle a particular command by writing a procedure for it could access the command on any of the machines.

Although the turtle was virtual, or perhaps because it was, it facilitated the children's understanding of the computer and the turtle as "synergistic" (Papert et al. 1979, 1.16), the turtle was a centerpiece of the technological and pedagogical approach of the experiment. It gave the experiment a "playful" and "poetic" quality, which Papert frequently remarked upon as a hugely important and successful element of his work. Reflecting on his intentions behind creating the turtle, Papert wrote,

> In our own work we have struggled, as in creating 'the turtle,' to find objects which simultaneously have *intrinsic* poetic and cognitive properties as well as being intrinsically resonant with a realisable technology. Thus the mathematical, the cognitive and the poetics are melded into one enterprise" (Papert 1977b, 18 original emphasis).

The "poetic" aspect of the Turtle was for Papert its ability "to appeal to the imaginations of the children" (Ibid). The turtle was a "creature" with "a bearing," or orientation in which the turtle "walked," a creature children could relate to and through which they could explore abstract bodies of knowledge such as programming, geometry, biology and physics. Papert depicted the "Intellectual Habitat of Turtles" by drawing a concept map in which the turtle is in the middle surrounded by "Physics," "Biology," "Geometry," and "Pictures." Thus, the turtle did epistemological work in that, by simultaneously engaging key principles of all of these disciplines, it helped to break down the boundaries among different bodies of knowledge.

The turtle not only connected abstract bodies of knowledge by virtue of teaching them simultaneously, but also connected them to the physical body of the child, thus making abstract concepts tangible. "Playing turtle" allowed children to put their bodies and their knowledge of physical space together to help them to learn concepts in geometry. Interacting with the turtle was frequently referred to as "playing turtle" because students were encouraged to use their own bodies to act out the sequence of "steps" that the turtle would need to take in order to draw a particular shape on the screen of the computer. In earlier LOGO projects, particularly ones in which the turtle was robotic rather than virtual, this kind of "playing turtle" was usually done as a group activity. One child would pretend to be the turtle and the others would tell her what to do. Edith Ackermannn, a psychologist and Papert's colleague at MIT, described the relationship between the turtle and the child as follows: "Papert's turtles become extensions of self that the child controls using words" (Ackermann 2004, 17). The turtle explicitly drew upon knowledge about space that, Papert and his colleagues argued, is held inside the body. It sought to bring out this "tacit knowledge" to the "mind's reach" (Ibid.). Ackermann observed: "One of Papert's greatest insights in designing LOGO-based Turtle Geometry, a software environment for building geometric shapes, was to tap children's knowledge about their own movement in space and to use this knowledge as a level to help them explore spatial relations and transformations" (Ackermann 2004, 15–16). The body's knowledge of space was harnessed to help children to learn abstract concepts in geometry, biology, physics, and programming, thus helping the child to articulate her process of thinking and learning.

The robotic or virtual turtle and Turtle Geometry software environment that it inhabited was the distinctive feature that made any LOGO-based experiment different from other software environments for computers in education. The turtle was a centerpiece of the computer experience in the Brookline LOGO experiment that defined the nature of the children's interaction with the computer. The experiment demonstrated how effective the Turtle was in teaching children key aspects of programming as well as geometry principles while also engaging them personally in their unique learning process. Aided by the turtle, children interacted with the computer, but this "computer" was not the same as the one available to the children in Ershov's summer camp.

C. Playing Turtle: Meaning of play in the experiment

"Playing turtle" as a way of learning about the computer, learning school content, and learning to think about one's thinking with it, exemplifies the central role of play = in the Brookline LOGO experiment. "Playing turtle" involved both pretending to be the turtle and treating the virtual cursor on the screen as an independent entity that one gives commands to but that then seemingly executes them with its own will. As discussed above, the turtle was intended to make the learning of abstract concepts concrete and encourage the child to become articulate about her thinking by letting her bring her body's "tacit knowledge" to "mind." It also had the role of encouraging the children to better visualize their mistakes and find ways to "de bug" or fix them.

"Playing Turtle" could be characterized as an act of mimesis in sociologist Roger Caillois' terms: pretending to be or putting oneself in the place of the Turtle (Caillois 1958). Caillois defined mimesis as one type of playful activity in which the person pretends to be another within spatial or temporal limits (e.g., the actor on a stage, the masked participant in a carnival). "All play presupposes," Caillois wrote, "the temporary acceptance, if not of an illusion (indeed this last word means nothing less than beginning a game: *in-lusio*), then at least of a closed, conventional, and, in certain respects, imaginary universe" (1958, 19). According to Caillois, one way to play is becoming an illusory character oneself, or behaving as an illusory character through mimicking or disguising oneself for another, or shedding one's personality to feign another.

"Playing Turtle," that is, identifying with the turtle and "feeling one" with the turtle was a playful act that allowed the child to enter the universe of the micro-world and had important pedagogical consequences for LOGO's designers. By pretending to be the Turtle, the child could go back and forth between being the one performing an action and "giving instructions to another" (the interactive artifact). Papert and his colleagues attributed to this oscillation between self and other the ability to achieve "deeper understanding" of both the content of the subject being learned and of one's own thought process. It allowed children to, for example, experience their mistakes as the mistakes of the "other," thereby giving them the necessary distance to see the mistake and correct it.[153] It also had the crucial function of helping children reflect upon their own thinking, a key goal of using computers in education, according to Papert and his colleagues. "The dynamic properties of interactive tools," Ackermann wrote, "are used to tap into learners' knowledge-in-action, while mediations are offered to favor the passage from reflection-IN-action to reflection-ON-action" (2004, 19–20).

By pretending to be the Turtle in the context of interacting with the computer, the child gained access to the "micro-world" in which the turtle lived. Consistently with

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[153] "The child rarely engages in constructive thinking about how and why the mistake happened and what can be done about it. But when the turtle draws a hexagon instead of a triangle, the reaction is much more constructive (or at least easily becomes so with a little encouragement). Children almost unanimously see the *turtle* (rather than themselves) as doing the 'wrong thing.' And, of course, we strongly encourage this, for the child is then much more ready to be objective about what happened. Moreover, we are able to urge them to *understand exactly* why the turtle did what it did… rather than merely make it do the 'right thing'" (Ackermann 2004).

Caillois' characterization of play as a "safe" space set apart from real-life by spatial or temporal barriers (Caillois 1958), Papert and his colleagues described the micro-world as a "safe" space for learning, where children can experiment "safely" with new concepts (Ackermann 2004). Papert described how the computer substituted a safe space for children's learning explorations in the very first LOGO publication:

> "One might dream of having children learn mathematics by giving them a ship to sail the ocean, a sextant to fix their position and a cargo to trade with distant peoples. A large part of our work is directed at trying to make this dream come true (at least in principle) by creating mathematical instruments more manageable than ships and sextants, but which still allow the child to develop and exercise mathematical arts in the course of meaningful, challenging, and personally motivated projects" (Papert 1971, 3).

In this way, the computer allowed a "fantasy" to materialize through the micro-world. The micro-world, in Papert's definition, was a space apart, a virtual space, a space for play. The computer could simulate a real world by creating a virtual micro-world accessible through playful interaction.

Ackermannn wrote, "Playing 'what if' or the ability to pretend (establishing a dialog between what is and what could be) is the means by which children as well as adults achieve the difficult balance between getting immersed and emerging from embeddedness" (2004, 23). This dynamic of going in and out of immersion was, according to Papert and his team, an essential part of the dynamic of learning, which involved slowly altering one's picture of the world—a dynamic that Papert was inherently interested in and that he sought to facilitate with the LOGO language and Turtle Geometry.

A child who failed to walk the line between being immersed in the micro-world and stepping out of it violated the implicit rules of the LOGO game. In the report about the Brookline LOGO experiment, researchers described one girl, Tina, who had difficulty sustaining this dynamic. She was too much attached to the particular computer on which she usually worked, considering it “her” computer (despite all of the computers being interchangeable because they were connected among themselves). According to the descriptions of Tina’s approach to the computer, she became too attached to it, giving it a name (“Peter”) and being upset when other students worked on it. In a sense, Tina had developed too close of a personal relationship with “Peter” to be able to use the computer to access her own ways of thinking. Here, however, were limits to what good play meant in the Brookline LOGO experiment. Tina’s relationship to the computer was not effective, according to the observers. Only once she developed a more practical and matter-of-fact relationship to the machine "as she came to understand the mathematical predictability with which the computer responded to her, and as she began to take pride in [*her own*] the accomplishments in story writing, 'Peter' came more and more to take on the status of a personal fantasy—one which a child *knows* is a fantasy, but persists in 'playing' sometimes because it's fun" (Watt 1979, 16.2). Tina's interaction with the computer did not lead the author of the report to conclude that she had created a "micro-world," although it seems that she had created a certain "safe" space she stayed within, accompanied by a named partner, in her use of the computer. But this form of playing with the computer was different from the ideal engagement with the micro-world imagined by the designers of LOGO and it points to the directive aspects of play envisioned in the Brookline LOGO experiment.

The micro-world—the playful place in which the child interacted intimately with the computer, switching between identifying with the computer and seeing it as another—was a place of learning and self-discovery. It was designed to be such a space by the researchers, given their particular ideas about the process of knowledge acquisition, about intelligence, and about the role of play in learning. In the researchers' view, it allowed the child to be a child: to access the body's geometrical and spatial knowledge, to imitate, and to pretend. It was also the site that the researchers sought to study or better understand. How does a child interact with the computer? How does the child think about the computer in relation to the self and in relation to other living and "intelligent" beings?[154] The micro-world was the place that the dribble file sought to document and help to give researchers access to. It was the place where the almost magical process of learning about one's own thinking and finding ways to become articulate about one's thinking (e.g. learning how to "debug" or identify and correct one's mistakes) took place. The LOGO micro-world was a solitary or intimate place, one that could be engaged only through one-to-one play with the computer, enabled by a computer system that "[could] be appropriated in a personal way by individual students" (Papert et al. 1979, 1.16). It was a playful space governed by particular rules of engagement, according to which exogenous fantasies (such as Tina's personification of *her* computer) were not deemed effective in becoming a "child epistemologist," whereas an oscillation between identification with the computer and separation from it as an *intellectual* partner were encouraged as a way to unlock and enhance human intelligence with the computer.

[154] Sherry Turkle's work focuses on these questions. Turkle was closely involved in the LOGO work in the 1970s and 1980s.

The Brookline LOGO experiment was founded upon the wish to give children the opportunity to experience the micro-world at the same time as studying how they inhabit it. The micro-world was an experimental site. Observing children's activity in the micro-world led Papert to articulate his theory of constructionism about how human beings used tools, media, and artifacts to create knowledge and create the world. The kind of interplay with the computer that Papert was building in the experimental site of the micro-world, in France Jean-Jacques Servan-Schreiber sought to build in the macro-world of an entire city neighborhood.

France

Ten years after the scene at SICOB described in the introduction to this chapter, French children once again appeared on television playing games with computers ("Centre Mondial Informatique" 1982). This time, a boy and a girl sat facing the camera, looking busy behind the computer's bulky body. Behind them, a news anchor interviewed Jean-Jacques Servan-Schreiber about his new initiative of the Centre Mondial Informatique et Ressource Humaine (CMI). Servan-Schreiber explained his vision for the metaphorical decolonization of the French, and particularly French youth, by teaching them to use computers. The children, quietly consulting each other about something on the screen, were there to illustrate his points. Like the girl playing the computer game at SICOB, the children represented the intrepid leaders of the future, confident in their handling of the computers. Unlike the text-based display used by the girl at SICOB, these children interacted with a graphical display and drew geometric designs on the screen using the LOGO Turtle Geometry software. Their activity was not explicitly described as a game and looked serious to the audience, who from time to time were shown a glimpse of the screen. In contrast to the guessing game, they were not required to input yes or no answers to the computer's questions, but rather could play around in a relatively unstructured way with the machine. In contrast to SICOB, they were not in an engineering milieu, but in the middle of the political events of that day's news hour. These differences represented the different approach that Servan-Schreiber took, as compared to the French computing industry, to bring about *culture informatique* in France, in pursuit of his vision of developing the French citizen as a *ressource humaine*.

Research-actions in the neighborhood

As we have seen, Servan-Schreiber proposed to President François Mitterrand that the way to build up French society as *ressource humaine* was to create a public center dedicated to the computer. The center doubled as a place where classrooms of school children or the general public could come to experiment with computers, as well as a world-class laboratory for computer scientists and experts from different countries and industries (education, agriculture, health, etc.) to come together to research, design, and run experiments with applications of computers to various areas of public life. The Centre Mondial was thus the headquarters from which a number of large-scale "social experiments" with computers were implemented—experiments that sought to teach particular forms of human-computer interaction as well as to learn about the uses that people put computers to. Appropriately, Servan-Schreiber also referred to these "social experiments” as “research-actions,” for the way in which they combined a formative activity with an investigative one. The object of action and research, however, was usually the society and community rather than individual psychology, which was the focus of the Brookline LOGO experiment. The term “social experiment” underscored the interest of CMI researchers in the effects of introducing computers on the level of the collective social order as opposed to individual psychology. Here, I focus on the CMI Paris headquarters as a site of the ideal kind of interaction with the computer that Servan-Schreiber designed, and on the Belle de Mai project in Marseille as one of the social experiments orchestrated by the CMI in other parts of France and the world.

During its five years of existence, the CMI led many computer-related projects in France and abroad. Its main laboratory was the show-floor open to the public on the Avenue Matignon, in a central and notably expensive neighborhood of Paris. The show-floor contained tens of micro-computers of different makes, both French and foreign, equipped with a wide range of software. French and foreign researchers on the second floor worked on projects to develop socially-focused applications of computers. However, developing technology was not the main focus of the CMI.[155] Instead, its leaders orchestrated numerous "research-actions" or "social experiments" (as the project leaders referred to them) with already existent technologies, "testing" them in the “social” field.

One of its most prominent projects was the Belle de Mai project (September

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[155] The little amount of technology that the CMI developed was used as an argument by the national agencies funding it from continuing their financial support of the center in 1985 (Defferre 1985). Apparently, there was an expectation (or perhaps an early promise by Servan-Schreiber) that the CMI produce technology--especially with the international engineering talent that it drew--and the CMI disappointed French political and industry leaders when it did not produce.

1982-December 1983) during which project leaders distributed micro-computers throughout a whole neighborhood of Marseille.[156] Belle de Mai was carefully designated by CMI leadership and Gaston Deferre, the Mayor of Marseille, as an ideal place to study the effects of the introduction of computers into the daily life of a French population.[157] The CMI experiment was run with the goal of one day generalizing this experiment to the whole of France.[158] Servan-Schreiber's understanding of a human being as a social being "of the world" and at the same time characteristically French, and fulfilled through the full employment of one's faculties with the computer, was central to the development of the CMI's ambitious Belle de Mai social experiment. While the CMI was itself an experimental space, the Belle de Mai project took the concept of experimentation with computers to another scale altogether—to daily life in a metropolitan city.

The Belle de Mai project was launched in September 1982 and lasted until the end of 1983. In the course of 1983, four hundred American-designed Texas Instrument (TI) computers were distributed throughout the neighborhood's public places--schools, libraries, and associations. Project leaders watched to see what residents would do with the computers (how and for what they would use them) and what transformations, if any, the introduction of these machines would bring about to the social structure of the

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[156] My main source of information about the Belle de Mai project is a report created six months after the project's launch titled, *L'Expérience pilote de Marseille, six mois après: premières évaluations, perspectives de développement* (1983) authored by Georges Chappaz (Maître-Assistant à l'université de Provence, Chargé de Mission du CMIRH pour l'operation Marseille) and Georges Vignaux (Chargé de Recherche au CNRS, Conseiller Scientifique auprès du CMIRH-Marseille).

[157] In fact, the Belle de Mai neighborhood of Marseille had been selected for this "social experiment" in part because of its capacity to represent a generalizable case..

[158] This mission was in fact pursued in the *Informatique pour tous* program, which I will describe in the following chapter, although in a more limited way. While Belle de Mai had an emphasis on the introduction of computers into daily life, *Informatique pour tous* worked by introducing computers into schools and children's associations.

neighborhood.

The project was a joint effort by the CMI and Gaston Defferre, then the Mayor of Marseille and a good friend of Servan-Schreiber. A budget of twelve million francs from the CMI and four million francs from the City of Marseille was used to purchase hardware and software equipment, pay personnel to run them, rent necessary spaces and furniture, and cover the project management costs for the CMI (Chappaz and Vignaux 1983b). One of the main supervisors in charge of communicating the goals for the project, of project operations, and of evaluating its progress was Georges Chappaz, a sociologist at the Université de Provence. Chappaz worked together with Georges Vignaux, a researcher at the *Centre national de la recherche scientifique* and scientific adviser for the Marseille arm of CMI activities.

Setting up an *informatique* environment

A. Organizing the experiment

Chappaz and Vignaux wanted to make absolutely clear to the readers of their report that the "ultimate goal of the spread of *informatique* is cultural, and not technocratic" (Chappaz and Vignaux 1983a, 106). Thus, the main objectives of the project were to "observe and analyze how each person—and the community as a whole—takes up and appropriates the computers, and to see how they invent new uses [for the micro-computers]: tools, games, companions, mirrors...according to their tastes, talents, needs" (Chappaz and Vignaux 1983b, 4). They also asked how knowledge structures can be developed and enhanced by learning to use the computer and what environments favor this enhancement of knowledge structures and multiply this positive effect.

Since the main stated goal of the Belle de Mai project was to study how French people in general relate to computers as a normal part of their daily lives, it was important for the organizers to select a site for the experiment that could be representative of the French population. What a "representative" site meant revealed their ideas about what they hoped the computer would achieve in French society.

Project leaders Chappaz and Vignaux elaborated the many aspects of Belle de Mai that made it an ideal experimental site. First, with a population of 17,000 among whom 3,500 were school children, it was deemed to be of the “right scale.” Large enough to qualify for a study that wanted to stand-in for the French population on the whole, it still had a distinct communal identity, which the researchers considered important as a kind of control to be able to recognize the effects of introducing the computer. The neighborhood was close to the center of Marseille, making it convenient to study administratively and giving it added importance. Relatedly, the neighborhood partook of the "life of a big city," that is, it was not a big city in itself, but it had the semblance of one, making it possible to approximate experiences in Belle de Mai to those in an actual large city. Finally, it was geographically contained, which was a prerequisite for the researchers who needed a well-defined experimental site where interventions and consequences could be more easily observed.

In addition to its size and geographical position, Belle de Mai was a good choice of a representative site for the experiment because of the kinds of people who lived in the neighborhood. Its identity as a *quartier populaire,* or working-class neighborhood, ensured, project leaders believed, that it stood to benefit from a socio-technical intervention. Put less optimistically, as a *quartier populaire,* Belle de Mai was perhaps seen to have a population needing improvement, and thus one that could appropriately be experimented on in pursuit of a socialist vision of technologically aided progress. As a "social experiment" and "research-action" of the CMI, with hopes one day for generalization to the whole of France, the Belle de Mai project sought both to enact and test the role and capacity of *informatique*.

In the years leading up to the experiment, the Belle de Mai neighborhood had been hard hit by the French economic crisis in ways that were considered to be characteristic of other communities around France. Chappaz and Vignaux described this neighborhood as ailing as a result of recent industrial transformations and increase in foreign immigration (1983b). The economic difficulties undermined the neighborhood's long history of strong social life, which was one of the experimental variables that the project organizers were interested in studying following the introduction of computers. "Common opinion" among residents, they wrote, is that the neighborhood is no longer like it used to be (Chappaz and Vignaux 1983b, 64). Chappaz and Vignaux recounted how in the past the neighborhood had been exemplary of the good social life. Previously, it had accommodated all of its residents' needs for lodging, work, recreation, culture, food and drink, and social exchange. Its social structure was made up of networks of family and neighborly relations, strong social cohesion and plentiful and diverse community events. With industrial changes, the neighborhood was seen to have lost many of these qualities. In 1983, Chappaz and Vignaux found that Belle de Mai was no longer able to offer most of its residents a local place of employment. The rate at which residents left the neighborhood to live elsewhere was increasing and the spaces for recreation and cultural activities no longer addressed the needs and desires of the majority of inhabitants. Economic activity in the neighborhood had changed profoundly through the spread of mass production and consumption and as a result of different mutations and consolidations of the industrial sector. Finally, family relations had eroded through the growing isolation of households from one another and the migration (forced or voluntary) of the employed for work, which significantly undermined the society's strength and cohesion.

The bleak characterization of this neighborhood in contrast to its healthy and socially strong past was a persistent theme in the description of many French cities and neighborhoods at this time. The oil crisis of the 1970s was seen as having created economic and social hardship in many parts of France. An important part of François Mitterrand's presidential platform was to help bring recovery to ailing regions like Belle de Mai. One strategy was to introduce the computer as a way to revive both social structure and economy. Chappaz and Vignaux's report six months into the experiment presented computers in precisely this way: "*micro-informatique* appears to be increasingly the 'natural' apparatus in response to social needs: [the need for] decentralisation, right to difference, conviviality, and the popularization of *informatique* tools" (Chappaz and Vignaux 1983b, 6). Belle de Mai's numerous public spaces—twenty-three schools and twelve civic associations—could now serve as the sites into which to introduce computers to see if the computers could somehow restore the neighborhood to its previous social vibrancy.

The careful planning that went into the choice of Belle de Mai as a representative experimental site distinguished the French social experiment from both the American and Soviet experiments described in this chapter. Papert and his colleagues explicitly chose the students who would constitute a representative sample for their study of children's interaction with LOGO in the Brookline school so that the study population would comprise a wide range of intelligence and ability as measured by standardized tests and their teacher evaluations. Ershov as we will see was not concerned about having a representative sample of students and welcomed all who were interested in learning programming into his Summer School. In part because of the city-wide scale of the Belle de Mai experiment, the organizers could not hand-pick the people who would use the computers they set up. They wanted a site from which they could generalize to the whole of France, but once the representative site was selected, it was important for them to create relatively unstructured, “natural” conditions to observe who would flock to the computers at that site.

B. The computer in the experiment

The 400 Texas Instruments micro-computers distributed among the Belle de Mai public spaces were central to the experiment. The role of the computers—to test if they could revitalize the ailing neighborhood—was representative of the role that the CMI more generally ascribed to the machines. The use of American hardware and software, while being skeptical of the American values that they believed accompanied these technologies, was also characteristic of the CMI's practices.

Despite the centrality of the computers to the experiment, the project mission emphasized its largely social (as opposed to technological) function. Chappaz and Vignaux insisted that the project was not about promoting any particular technology or letting the technology dictate a social use. For example, instead of speaking about "communications," which the authors suggested brought images of cables and connections to mind, they preferred to use the term "*social* communications," thus emphasizing the use to which people put the technology, how they used it, and how it was distributed and marketed. Elsewhere in the six-months report, they described the goal of the project as helping citizens to "appropriate" and "master" communications systems. In other words, the citizens would learn how to assert themselves over the technology.

The computers selected for the Belle de Mai experiment were micro-computers made by the American company, Texas Instruments (TI99/4A) and ran LOGO. The choice of LOGO for the Belle de Mai project, with its opportunity for individual self-expression and its apparently universal understandability and simplicity, reflected Servan-Schreiber’s at once individualized and universal idea of each person as a *ressource humaine*, as well as the researchers’ “social” goal. Of the 800 programs available on the TI99/4A, 60 had been translated into French, including games, management software, various education programs (examples that Chappaz and Vignaux listed were for learning about electricity and mathematics), and word processing software. LOGO was selected because, as Chappaz and Vignaux put it, it is the "simplest language that could exist." "Simplicity" for them meant that the language was intuitive to each individual human user, irrespective of the person's intellectual inclinations:

> Programming the Turtle requires that one always think about the way in which one does oneself what one wants the Turtle to do. [...] In this way, each person can become the builder of one’s own intellectual structures, enter at one’s own pace into this new culture (Chappaz and Vignaux 1983b, 12).

Chappaz and Vignaux described LOGO as universally understandable. It was at one and the same time for everyone *and* personal, in the sense that it allowed all users to interact with the computer and to take part in computer culture through their own experience and at their "own pace." Chappaz and Vignaux contrasted LOGO's universal simplicity with the "mathematical bias" of BASIC. "BASIC is simple," they wrote, "but for whom? For those, surely, who conceived it. Only children who already are close to the engineers' 'math spirit' would benefit from this language. The others, once again, would be forced to admit that they are not 'gifted' for that" (Chappaz and Vignaux 1983b, 15). Chappaz and Vignaux presented BASIC as a highly particular computer language that was fitting only for a minority of mathematically inclined individuals and off-putting for everyone else. In contrast to BASIC, LOGO appeared to accommodate all tastes and styles of learning because it was built upon actions like moving forward and turning, which were deemed understandable to all. Presented in this way, the use of LOGO supported the vision of the Belle de Mai project leaders that *micro-informatique* could contribute to decentralization, to diversity, conviviality, and popularization of *informatique* as a tool.

As suitable as LOGO was for the French organizers' mission, importing an American programming language that ran on micro-computers created by an American company presented challenges. Chappaz and Vignaux were insistent that the appropriation of the technology should be done consciously. By this they meant that the technology should be used according to "our [French, and even more locally Belle de Mai] social imaginary," rather than allowing the "American imaginary" inherent in the technology to be imported alongside with it. American technology was selected for its price and quality—French-made computers were both more costly and deemed inferior in technical specifications, but its use came with the price of potentially importing American values of market-driven capitalism, which the leaders of the CMI saw as detrimental to their own hopes for achieving social transformation. Belle de Mai researchers addressed this problem practically by setting up conditions around the use of the machines, such as choosing French-infused public spaces like schools and associations that would help, they believed, to neutralize the "American" in the machines. This fear of importing American values with American-designed technology was a persistent concern of the CMI across its diverse projects.

While the experiment's organizers insisted that Belle de Mai residents would become masters of the technology for their own purpose, implicit in the notion of "social communication" that they sought to promote was the promotion of a new and close collaboration of the public with the technology producers. One goal of the project was to bring into more immediate contact the professionals who produced the technology and the public that was imagined as its user, so as to enable the public to make its demands on the computer industry more directly. This goal was also part of the totalizing space of the CMI on the Avenue Matignon in which experts, industrialists, and users were under the same roof. This new proximity between the computer industry and the users paralleled Servan-Schreiber's envisioned closeness between the computer and human being, upon which the development of *la ressource humaine* depended.

In sum, the micro-computer played a critical role in the Belle de Mai project. The entire experiment was organized around the observation of regular people interacting regularly with the machines. A large enough number of computers had to be introduced into the neighborhood in order to make these interactions commonplace and frequent but also in a way that would guide their use to result in particular imagined outcomes, e.g., to restore the "social communication" of a neighborhood that had once had it but had lost it due to economic troubles. The choice of LOGO was supposed to help to make the computer accessible to every person who chose to use it because it was deemed to be universally intuitive. This role of the computer in the French social experiment shared some similarities with its role in the American case, not only because they shared LOGO as a programming language, but because they emphasized the set-up of an experiment in which interactions with the computer would not be forced or overly structured. However, there was a big difference between the French and American approaches in regard to the way in which the experiment was organized around the computer. Notably, the rigor in both experimental design and observation devised by Papert and his team for the Brookline LOGO experiment was not present in Belle de Mai nor, for that matter, in the activities of the CMI as a whole. This difference stemmed from the different contexts in which these experiments were situated. Papert was doing NSF-funded science against lingering concerns of children falling behind, whereas Servan-Schreiber was doing national revitalization in a socialist imaginary. While children's (and the general public's) interaction with the machine was foregrounded by the CMI, represented by the children's play with the computer in the televised interview with Servan-Schreiber, their interactions remained largely unsupervised and without a centrally pedagogical purpose. Rather, there was a hypothesis that just offering opportunities for "playing around" with the computer would form *culture informatique* and the *ressource humaine*.

C. Playful experience: Meaning of play in the experiment

Playing games with the computer was a central activity that children engaged in at the headquarters of the CMI, but as far as one can glean from sources this was not because there was an explicit theory of why playing games was instructive or could lead to better learning and self-understanding (as in the case of the Brookline LOGO experiment and the Soviet computing summer school). Rather, it was, as represented by the image of the children playing during Servan-Schreiber's interview, an informal way to engage the young and to facilitate the creation of an *informatique* environment.

Staging the *informatique* environment required, above all, creating opportunities for people to have casual, one-on-one interactions with computers. This idea of the one-on-one relationship between computers and people was the crux of Servan-Schreiber's vision of how *ressource humaine* and *culture technique* would emerge. While Papert, Ershov, and Servan-Schreiber's French compatriots, such as the engineers of the SICOB game and teachers and computer scientists like Jacques Baudé and Jacques Perriault, worked on specific software and curricula to advance their visions of computer literacy, Servan-Schreiber focused on giving as many French people as possible a hands-on experience of interacting with the computer.

The notion of the *informatique* environment was in stark opposition to teaching *informatique*. The purpose of the Belle de Mai social experiment, Chappaz and Vignaux insisted, was precisely *not* to teach *informatique*. "We do not teach, *it is not possible to teach informatique in a standardized way* at a scale greater than five or six pupils [...]," they wrote, "[Our project] is about the promotion of a brand new culture, which cannot be established except through the construction of actual *informatique environments* for the public" (Chappaz and Vignaux 1983b, 10–11 original emphasis). The idea of creating an *informatique* environment as opposed to actively using the computer as a tool of the intellect was consistent with the broader French interest in fostering a culture instead of a more technical literacy.

The display of micro-computers in public venues and the use of various computer games, both educational and just-for-fun, was part of Servan-Schreiber's strategy for creating the right kind of environment with the machine. Play with the computer stood in contrast to actual instruction. Even if games like SICOB's were used in the CMI or in the computers distributed throughout the Belle de Mai neighborhood, what mattered for Servan-Schreiber was not the particular lessons of computational thinking or reasoning that the game developed, but the experience of interacting with the computer. In Roger Caillois' terms, the element of play that Servan-Schreiber sought to promote was not imitation (as in LOGO), competition (as in the Soviet case), or chance, but rather what Caillois called *ilinx* (from the Greek word for "whirlpool"), or games that "momentarily destroy the stability of perception" or transport a person to another reality (Caillois 23-4). Thus, one-on-one playful interaction with the computer in the case of the CMI's activities meant an interaction that was supposed to lead to the transformation of the individual into a member of the *société informatisée*. Play helped to adapt the CMI visitor or the resident of the Belle de Mai to the new environment of *informatique* created by the presence of the micro-computers in a way that was supposed to be gradual and accessible to all.

Soviet Union

> *The first program: And now try to perform the following small assignment. You need to create a program for the robot* DEZHURIK *[from Russian,* dezhurnny*, or "the one on duty"], who is able to perform the responsibilities of the student responsible for classroom duties during recess. [Here are the operations the robot can perform]:*
> *CLOSE WINDOW*
> *ERASE THE BLACK BOARD*
> *WET THE CLOTH*
> *OPEN WINDOW*
> *RETURN TO YOUR PLACE*
> *During recess,* DEZHURIK *needs to air out the classroom and straighten up the blackboard. Right now he sits next to you at the desk. The lesson is coming to a close. The entire blackboard has writing on it; the cloth is completely dry. The only window in the class is closed.*
> *Attention! The bell rings. The robot awaits your program.*
>
> The first program from Genadii Zvenigorodskii's textbook for 5^{th} to 8^{th} graders (1985, 39).

The first program that Soviet children were instructed to think through when beginning their computer literacy course was to give instructions to an imaginary robot. As in the case of LOGO or the SICOB, this was an exercise in giving instruction to another. Unlike in the Brookline classroom or the Belle de Mai center, however, the “other” here was a wholly imagined entity—there was no actual robot to instruct—and the task itself (taking care of the classroom during recess) was highly structured, with a pre-defined set of actions drawn from a programmed repertoire of classroom life. This practical exercise was preceded in the textbook by an explanation of why it was important to learn programming. The textbook’s author, Genadii Zvenigorodskii, encouraged the students to compare their calculating speed and ability with that of the computers that launched Sputnik (1985). By learning to program children would harness the impressive calculating ability of computers and become effective partners of the machine. While parallels between humans and computers were part of both the general motivation and the first programming exercise, drawing this parallel depended not upon imitation of the computer (as in the case of LOGO) or on the casual experience of the computer (as in the CMI experiments), but on friendly and productive competition between people and computers. Creating opportunities for this kind of competition between people and computers was a central element of Ershov and his colleagues' strategy for implementing their visions of second literacy.

<u>Experiments in building a new society</u>

Ershov frequently emphasized the experimental nature of the activities involving school children and computers, both the ones he and his team conducted in Novosibirsk between 1976 and 1984 and the ones that followed the 1985-1986 Soviet reform of general education. In 1986, at an academic conference, Ershov described the computerization of Soviet schools as "an experiment in building a new society." "We are experimenting," Ershov said,

> on ourselves and our children. But we took up this project and we cannot go back. [...] I mean no grandiloquence, but in relation to the training in computer technologies and their introduction into society we are now in the position of the year 1941. It is useful to remember this. It is frightening to go into battle, but if you know that it is essential to do it, you go (*Igra S Komp'iuterom* 1986, min 13:40 – 14:15).

By talking about this work as "an experiment in building a new society," Ershov sought to convey to his colleagues the novelty and risk of their endeavor. There was no blueprint for what they were about to do. The process and outcome of the experiment were uncertain. Yet, like the war against Nazi Germany, which loomed large in the

Soviet imagination as the most important battle and victory in history, for which the greatest sacrifices of life and resources were made, it was necessary to pursue the building of this new society through computer literacy at all costs.

In addition to the uncertainty of the venture, Ershov had yet another reason to see the work on the introduction of computers into schools as experimental. At stake for Ershov in these projects was not only to teach children programming, but also to understand the child's interaction with the computer and the form that the institution of the school should take in the age of the personal computer. Ershov believed that schools and, more generally, Soviet society would be different with the spread of computer literacy, but only by conducting the experiment itself would the structures of the new society emerge. The realization of the vision of second literacy was thus an experiment on and with society, as well as for the benefit of society.

Ershov's wish to understand the child's interaction with the computer and the social institution of the school in the age of the personal computer served as the initial impetus for launching the experiment of teaching children programming. In 1964 or 1965 Ershov heard a talk at the Novosibirsk Computing Center, where he was working, about a future computer that could fit on a postage stamp (Ershov 1985). He was intrigued by this idea, particularly since at the time there was only one computer in the whole Academic City and it occupied an entire wing of a building (Ibid.). Ershov imagined a future computer whose size would be between a postage stamp and a room: it would be a "hybrid" machine that combined a television screen and a typewriter keyboard and would fit on a school desk (Ibid.). This imagination of a foreign technology made up of two very familiar technologies that could be found in most homes in the Soviet Union, appears to have been a condition of possibility for Ershov to imagine everyone one day being able to use such a machine. This hybrid machine would be "personal" (a word Ershov used) in the sense that a family or an individual could own one and be capable of using it. He then wondered what the institution of the school would look like if this kind of future personal computer were widely available. In pursuit of this question, Ershov launched a series of experiments that would occupy him until his death in 1988.

In order to understand the future of the school with the personal computer, Ershov believed that he had to observe actual children using actual computers. This experiment began when Ershov arranged with the director of the Akademgorodok, Yuri Marchuk, to allow children from a near-by institution, School No. 166, to use the computer of the Akademgorok Computer Center, where Ershov was director. The students of School No. 166 received instruction in *informatika* in their school and would come to the Computing Center to practice their lessons with the Center's computer. This was the beginning of experimental activity in simultaneously teaching children programming and learning from observing the children's interaction with the machines what the future school might look like.

Young programmers at camp

By 1977 the relationship between the Novosibirsk school and the Computing Center was well established and came to be known as the "school of young programmers." This program trained 70 - 200 young programmers per year ((Alekseev and Vragov, n.d., 2). A young member of Ershov's team, Genadii Zvenigorodskii, had the vision to expand the number of children who could participate in learning programming as well as create a new space for studying programming outside of school by starting a summer school for young programmers. The first summer school was held in 1975 and attracted local Novosibirsk boys and girls. In 1978 the school welcomed for the first time students from other regions of the USSR and took on the name of "All-Soviet Summer School," bringing together more than 150 students from grades 5-10 from twenty-two regions and republics of the USSR (Ershov, Zvenigorodskii, and Pervin 1979, 20). Ershov and his team led the All-Soviet camps for eleven years and their success prompted him to work on organizing, in the last years of his life, an international summer camp.[3]

The All-Soviet Summer School consisted of lectures, practical activities and labs, and exams (Quartz 1978, 14).[159] The pedagogical process was organized around practical programming work focused on a particular theme (Alekseev and Vragov, n.d., 2–3). The two-week program consisted of general lectures about programming, delivered by distinguished programmers across the Soviet Union, and pedagogical lectures and seminars about various languages and programming systems. Each summer school ended with an event called the "Olympics." This was the moment for the students to "[demonstrate] deep knowledge and practical skill in programming" (Quartz 1978, 19 quoting official records of the summer school). During the two-week summer school, the students, their teachers, and sometimes also accompanying parents, all lived together in Novosibirsk University dormitories, ate in the cafeteria, and participated in many social activities together that included dancing, sports, and singing songs with Ershov on the banks of the Obe River.

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[159] The summer school had an annual budget of 40,000 rubles (Alekseev and Vragov, n.d., 3).

The Summer School was a hybrid of the familiar and the exotic. Donald Quartz, an American author who interviewed students of the organizing committee and wrote a book about the 1978 summer school, described it in ways that lent it an aura of an immersive, collective experience organized around the new, mysterious, and powerful body of the computer. Quartz recalled arriving at one of the summer school dorms after all the students had already left to discover it full of perforated paper whose content he could not understand:

> When the author entered the dormitory #9 on Pirogova Street, it was already empty. Feet gently stepped on perforated pages strewn about the corridor; the wind playfully blew about the huge pages of perforated paper. The author picked up one of them. On it there was a drawing of a backpack of huge proportions, apparently substituting for a suitcase for one of the participants. The author could not understand the contents of the other papers (Quartz 1978, 3).

Quartz's description of the dormitory room mythologized the school and its participants. The perforated paper was a by-product of the interaction of the computer and the young computer experts. The American did not understand the paper's content not because it is written in Russian but because it was in the foreign language of the computer. In addition to this unusual paper trail, Quartz found in the rooms the most banal object associated with Soviet gatherings: empty tin cans from sweetened condensed milk (Quartz 1978, 21) that students had brought with them to supplement their meals. This mixture of mythical and mysterious and the mundane and banal in descriptions of the summer school and of its participants echoed Ershov's description of the future computer as a hybrid of familiar TV screen and typewriter keyboard. It also echoed science fiction accounts of children and the new computer technology such as in the mainstream Soviet family film *The Adventures of Electronic* (Bromberg 1979) and the more nuanced and intellectually-critical novel *Ugly Swans* (Strugatsky and Strugatsky 1967). The hybridity of the computer (and programming) at once familiar and foreign enabled it to become a worthy partner of the human, as befitting the Soviet imaginary of the computer literate citizen.

A. Organizing the experiment

Although Ershov was inspired to invite children to the Computing Center by his interest in learning about what the future school might look like, the program of experiments, investigations, and research projects between 1976 and 1984 that he led with an "informal group" of researchers at the Novosibirsk Centre did not explicitly center on observing children. The diverse activities that the group led included giving children (from the regional school of young programmers, the Soviet-wide summer school, and a school by correspondence[160]) professional training in programming (conducted at an interschool training center), developing pedagogical programs (writing textbooks for schoolchildren and making special courses and projects designed for

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[160] The at-a-distance programming school was developed in 1985 and used the popular children's physics and mathematics magazine, *Kvant* (English "Quantum"). *Kvant* was founded in 1970 by Nobel laureate in physics Peter Kapitsa, experimental physicist Isaac Kikion, and mathematician Andrei Kolmogorov. Ershov was a member of the magazine's editorial board and frequently published articles in the magazine's programming section. The magazine had a broad readership—"from fifth graders to pensioners"—and catered to the amateur programmer and computer hobbyist (A. N. Vilenkin, "Kto i kak chitaet *Kvant,*" *Kvant,* no. 11 (1988): 89). Afinogenov (2013) argued that aspects of Ershov's vision for informatics education were realized through the journal and its at-a-distance programming school, while the informatics program in schools "failed" (Afinogenov 2013: 583-4). Unlike Afinogenov, I see the pedagogical activity of *Kvant* to be intimately related to the general education course and textbook developed by Ershov and his team. Like television, magazine, and radio programming popularizing or "sensibilizing" people to computers and informatics in the US and France, the articles in *Kvant* and the at-a-distance programming school were complementary to Ershov's other efforts and therefore its failure or success cannot be evaluated separately.

teacher training), and creating software (the educational programing languages “Robik” and “Rapira” and the “Shkol’nitsa” (Russian for “schoolgirl”) system of basic software,[161] as well as experimental teaching software in various fields). These activities reflected the broad approach taken by Ershov and his colleagues to the development of programming education. Specifically, the goal of all of these activities was to "find the forms and means of teaching school children the foundations of programming in conditions in which electronically calculating machines would be generally a part of school education so as to prepare the next generation for the not-so-distant future when computers will be on almost every work space[162]" ((Ershov’s introduction to Zvenigorodskii 1985, 2). This list of activities, however, did not account for the flipside of the experiment—learning about the human being and human relationships to the computer that these activities both depended upon and sought to illuminate. This interest was not a separate research activity, but an inseparable part of each educational initiative that Ershov and his core team undertook.

Despite their clear interest in encouraging human and social development with the computer, Ershov’s core team did not consist of psychologists or artificial intelligence specialists, as in Papert’s case. Instead, Ershov’s closest collaborators in projects of

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[161] The development of the *Shkol'nitsa* system was led by Zvenigorodskii. It was, as Ershov expressed it in the preface to Zvenigorodskii's textbook *Pervye uroki programmirovaniia,* "an embodiment of the approach to programming that this textbook develops" -- the approach that I have been describing in this dissertation. Zvenigorodskii died suddenly (he was only 33 years old) just a few months before *Shkol'nitsa* was finished. *Shkol'nitsa* understood the languages *Robik* and *Rapira* for teaching programming -- developed in Novosibirsk for children from 2nd to 10th grades -- and other programming languages. "It knows how to perform musical pieces and to draw. This system contains tens of programs for use in school lessons in different subjects, for example, a model of a chemical laboratory, astronomical reference book, drill for multiplying, Russian-English dictionary, and others" (Zvenigorodskii 1985, 32).
[162] "Work space" here denotes a child's desk, or space for working in the school.

computer education were Yuri Abramovich Pervin, a computer scientist,[163] and Genadii Zvenigorodskii, a young instructor.[164]

Zvenigorodskii was passionate about teaching children (before coming to the Computing Center he had worked with youth in Kharkiv, Ukraine). During the course of his work in Novosibirsk he pursued a doctoral degree with Ershov as his main supervisor. Zvenigorodskii's dissertation, defended in 1981, was on the topic of how to create what he called an "operational environment" for learning using the computer as a tool.[165] Zvenigorodskii postulated three hypotheses in his dissertation. First, that a time would soon come when the computing classroom in middle school will be just as common as

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[163] Pervin's biography reveals fascinating connections between mathematics, early computer programming, and pedagogy. He studied mathematics in the Nizhnenovgorod (at the time, Gor'kii) University and developed an interest in programming. In his last (fifth) year of undergraduate study was transferred to the Moscow State University to study at the institute of applied mathematics led by M. V. Kel'dysh, President of the Soviet Academy of Sciences. In 1957 he completed a thesis-project in which he developed an algorithm (and implemented it into a program for the "Strela" computer) to play dominos (Pervin Journal Interview, 7). Just before completing this degree, he was invited by Ershov (an invitation that was supported by his adviser, the famous Soviet mathematician and computer scientist, A. A. Liapunov) to join the newly founded Novosibirsk Akademgorodok's Computing Center. However, Pervin decided to not take up the offer and return to Gor'kii. After finishing his studies he worked on various applications of computing to industrial projects, but as his children grew up he became interested in teaching them programming and facilitated the creation of an informal educational program where children would write computer programs and then take them (on punch cards) to the Gor'kii University computer center computers (which included computers like, *Strela, Ural, Minsk-32, BESM-4*) (Interview). In 1969 he spent a year abroad in France as an intern from Gor'kii University. Liapunov, who Pervin describes to have known well French researchers in mathematics and programming, gave him introductions to leading scholars. During his year abroad, Pervin (now fluent in French) developed strong relationships with the Belgian pedagogues Frédérique and Georges Papy. He translated Papy's books (*L'enfant et les graphes* 1968) into Russian and describes that this project left an important influence on his subsequent work. In 1973 Pervin was again invited to join the Novosibirsk Computing Center, this time to work on developing programs for the then-new Soviet computer system *Elbrus.* There he developed a close relationship with Ershov and quickly joined his group of researchers working on school informatics—work that joined Pervin's interests in programming and pedagogy. He completed his doctoral dissertation at the Novosibirsk Research Institute (NII) from the Academy of pedagogical sciences. Pervin continues to this day to work on computers in education in Russia and frequently collaborates with French scholars, such as Georges-Louis Baron, in this field.

[164] Other participants of the "informal group" were researchers from a number of academic institutes (above all, the Computing Center) and the Novosibirsk University, and also of college and school teachers (2-3).

[165] The title of Zvenigorodskii's dissertation was, "Mathematical support for the educational process—the means for forming the operational environment."

the sports gym, the physics laboratory, the chemical laboratory, and the art room. This was a hypothesis that Ershov was also convinced of (Ershov 1981b, 1); it was, in fact, the premise with which Ershov launched into experimenting with children and computers. Zvenigorodskii's second hypothesis was that students should not only study programming as a subject matter in school, but that programming should become the "organic means" facilitating the entire educational process. The use of programming as a support of education as a whole is what he termed the "operational environment." Furthermore, Zvenigorodskii's third thesis, was that programming would not only be the material means of the educational process, but also the source of fundamental concepts, habits, and skills that would form what he termed "operational thinking" (Ershov 1981b, 1). Ershov agreed with these hypotheses of Zvenigorodskii's dissertation.[166] They became the working hypotheses with which Ershov, Zvenigorodskii and Pervin launched the activities of the young programmers school and summer school. The young programmers school and summer school were the places where Zvenigorodskii practiced and investigated how programming could become the "operational environment" and come to constitute "operational thinking." The schools were the experimental sites where the researchers both developed these hypotheses and sought to make them realities.

The researchers all the time observed and learned from watching the children. They observed the seemingly effortless way in which children could become masters of working with computers. They found the resolve and fearlessness with which the

[166] Ershov believed there to be ample evidence to suggest that teachers and psychologists were in agreement about the utility of informatics for the development of the educational process. He cited Papert's IFIP 1981 talk devoted to this subject and also the work of Professor Stoletov in *Literaturnaiia gazeta,* January 21, 1981, which argues that a child's ability to formulate a theory about the subject she is studying plays a crucial role in the educational process (Ershov 1981b, 1).

children interacted with the computers a confirmation of their initial hypothesis. If programming came so naturally to children, then it could—and should—come to constitute the "organic means" for learning.

What did they observe to make them believe this? They observed that children who could not even read could easily use the machine to draw and play games. They were even more fascinated and interested in whether children could program the computers. They wanted to know if children "can become the masters [*хозяин,* also "owner" or "host"] of this machine." They found that,

> Here also the results were very positive. After just half a year of work on in the school of young programmers a few kids emerged for whom work on the EVM did not create any difficulty. Moreover, we observed that they are learning this task a lot faster than us. They have a kind of lightness in their fingers, some kind of error-less state of mind and after a few lessons in computer literacy they were able to work very well in the computing center (Ershov 1985, 5–6).

To illustrate this miraculous capacity of children to be comfortable with computers and to learn programming, Ershov used the example of a student from the 9th grade named Zhenya Nalimov. Nalimov became the child-expert of the new American computer that the Computing Center received. He started using a new computer at the Center that was "allegedly American" and no one yet knew how it worked. In less than a year after this machine appeared, Nalimov became the most knowledgeable expert about the machine. Ershov described how no one created this reputation for him; it was just the case that when a scientist at the center had a question about how the machine worked they would first go to ask Nalimov and he would provide all the answers that "actually worked" (Ershov 1985, 6). Examples like these, which demonstrated the ease and fearlessness with which children worked with the computer, served as evidence for the researchers that programming was part of human nature, or something that people do even in the absence of computers. In children, the researchers found people who readily approached computers and learned to do what computers do.

Instead of focusing on the psychology of the child and of the development of child learning as in the case of LOGO, the core team of Soviet computer literacy researchers (which consisted mainly of computer scientists and teachers with no special expertise in human psychology) concentrated on the programming capacity that both computers and humans appeared to share. While Papert and his team defined artificial intelligence as "computational psychology" and considered the computer as a Rorschach that reflected the mind, thus emphasizing the computer's capacity for unlocking the human mind, the leaders of computer literacy in Novosibirsk worked towards developing an effective collaboration between like-minded humans and computers for the achievement of external tasks not linked to individual development.

The places where second literacy was taught became themselves the laboratories for experimenting with building a new society. The summer camp that took place on the grounds of the Novosibirsk Akademgorodok, with its Computing Center and its dormitories and cafeterias was at once the field of implementation and the lab of investigation. One consequence was that many of the scientists using the Computer Center were surprised and uncomfortable to suddenly find children competing for access to expensive research computers. Ershov discussed the difficulty of overcoming the researchers' concerns "to allow a crowd of kids into a large and serious institute who would displace the adults in their attempt to access the terminals of the EVM" (Ershov 1985, 4). Archival records, to my knowledge, do not help explain how Ershov was able to convince the Akademgorodok's director, Yuri Marchuk, to allow this to happen despite scientists' concerns. However, we can conclude from the fact that it was actually done that Marchuk was convinced by Ershov's vision for the need to investigate the interaction of children with computers. This unordinary act of breaching the boundary between the serious space of the Computing Center and the "crowds of children" was also of interest of the public following Ershov's activities.[167]

Once the crowds of children were let in and the Computing Center became an experimental laboratory in forming computer literate citizens, the experiment became open to all who were interested in getting involved. This "open" attitude of the experiment was first of all exemplified by the criteria used to decide who could take part in the Summer School. There were no prerequisites to participate, only, as Ershov put it, to be a good student in school and have no conflict about attending the school with one's parents (Ershov 1985). This last "requirement" for participating in the summer school was in part a joke, but in part serious because of the parents' lack of familiarity with the idea of programming and that their children should spend time learning it. Even more than lack of familiarity, the common perception was that parents hesitated to allow their children to program because they were concerned that it would make their children into robots or machines (see, for example, the concern of parents expressed in the Strugatsky brothers' science fiction story, *Ugly Swans*), and thus remake them in a way that would make their own children foreign to their parents.

These open criteria for participation resulted at times in entire delegations coming to Novosibirsk without invitation (Quartz 1978, 9 quoting from official records).

[167] As evidenced by the fact that Ershov was asked about this in interviews (e.g., Ershov 1985, 2).

Delegations of students, teachers, and parents arrived from various regions of the Soviet Union, sometimes bringing twice as many people as the spaces that they were allotted. They crowded dormitory and classroom space and, in particular, strained the already-limited access to computers that the hosts had planned for. The organizers accommodated everyone, finding extra mattresses and arranging for extra meals with the cafeteria that the visitors supplemented with canned goods that they brought with them. Apart from straining the organization of the school's logistics and activities, the extra participants demonstrated the ad-hoc and experimental nature of the programming summer school, its great appeal and demand across the Soviet Union, and the willingness of the committee to accommodate everyone interested.

Parents were both eager to send their children to the school and concerned about the long journey to Novosibirsk and about what the children would learn there. In an effort to reduce the uncertainty of the experience, parents sometimes accompanied the students on the long journey to Novosibirsk and also stayed for the summer school activities. There, they were invited to participate in the collective development of programming materials, especially for education and gaming (Quartz 1978, 2). Similarly, teachers of informatics and program leaders who accompanied the student-delegates could participate in methodological seminars and discussion groups to contribute to the development of pedagogical programming materials.

The location of the Summer School in Novosibirsk, far from the political center of the Soviet Union, did not prevent the activities there from being spread throughout the Union. The results of the summer schools were published in the children's mathematics journal *Kvant* and *Informatics and Education* journal, as well as spread through newspapers, radio and television programs. Participants in the summer school spread their knowledge on returning home, helping locals learn programming. In this way,

> The Novosibirsk summer school continues to perform the role of the leading center for the distribution of experience of teaching informatics and an experimental site for teaching of the 'technology of programming' in collective projects, and for the development and distribution of contemporary educational programming means (Quartz 1978, 3).

The openness of the Summer School to almost any participant who wanted to learn programming and take part in the social experiment of computers in the society was part of the experiment's very design, in order to see who would be attracted, who would come, and for what purpose they came.

B. The computer in the experiment

Given that the original impetus for Ershov's experiment was his interest in the school in an era when computers would be a regular part of the class environment, it is surprising that the computer played a relatively small role in the experiment. The artifact itself was far from central to Ershov’s and his colleagues' social experiment. The experience of the summer school students was a case in point.

During the course of the summer school children heard lectures in regular classroom settings and practiced exercises in programming *on paper*. They visited the Computing Center—whose terminals were the only computing resources for the summer school—but they did not get to work extensively on the computers. Even during the final competition at the end of the summer school, referred to as the "Olympics," which was intended to give students "practical experience" with programming the computer, the majority of students never got to practice their skills on real machines. The Olympics began with all participants solving programming problems on paper and only the ones that did well in the paper round were allowed to move on to the "practical tournament" part of the competition (Quartz 1978, 19 quoting from official records).[168] Access to computers during the Olympics reflected the pattern of access to computers during the entire summer school: in both cases, using the actual computer was reward and motivation for participating in the school, but by far not the main activity.

This de-centered nature of the computer both reflected and contributed to the concept of *informatika* (informatics) of Ershov and his colleagues and the practical pedagogy of "school informatics" that they developed based on the summer school experience. In his 1985 textbook for second graders, Zvenigorodskii wrote:

> If you want to learn how to create programs for robots and calculating machines, to master key concepts, laws, and tricks of programming, prepare yourself for serious work. Get ready some notebooks with graph paper, a pen, pencil, and ruler (1985, 32).

This textbook, as well as the curriculum developed to support it and the school informatics program for grades nine and ten, reveals how from the perspective of the researchers actual use of the computer was not essential in order to learn programming. Unlike the central role that the computer played as an artifact in the creation of the *informatique* environment conceived by Jean-Jacques Servan-Schreiber in France, creating the so-called operational environment in the Soviet Union required very few actual machines. Instead of emphasizing practical work with the machine, the researchers emphasized learning the formal programming operations that they considered

[168] Quartz does not indicate how many of the one hundred students who participated in the competition in the 1978 summer school went on to the practical round and had a chance to use the computer.

to be fundamental to not only all computers, but to human thinking as well.

C. Playful competition: Meaning of play in the experiment

As the space of the early experiments with society, the summer school made possible particular ways of learning in an immersive, competitive and playful environment that could not have been achieved in a school classroom or even in the Novosibirsk school of young programmers. In addition to its educational content, there were many recreational and communal activities that lent this exceptional school the air of a typical Soviet summer camp. Sports competitions and dances brought students together to relax after \ lectures and homework. One of Yuri Pervin's most cherished memories of his work in the Novosibirsk Akademgorodok was when Ershov, playing the guitar, led the group of young programmers in song on the banks of the Obe river near the Akademgorodok (Pervin 2014). Even the most extraordinary summer school had the spirit of the familiar Soviet "Pioneer camp" for children, which was a fundamental passage point for all children growing up in the Soviet Union.[169] Despite being open to invited and uninvited participants alike, indeed any who were willing to make the journey to Novosibirsk, the summer school was a space apart from regular life. It was an immersive experience in learning programming, presented to the participants simultaneously as a new language and a new way of thinking.

Ershov and his colleagues believed that the environment in which programming was taught mattered even more than the kind of language that would be used to teach programming. In an important 1979 essay on computer education, “School informatics:

[169] On the role of the Pioneer camp in the development of children in the Soviet Union see (Kil’dyshova 2012).

Conceptions, Current State of Things, Perspectives," Ershov, Pervin, and Zvenigorodskii described how the most effective pedagogical approach to developing computer literacy in children was to teach programming outside of school. The reason for this was the nature of the teenager, whose "interests and spiritual forces," as Ershov explained, "go to the understanding and assertion of one's position in society" (Ershov, Zvenigorodskii, and Pervin 1979, 19). They suggested that programming helps the young person to understand her place in society and to stake it out for herself. These benefits of programming would be especially pronounced when it could be taught in an environment such as a student-run "laboratory" or a summer school (camp) because these environments enabled the young person to develop a stronger relation to society while learning programming as a skill and a way of thinking (Ershov, Zvenigorodskii, and Pervin 1979).

In organizing these educational programs outside of the school, Ershov was inspired by the educational approach of a famous Soviet pedagogue Anton S. Makarenko. In the beginning of the 1930s, Makarenko began to put children (especially orphans of the Russian Revolutionary war) into special children's colonies where the children studied and worked while also making socially useful products. One such colony produced a photo camera that became famous around the Soviet Union. Ershov praised this pedagogical style for enabling young persons to develop their social role: it "not only got the students accustomed to labor, gave them a professional skill and taught them economic skills, but, most importantly, gave the teenager access to the latest technologies, which allowed him to develop confidence in his participation in the main forces of technological progress" (Ershov, Zvenigorodskii, and Pervin 1979, 20). Ershov approved of the way in which learning in a live-in colony made technical learning a part of one's occupation and social life. Unlike a student in the classroom who learns diverse subjects without seeing them applied to practical problems, learning in the colony was integrated with one's livelihood and shared in the community with a direct outlet to the larger world. In other words, learning in the colony was more concrete and less abstract.[170] It was also a way to introduce the young person into society and enable him or her to serve a social function.

In addition to providing this holistic environment in which technical knowledge could more effectively be integrated with the human person, the competitive and playful nature of the summer school reproduced aspects of the computer game that Ershov and his colleagues considered advantageous for the development of the human-computer relationship. Ershov described how, involved in a competitive game with the computer, such as chess, the machine's artificiality falls away and the computer appears as a good opponent or "partner" rather than a hostile entity to compete with. "The person who competes with the machine in this moment of competition," Ershov said in a televised interview,

> does not think if the machine is creative or not. He tries to compete with the machine and discovers that this is very difficult, he must concentrate to win, and maybe even not be able to win (Ershov 1985, 21).

According to Ershov, this competitive struggle with the computer was not only entertaining and engaging for the human being, but revealed something about the very

[170] Ershov's preference for more concrete instead of abstract learning is similar to that of Papert, for whom learning in the samba school was the ideal.

meaning of concepts like "creativity" and "intelligence." "Development of machines in this direction," continued Ershov,

> many of the things that we call by diffuse words like 'creativity,' 'intelligence,' etc. actually contain in them phenomena that we do not yet understand […] the search for laws that allow the machine, by following strict rules, to carry out in a logical fashion this [intelligent activity] are in fact the discovery of the secrets of intellect. […] [T]his is the path to the human being knowing herself which simply cannot be done without the electronic machine (Ershov 1985, 21).[171]

The benefit of the competitive environment of the game, according to Ershov, was that the "serious" competition with the machine over who is more intelligent or creative would be transformed into an engaging and friendly competition through which the human player could learn about herself. Ershov and his team sought to reproduce these qualities of the game with the computer at a collective level in the summer school in order to aid the instructional process in programming, teach programming as a fundamental way of thinking (Zvenigorodskii's "operational environment" and "operational thinking"), and also more effectively understand the human being (i.e., "human being knowing herself") in relation to the computer.

In previous chapters I have described how Ershov and his colleagues had the vision of the computer as a productive partner of the human being. Learning to become a partner of the machine required transforming any potential fear or apprehension of the machine that could be a source of hostile relation to it and "unfriendly" competition over intelligence or creativity into a friendly and productive partnership. Ershov and his team pursued this project in their Novosibirsk experiments by emphasizing the utility of

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[171] To be precise, the presence of an actual computer was, once again, not essential. It was enough to confront the machine as a playful and competitive opponent *on paper,* where the key algorithmic action took place, according to Ershov.

competition and comparison with the machine as a way to measure oneself and then used the game with the machine as a way to become the machine's partner, "generously transferring [human] knowledge" to the machine in return for being able to do things "faster and more adeptly" (Ershov 1985, 18).

While Soviet computer literacy pedagogy relied upon games in which mimesis was the dominant play-type (as in the first programming activity in Zvenigorodskii's textbook, cited at the opening to this section), Soviet games with computers emphasized competition, or what Roger Caillois called the *agôn* play-type (Caillois 1958, 14). The emphasis on competition comes through even in Ershov's beloved metaphor for the ideal relationship of the human to the computer: the jockey on a horse. With this metaphor, Ershov wanted to communicate the seamless bond, mutual understanding, and even physical pleasure and ease of the ideal human-computer relationship. The relationship between jockey and horse can be described as playful, in the sense of having fluid and intuitive control over one's body and movements and those of another (see Rahner 1967). However, there is an undeniable element of competition in this game, where the effectiveness of the partnership is mobilized by the race to the finish. It is also no surprise that the camp atmosphere, which Ershov considered the ideal environment for becoming computer literate, and as relatively playful compared to the regular school classroom, was crowned by the Olympiad, where camp participants competed with one another to demonstrate who had best mastered the partner-computer. Finally, the competitive dimension of the Soviet game with the computer comes through in an illustration by Zlatkovskii accompanying Ershov's UNESCO speech (Ershov 1981a). It depicts a child sitting in front of a large computer console, closer to the kind that one might expect in a nuclear command and control center than to a personal computer, and a Jack-in-the-Box pops out of it. Like an image of a rose growing from a rifle, Zlatkovskii's illustration suggests that the child's playful mastery of the computer can subvert deadly adult war games into humor and entertainment, conveying the socially-transformative power of the second literacy in the hands of the younger generation, while still framing it in nationally strategic and competitive terms.

Masters of play

Three different experiments in human-computer interaction grew from the thinking of pioneers in the United States, France, and the Soviet Union as they contemplated the social transition to the information age. They were experiments at different scales (classroom, city neighborhood, and summer school), of different durations (year-long observation; multi-year deployment; annual two-week event), and conducted with different technical means (four computers equipped with LOGO; four hundred computers distributed throughout a neighborhood; limited access to the terminals of a large computer in a national center of academic research); and they targeted different people (children of different abilities from a local Boston school; the population of a whole city neighborhood; motivated and passionate children, their parents and teachers, from across the Soviet Union).

Each experiment used play with the computer as a strategy for both teaching computer literacy and learning about the child's "natural" use of computers. In all three cases, children played with the computer: "playing turtle" in the LOGO micro-world, playing around with computers at the CMI or in a city neighborhood, or playing against peers in the summer school Olympiad. In the American and Soviet cases, the computer game was by design an instructive exercise and also one through which, the designers hoped, the player would learn not only content, but something about the player's own forms of reasoning and thinking. Although Servan-Schreiber did not have an explicit theory of the game of this kind, he also relied upon games and casual play with computers to create *informatique* environments in which a person could develop as a *ressource humaine*. In the case of the United States, the path to computer fluency lay in playfully imitating the computer; in France, *culture informatique* meant letting oneself playfully experience the computer; and in the Soviet Union, second literacy came through playful competition with the computer. These three types of playful engagement with the computer both reflected and reproduced the imaginaries of the computer literate or cultured citizen in each of the countries.

Regardless of the dominant characteristic of play in each case, play with the computer was explicitly sought out so as to provide a way for the child to escape the narrow design of the experiment (as in the SICOB vignette) and move from being a passive subject to an active master or teacher of the computer. As such, the player instructed the computer, the actual teachers, the experiment designers, and society at large in the "right" interaction between humans and machines. Interplay with the computer was a serious (instructional) activity at the same as the designers of the experiments used it to create for the player the opportunity to have an (seemingly) unstructured encounter with the machine.

This use of computer games and play in the experiments reveals the experiment designers' reverence for children's seemingly innate knowledge of the computer and their wish to ensure that this knowledge would not be suppressed, but, on the contrary, be amplified with the machine. At a moment in time when a serious technology, originally tightly controlled by experts, moved out of experts' hands for use by the general public, there emerged a reverence and respect for what the child knows and for what children could teach adults about the computer. This moment marks an important shift in the history of social experimentation and human experiments in which the subject is considered to know something (see, for example, Lemov 2015). The child as a fluent player with the computer, as opposed to a mere user of the computer's pre-determined functionalities, was an ideal of the master computer—of the computer literate and cultured person—for all three of the pioneers.

Each of the experiments carved out a safe space for play where the interaction with the machine could take place. Interactions in the LOGO micro-worlds were governed by the specifications of the programming language, the movements of the Turtle, and the unpredictable exploratory activity of the child. In order to make the experiment possible, Papert and his colleagues even needed to invent a new endogenous method for evaluating the activities in the micro-world (and in the mind)—the dribble file—which circumvented the usual authority of the teacher in the classroom. In France, the CMI was an entirely new institution created for the express purpose of organizing *culture informatique* projects. It was a space set apart from the usual French public organizations in the way that it cut across political and economic interests, drew upon the funds of different French Ministries, and hybridized France with "the world" within one building. For the Belle de Mai experiment the CMI carefully selected a neighborhood that was geographically circumscribed and had a strong communal identity. At the same time, its usual modes of interaction were seen to have weakened and it was thus a good target for trying to rewrite the rules of social interaction through the introduction of the computer. While Servan-Schreiber established his space-apart right in the Parisian heart of the French state, Ershov worked at the periphery of the Soviet Union. In the Novosibirsk Akademgorodok, which was already a place where not all rules of Soviet society applied (Josephson 1997), Ershov crafted a space that challenged traditional boundaries between expert researchers and children.

While defining games and play, Roger Caillois observed the centrality of spatial and temporal constraints: "Play is essentially a separate occupation, carefully isolated from the rest of life," he wrote. "[G]enerally [it] is engaged in with precise limits of time and place. There is place for play: as needs dictate, the space for hopscotch, the board for checkers or chess, the stadium, the racetrack, the list, the ring, the stage, the arena, etc. Nothing that takes place outside this ideal frontier is relevant" (Caillois 1958, 6). By creating new technologies, institutions and pedagogical innovations, the pioneers delineated their own ideal frontiers, unbound by their society's usual rules of the game, in which people could come together with computers in playful ways.

In the following chapter, I examine how the lessons that the pioneers learned from these experiments provided the foundations for textbooks, curricula, and best-practice recommendations for experimentation with computers and children in wider sites: at the level of general education in each nation. And I examine the fate of the interplay ideal when the pioneers sought to implement it at the national scale, where the traditional rules of the game remained dominant.

Chapter 5:
A Return to Rules

With the rise of the nation-state, promoting literacy and culture became undertakings on the national-scale, aimed at supporting and developing the identity of the nation. Computer literacy and culture, however, did not start out as national in scope. Projects to develop computer literacy and culture began, as we saw in the previous chapter, as local experiments involving relatively small segments of the population in specially created experimental settings. The pioneers of these projects, however, believed that computer literacy and culture ought to be implemented on a national-scale.

Seymour Papert, Jean-Jacques Servan-Schreiber, and Andrei Ershov all felt the need to scale up their computer fluency, *culture informatique*, and second literacy projects from local experiments to the national level, but they used different arguments. In a 1977 address to Congress as part of a Hearing called "Computers and the Learning Society," Papert called on the US federal government to create a "mandate to mobilize for [...] a paradigm shift in our way of looking at computers" (US House of Representative 1978, 272). Papert argued that the federal government had to lead this mobilization. Neither the established funding mechanisms for research on computers nor the educational community would be able to accommodate the kind of "holistic" and "global" change in human learning that Papert envisioned would follow from the introduction of computers into society. Without the federal government leading a full-scale effort to entirely rethink education in light of the advent of personal computers, Papert predicted that researchers studying how to use computers in education as well as members of the educational community would pursue unsatisfying incremental changes to the existing educational system.

Papert was motivated to appeal to the federal government by the scale of the imagined technological change he saw the computer industry to be leading. He believed that, whether the government or the educational community liked it or not,[172] the computer industry would bring about a world of "computer culture" in which adults, children and babies would be affected by computers in the school, the home, and their places of work (258). “The computational revolution is certain to happen,” he predicted, “it is driven by industry rather than by the educational community. It will take place in the home whether or not the schools accept it” (262). Papert considered it a responsibility of society—and of the federal government as its leader—to encourage, at the least, studies about "learning environments totally redesigned so as to respect the integrity of the new technologies" (260).

The cost of failing to make a nation-wide reassessment of learning in the age of the computer would be what he called anachronistic technological "digging in," or getting stuck in outdated, inefficient and yet difficult to change ways of doing things. "Without an immediate stock-taking," Papert told Congress, "we may be digging ourselves into ways of using computers which could turn out to be counterproductive to education"

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[172] Here Papert appears to attribute to computer culture a kind of inevitability (it would come about on its own), while in other parts of his statement before Congress he said that "computer culture" is something that needs to be made, e.g. "You cannot build a new computer culture the way you would make a minor curriculum reform" (US House of Representative 1978, 266). My interpretation is that he wanted to talk about different types of computer culture. One kind of computer culture would come about on its own thanks to industry's push of computers. In this culture the computer would be a tool used in the service of the existing educational system. The other computer culture could be made if the Federal government made deliberate action to think "globally" and "holistically" about computers and learning. Papert preferred the latter.

(263). Unreflective use of the computer in education, Papert thought, would bring about inefficiencies that would not only miss taking advantage of the full educational potential of the computer, but would be harmful to education. Papert's favorite example of such digging in was the "anachronistic" persistence of the QWERTY keyboard, which people continued to use even though their typewriter-based key layout slowed down and made typing more awkward. Falling into the habit of using an educational technology designed without holistically reconsidering the role of the school in the age of the computer, however, would have more significant negative outcomes than mere inefficiency.

According to Papert, the greatest problem with inaction, or action by incremental changes rather than a global rethinking, was the loss of opportunity to help the majority of school students to reach their full potential as learners. "I believe," Papert told Congressman James Scheuer (D-NY), "that very, very few kids reach anything like the intellectual attainments of which they are capable" (273). Papert warned that this loss of America's children's intellectual potential would limit America's international power because other nations were already thinking about how to take advantage of the true capabilities of the computer for learning (267). Thus, Papert considered a national-scale intervention into computers and education necessary to capitalize on the opportunity to improve the each person's capacity of intellectual self-fulfillment and to aggregate this capacity across the nation.

While Papert argued for national-scale implementation of computer fluency programs in order to aid the flourishing of every single American, Jean-Jacques Servan-Schreiber argued for national intervention primarily out of concerns for the future of France. Servan-Schreiber worried about the waning of France political and economic influence in international affairs. As a result of his own research and writing, he came to believe that only managerial training of the French population (Servan-Schreiber 1967) and computerization of society (Servan-Schreiber 1980) would allow France to regain its status in the world. As I showed in Chapter 3, Servan-Schreiber's concept of *ressource humaine* was born out this way of thinking about the problems confronting France and out of his ideas about how the computer could be used to remedy them. Servan-Schreiber saw the need for a national project to ensure the development of each person with the computer because each person was a resource for the French state.

Ershov, too, argued for the national implementation of second literacy because he saw *informatika*—the foundation of second literacy—to be a natural inheritance of all human beings. Ershov considered *informatika* to be a new "basic science" like biology or physics and he believed that studying *informatika* would allow the person to acquire self-knowledge. As such, second literacy would serve as an essential property of being human, and thus, Ershov thought, must be part of each child's general education.

Ershov developed this holistic understanding of *informatika* during the course of his experiments teaching students programming as part of the young programmers school and All-Soviet summer school in Novosibirsk. *Informatika,* according to Ershov, was neither a way of dealing with technoscientific information nor limited to the science of the computer (Chernyi 2011). Instead, Ershov claimed for it a broader third meaning—it was "a fundamental natural science that studies processes of transfer and processing of information" (Ershov 1984, 167). According to this broader definition, *informatika* was not restricted to what computers did nor was it necessary to use computers to do it. The definition supported Ershov's vision that informational processes constitute both the individual human body and the social body (Ershov 1981a). Encouraged by the positive results of seeing young children as not only capable of programming, but also of doing so with passion and involvement, Ershov and his colleagues argued that a particular branch of *informatika* that they termed "school informatics" (*shkol'naiia informatika*) must be taught as part of general education in order that, beginning with children, the whole Soviet population would acquire computer literacy.

In addition to thinking of *informatika* as a basic or even human science, Ershov and his colleagues also considered second literacy to comprise a set of essential skills that everyone in the information society ought to know. One colleague, Yuri Pervin, described these skills and their foundational significance as follows:

> The knowledge of how to plan one's activity, to build informational models (to describe the structure of given data), the ability to search for information necessary to solve a given problem, the ability to communicate in a group and, finally, the skills of when to turn to a particular technological instrument, these are necessary for everyone and that is why they should be formed in the school years (Pervin 2014).

Ershov and his colleagues' program of school informatics for 9th and 10th graders was designed to teach students these essential skills, the sum of which was to give the student a foundation in algorithmic thinking. For them, algorithmic thinking was a new basic skill of the information society. Its basic nature derived not only from its relevance to the computer revolution, but also because they saw information and informational processes to be a timeless part of the natural and social worlds.

In each case, the pioneer's argument for the national implementation of computer literacy and culture underscored a perceived failure—with the school, with participation in civil society, with productivity—that the ideal computer player was expected to remedy, especially when that ideal was extended to the scale of the nation. At bottom, the remedy entailed transforming subjects into what I call playful subjects, whose subjectivity would be constituted in part by their free and interactive relationship with the computer and who therefore would be expected to have different, more creative and productive, relationships to the nation-state.

Extending the ideal of the computer player to the national scale, however, was not as straightforward as simply increasing the number of people participating in experiments of the type discussed in Chapter 4. Extension required collaboration with ministries of national education and industrial leaders—institutions with their own ways of doing things and implicit ideas about computer literate subjects that did not necessarily align with the ideals of the pioneers. In this chapter I examine the specific strategies that the pioneers used to extend their visions and the resistance that they encountered when their ideal rules of engagement, which they managed to create in relatively isolated experimental settings, bumped up with established national ways of doing things.

United States

It is difficult to think about implementing an educational program at a national scale in the United States. Education is the constitutional responsibility of the states. Most decisions about what to teach and how to teach are taken at the state or local community level.[173] The US Department of Education, however, sets standards, funds various educational initiatives, and has historically provided information to schools about

[173] This is especially true at the primary and secondary level of education, where the vast majority of funds for education come from local communities and the State (U.S. Department of Education 2012).

"what works" in education, and in this way indirectly influences educational standards and curriculum. There have also been identifiably national movements to teach particular subjects or ideas. By "national movement" I mean those subjects that are deemed to be so important or controversial at a particular period of time that the majority of school districts around the country must take a stand on them, i.e., either teach them or explicitly teach something else as an alternative (e.g., debates about creationism or the New Math curriculum[174]). In addition, there are "basics" that every school is expected (though technically not required) to teach, which are frequently referred to as the "3R's": reading, writing, and arithmetic. In the history of American education, computer literacy was both: a movement that public schools around the nation had to respond to and a new basic skill.

National developments of computer literacy

There are three discernible stages in the development of computer literacy as a national educational phenomenon in the United States.[175] The first stage began in 1968,

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[174] In *The New Math: A Political History* (2015) Christopher Phillips argues that the New Math curriculum promoted a new kind of American subject. New Math curriculum and initiatives to introduce computers into education (especially the computer assisted instruction) both benefitted from the National Education Defense Act (NDEA) passed in 1958 in response to the launch of Sputnik. NDEA expanded Federal involvement in education (see Phillips 2015; Ravitch 1995).

[175] Important events in local school initiatives in computer literacy include:

1972, Minnesota Education Computing Consortium (MECC) formed by Community College system, Department of Administration, Department of Education, State College System and University of Minnesota.

1973, Lawrence Hall of Science Computer Literacy program organized by Arthur Luehrmann.

1977, first publication of the *Personal Computing* Magazine.

1978, Rosemount School District in Minnesota instituted computer literacy for grades 3-8.

1979, *ComputerTown, USA,* a community organization for teaching computer literacy, formed in Menlo Park, CA. Organized by the People's Computer Company (formed in 1972).

1979, *K-12 Course Goals in Computer Education*, Multnomah County, Oregon when Congress, under the guidance of President Lyndon B. Johnson, directed the National Science Foundation (NSF) to provide a leadership role in the use of computing in science and in education (Seidel, Anderson, and Hunter 1982, 3).[176] As a result of this law, from 1971 to 1981 the Science and Engineering Education Directorate of the NSF invested over $70 million in different efforts to expand the use of computers in science education (Ibid.)[177] With the official NSF mandate to support computers in education came a wave of research projects that presented alternatives to CAI and opened up new, non-behaviorist ways of using computers in education.[178] As I described in Chapter 2, these alternatives included the 1967 project led by Wallace Feurzeig at Bold, Beranek and Newman (BBN) to create a programming language for teaching mathematics (which was the origin of LOGO) and the introduction of the concept of computer literacy in

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From the side of the computer industry, in 1978, the Association of Computing Machinery (ACM) sponsored an Elementary and Secondary School Subcommittee chaired by David Moursund.

176 Congress also made a change in the NSF statute in that same year (1968) to allow it to support applied research ("The National Science Foundation: A Brief History" 1994). That same year, the Boy Scouts of America introduced a "computer merit" badge (Seidel, Anderson, and Hunter 1982, 39). This badge originally featured an image of a punchcard (see comment of eary recipient of the badge to an article in Wendell 2015). Sometime in the 1980s (I have not been able to find the exact date), it was replaced with one showing an image of a personal computer on a blue background. The merit badge has an interesting history, which speaks to the changing way of seeing the meaning of computer literacy. On December 31, 2014 the Computer merit badge was retired and replaced by a new "Digital Technology" Merit Badge, which shows a computer circuit. Requirements for the Digital Technology Merit Badge include the Boy Scout explaining to his counselor about how images and texts are digitized, explaining what a computer network is, knowing about copyrights of digital materials and about recycling old digital technologies, as well as a project that can involve making a website and exploring careers involving digital technologies (Boy Scouts of America 2015).

177 Another small milestone in Federal involvement in computer education was a 1975 NSF sponsored conference titled, "Ten-Year Forecast for Computers and Communications: Implications for Education, 1985" (cited in Seidel and Anderson 1982, 45).

178 In Chapter 2 I explain the legacy of behaviorism in CAI approaches to computers in education and the reasons why alternative, non-behaviorist approaches were considered to be necessary. CAI work began earlier, in response to the 1958 increased interest and expenditure in developing American science and mathematics education, which was prompted by the successful launch of the first satellite, *Sputnik,* by the Soviet Union (Suppes 2013). In 1963 research and development on CAI began at the Institute for Mathematical Studies in the Social Sciences with funding from NSF and Carnegie Corporation (see Seidel and Anderson 1982, 37). And in 1965 the Computer Curriculum Company (CCC, a company created by Patrick Suppes) began to market its computer-based drills in math and reading to elementary schools.

Arthur Luehrmann's1972 article. Papert and his colleagues' work with LOGO, such as the Brookline LOGO experiment, was frequently supported by NSF grants distributed pursuant to this initiative.

The second stage was marked by a multi-day congressional hearing on the topic of "Computers in the Learning Society" organized in 1977 by Congressman Scheuer, chair of the House Subcommittee on Domestic and International Scientific Planning, Analysis, and Cooperation of the Committee on Science and Technology.[179] The 1977 hearing took stock of all of the diverse approaches to computers in education, both those already implemented (like CAI and CMI) and those in progress. Representatives of all of the approaches testified at that hearing. They included members of the New York State school board, which had implemented a computer-assisted school management system (CMI), Professor Patrick Suppes appeared as the lead representative of computer assisted instruction (CAI), Seymour Papert presented his vision for how computers can revolutionize learning, Arthur Luehrmann called for national teaching of computer literacy, and other individuals, including Raymond Kurzweil, described the computer-devices they had engineered to help the handicapped learn.[180]

A follow-up survey of the witnesses present at the hearing revealed that almost 90% of respondents believed that "computer literacy is a desirable national goal" (US House of Representative 1978, 687). This way of formulating the survey question in terms of "computer literacy" (rather than, for example, CAI) reflected what the

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[179] A subcommittee of the Committee on Science and Technology, U.S. House of Representatives.

[180] Two years before the Hearing, in 1975, Congress passed the Education for All Handicapped Children Act that extended the constitutional right to education to handicapped children. This law played an important role in guiding the direction of research on computers in education, with a large portion of research becoming concerned with using computers to help handicapped or children with learning disabilities to learn.

committee members considered to be the key unifying concept that emerged from the diverse approaches to computers in education presented at the hearing. The hearing underscored the national importance of research and development in computer literacy, particularly looking to technologically aided "literacy" as an opportunity to remedy an educational system that was perceived to be "failing" a very large number of American children.[181]

Finally, the mid-1980s was a time in which interest in computer literacy peaked in the United States, as evidenced by the efforts of the National Center for Education Statistics (NCES) in 1983 to create a standardized definition of the term so that school districts in different states could teach something recognized as computer literacy as well as evaluate if their students had learned it.[182] In the same year, a survey conducted by the National Education Association, a national union of teachers from pre-school to university graduate programs represented in every state ("National Education Association: About NEA" 2015), found that just over 11% of the teachers they surveyed used computers for instructional purposes and of these the majority used them for drill-and-practice rather than to teach students computer literacy broadly defined (Norman

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[181] One outcome of the Hearing was a bill passed by the House of Representatives in 1979 "to establish a national commission to study the scientific and technological implications of information technology in education" (cited in Seidel et al. 1982, 47).

[182] NCES 1983 definition of computer literacy was as follows: "Computer literacy may be defined as whatever a person needs to know and do with computers in order to function competently in our information-based society. Computer literacy includes three kinds of competence: skills, knowledge, and understanding. It includes: ability to use and instruct computers to aid in learning, solving problems, and managing information; knowledge of functions, applications, capabilities, limitations, and social implications of computers and related technology; and understanding needed to learn and evaluate new applications and social issues as they arise" (Lockheed et al. 1983).

1983, 25).[183] The survey of teachers revealed that relatively few teachers across the United States used computers, and they did not teach computer literacy either in the way that Luehrmann called for or in the form that Papert and his colleagues had designed. Despite national interest in computers in education and, more specifically, the belief in their importance, computer literacy programs had not been adopted in most American classrooms.

Papert and his colleagues skillfully navigated this context in order to help to bring LOGO to the national scale. LOGO research benefited from a large number of grants from various NSF programs, from both computer engineering (in the Directorate for Computer and Information Science and Engineering[184]) and education (in the Division of Research on Learning in Formal and Informal Settings[185]).

While Papert used federal funding to advance his research and development of LOGO and appealed to the federal government ford action on computers in education, he also collaborated on projects with private computer manufacturers to deliver LOGO into classrooms. Papert always recognized the computer industry as a powerful force in driving the introduction of computers into the home. In his account, the computer industry, or "technologists," as he called engineers in computer companies, would soon put a computer in front of every adult, child, and baby (US House of Representative 1978).

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[183] This finding was relatively consistent with that of an earlier 1970 study that found that 13% of secondary schools used computers for instruction (again, their use of computers was predominantly CAI or drill-and-practice) (Darby, Korotkin, and Romashko 1970).
[184] Funded a LOGO research grant titled, "Logo (A Computer Language) Methods in Science Education Using Low Cost Home Computers," November 1, 1979 – April 30, 1982.
[185] Funded a LOGO grant titled, "Constructionism: A New Opportunity for Elementary Science Education," May 15, 1987 – October 31, 1990.

Because he believed that the introduction of computers into daily life was consequential for individual psychology, he worried about the computer industry's unreflexive push of the technology. In response to concerns expressed by one Congressman about the possible "harmful psychological side-effects" of exposing very young children to computers, Papert expressed his view of the two possible kinds of mental effects[186] of the computer:

> It is very clear that the close, intimate interaction with computers has a powerful effect on the mental life of some individuals. We know cases where that effect seems to be negative. It makes people antisocial and draws them into such close relationships with machines that they are cut off from other people. We know other cases where it is invigorating and stimulating and brings the kid out of the depths of depression, out of even autism in one well-documented case. So both of these things can happen (US House of Representative 1978, 281–2).

Papert considered it to be the federal government's responsibility to support researchers like him to study the consequences of the coming of the computer and to develop social and technical mechanisms for steering their use in socially desirable directions. Although he feared that simply allowing the computer industry to bring the computer into public and private life might result in harmful psychological effects, he explicitly chose to collaborate with industry to steer the technology in what he considered to be desirable directions, where the computer was an "invigorating and stimulating" tool for each individual to reach his or her full potential as a learner.

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[186] These are the kinds of psychological effects that Sherry Turkle studied both as part of the LOGO team of researchers and in her own studies which she published about in *The Second Self: Computers and the Human Spirit* (Turkle 1984). Papert saw an important role in collaborations between computer scientists, social scientists like psychologists, and scholars of the humanities in thinking about computers in society and understanding their "effects" (e.g. see, Papert 1977b).

In an effort to secure the educational market, the computer industry was carefully and strategically connecting up to the needs and goals of the educational communities. Papert accurately characterized the technologists' push of computers into the home and the school as unreflexive about its influence on the minds of school children and their teachers and on the broader interests of the school. In 1985, Apple Computer created a group called the "Apple Classroom of Tomorrow" (ACOT), whose mission was "to create tools for the mind and to place them into the hands of every person" (Apple Computer Inc. 1987). Its charter was to be "a long-term action-research and applied development project" and it sought "to simulate a future in education when all students and teachers have computers all the time." Even the mission of an especially founded organization devoted to computers and education was scarcely reflexive, as it mostly sought to put all students and teachers in front of computers—the kind of blind push that Papert predicted and worried about.

ACOT actively pursued the company's mission by installing hundreds of computers in elementary school classrooms from schools in Cupertino, CA, its headquarters hometown, to Blue Earth, MN, Eugene, OR, Columbus, OH, and Nashville, TN. These computers came with software packages that included "Apple LOGO" as well as other educational programs. The manager of ACOT, Dr. Martin Engel, described the driving vision of Apple as a company and as the underpinnings of the ACOT program: "one computer-one person—the empowerment of *all* individuals with control over computers" (Apple Computer Inc. 1987). Thus Apple, too, had a vision of how the use of the computer could be empowering for individuals, and it actively sought to put its vision—and its technology—in the service of what it considered to be the mission of the educational system. For example, Apple was a national sponsor of the "Thanks to Teachers" campaign, which recognized teachers as "the most valuable national treasures." In one commercial expressing Apple's sponsorship, John Sculley, Apple CEO at the time, said: "At Apple Computer we have a philosophy that we want to change the world one person at a time. [...] We recognize that changing the world is exactly what society asks teachers to do" (Apple Computer, Inc. 1985). In this statement, Sculley linked up Apple's individualistic mission to expand use of its products to what he claimed was the socially entrusted mission of teachers. This is just one illustration of how computer companies sought to create new markets for their products by offering their technologies as means for teachers to carry out their contract with society.

To shape the computer industry's influence on education and its “mental effects” more generally, Papert and his colleagues supported and encouraged the development of LOGO by private and public actors for implementation on different computers. The history of LOGO's development always involved private and public institutions, and to increase LOGO's distribution, Papert pursued collaborations with multiple computer manufacturers at the same time. LOGO research started at BBN, moved to MIT, developed also at other universities in the United States as well as abroad (including Edinburgh, Tasmania, and France), developed by schools, and private companies like Apple (beginning with the Apple II), Texas Instruments, and IBM. These entities all pursued different paths for working on LOGO, either by licensing LOGO from MIT or writing it themselves from scratch. For example, one of the earliest versions of LOGO for the Apple II was created in 1980 by a company called Parafin, which licensed LOGO from MIT. However, the most popular version of LOGO for the Apple was called

"Apple LOGO" and was developed in 1982 by a company called LOGO Computer Systems International (LCSI), based in Canada, which licensed the software to Apple.[187] Papert and a few former members of the MIT LOGO GROUP founded the LCSI in 1981; however, in forming the company they completely rewrote LOGO in order to avoid licensing the technology from MIT.[188]

The Lamplighter School Project

One such collaboration with Texas Instruments led to what *BYTE* magazine referred to as "the most ambitious LOGO project to date" (*BYTE* 1982, 117). The Lamplighter School project, begun in 1982, demonstrated the interweaving of private and public interests involved in the distribution of LOGO to classrooms around the United States. It also showed how, outside of a tightly monitored experiment such as the Brookline LOGO experiment, projects to put computers in the classroom attracted a lot of press and interest in their initial periods as novelties but were difficult to sustain in the long run.

The Lamplighter School project was a high-visibility initiative in which Papert and the MIT Artificial Intelligence Lab collaborated with the Lamplighter private elementary school in Dallas, Texas and with the computer manufacturer Texas

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[187] The 1982 version was the second version of Apple LOGO (original developed in 1980) and it was developed by Gary Drescher, Edward Hardebeck, Steven Hain, Jim Davis, and Margaret Minsky at LCSI (Boytchev 2014).

[188] As of 2011 there were 239 versions of LOGO around the world (Neubauer 2011). Most of these versions are not working or have been retired, however, a number of them are still in-use and are being developed by vibrant communities of teachers, engineers, and students. For example, LCSI claims on its website that it continues to offer "constructivist educational software for K-12 schools around the world" (http://www.microworlds.com/). A project to collect information about all of the past and current implementations of LOGO called the "LOGO Tree Project," started in 2002 (Boytchev 2014).

Instruments to put TI personal computers running LOGO in the school. The fact that the founder of Texas Instruments, Erik Jonsson, was at the time the mayor of Dallas and had grandchildren in the Lamplighter School facilitated the project.[189] Jonsson and Papert began collaborating in 1978 to create a version of LOGO for the Texas Instrument TI-99/4 micro-computer.[190] This was the first implementation of LOGO on a computer other than the large PDP-1 or PDP-10, which were bulky and could not easily be introduced into a classroom. In contrast, the TI-99/4 was a micro-computer that was specifically marketed for the home as a "home computer" and was the first of its kind to have a 16 bit microprocessor. The Lamplighter project introduced fifty TI-99/4 micro-computers that ran the first implementation of LOGO on the TI machines, at a cost of $400 for each machine, while a year of tuition at the school ranged from $1,000 for three-year-olds to $2,750 for fourth-graders (Applebome 1982).

The goal of the project was "to establish a setting in which student access to computers would not be a limiting factor and to see what students [aged 3 - 9] could learn in such circumstances" (*BYTE* 1982, 130). The fifty computers distributed throughout the school for 400 students meant that a ratio of 1 computer to 8 children was at the time deemed to be sufficient to make "the idea of a 'computer culture' a reality" (Nelson 1981, 14).

The idea for creating this kind of computer-immersive school environment was consistent with Papert's and his colleagues' plans for continued experimentation with

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[189] He was also the school's first board chairman, according to *The Dallas Morning News* (Miller, Godinez, and Jacobus 2010).

[190] A LOGO implementation called "Pascal LOGO" (PLOGO) was created in 1977-8 by Gary Drescher (Boytchev 2014).

LOGO beyond the scale of a single classroom. It must have also resonated with Jonsson. With his personal and professional connections to the computer industry, the community of Dallas, and the Lamplighter School, Jonsson must have seen all of his interests converge in this computer project. Although it is not known how Jonsson first encountered LOGO and why he believed in LOGO's approach to computers in education, there are important ideological connections between LOGO and the Lamplighter School. The school's name came from an aphorism: "A child is not a vessel to be filled but a lamp to be lighted" (Applebome 1982). To the extent that the school's name represented its educational philosophy and attitude to children, it was consistent with Papert's view that computers are tools that can help to "invigorate" and "stimulate" each child according to his or her own interests.

In addition to the idea of the child expressed in its name, the Lamplighter School's spatial layout reflected the LOGO learning philosophy. The school was an "open," expansive environment sprawled across a 12-acre site in north Dallas and featured "unwalled, open classrooms in odd-angled shapes, bright wall coverings and carpets and attractive open learning areas," all of which invited the students to learn through self-driven exploration in an alternative setting to a traditional classroom (Applebome 1982)[191]. These aspects of the Lamplighter School made it an ideal setting to introduce the LOGO-running computers and it shows how one community's idea of the child and

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[191] The theme of classroom walls and computers frequently comes up. For example, the Apple docudrama, “Everyday Heroes,” begins with a conflict between the protagonist computer teacher who wants to tear down a newly built wall in the school to create the right kind of computer environment for the children and the conservative and skeptical principal (Apple Computer, Inc. 1985).

approach to education resonated with the computer industry's and Papert's vision of what computers could do for learning.

The school's innovative features and the novelty of having so many computers in a school attracted a lot of attention to the Lamplighter project at the outset. Authors of numerous popular-press and newspaper articles about the project described the remarkable juxtapositions of usual aspects of the school with the novel presence of the computers. *The New York Times* reported on a strange inventory that mixed children, animals, and computers: "The Lamplighter School has bright open classrooms, 413 students ranging in age from 3 to 9, goats named Maxine and Laverne, a cat named Bubblegum and 50 Texas Instruments 99/4 computers" (Applebome 1982). The computers occupied inconspicuous places "next to rows of Dr. Seuss books and walls covered with finger paintings"—a setting worthy of the discovery-oriented and playful ideal of LOGO (Applebome 1982). A senior engineer with Texas Instruments who worked on the design of the Lamplighter School computer system, remarked that this placement of computers was purposeful and different: to create an environment in which children could have an "experience" with the computers that was "discovery-oriented learning" that would be "profoundly" different from the use of computers as "flashcard machines" or for drill and practice activities (Dr. Nolte, quoted in Applebome 1982).

To visitors who observed the children's interaction with the computers, it appeared that this goal was actually being realized. They remarked how "normal" the children's attitude to the computers was. The computers were like other objects and activities in the school. While some children worked with the computers, others "were engaged in more conventional activities: building with blocks, putting together a puzzle, playing with toy cars, playing house, and finger painting" (*BYTE* 1982, 130; 132). "Computers for these young students are just another way of exploring their world," *BYTE* magazine concluded (*BYTE* 132). "While some children are occupied with computers, regular school life goes on for others. [...] Computers are accepted by the teachers and students as an integral part of the school, but they are not allowed to dominate it" (*BYTE* 132). Like the reporter at the SICOB exposition in France who remarked about the children's fearless use of the computers, the authors of these popular articles appeared fascinated by how children's interaction with these new educational toys hardly seemed to be noticed by the students or the teachers.

The normalization of the computer presence in the Lamplighter School produced an effect as if "nobody's watching," as *BYTE* reported. Unlike the Brookline LOGO project, no one apart from the teachers and staff, who were too busy to do it, was studying the effects of the children's interaction with the computers on their learning. The absence of this attention to the effects of the student's interaction with the computers went hand-in-hand with the absence of curriculum development and the inclusion of the computers into educational activities of the school. According to Lamplighter's headmistress Pat Mattingly, "The teachers just don't have enough time for curriculum development in addition to all their other duties" (*BYTE* 132). Even existing functionalities of the LOGO went unused because some technological needs were overlooked. For example, although a simple screen editor for writing was available to students as part of the LOGO system, they did not use the computers for creative writing because in the first three years of the project the equipment at the school did not include printers. This observation that "nobody's watching" the experiment could, in part, be interpreted as a fulfillment of the wish for the computers to be part of the normal activities of the school. The normality of the computer itself erased interest in tracking students' work with it. As a corollary of its ubiquity, by becoming part of the school environment and blending in with ordinary toys and activities, the computer lost its status as a novel experimental object.

The fate of the Lamplighter School experiment mirrored that of many LOGO projects in classrooms around the United States. They went from being remarkable to being unremarkable. In one way, this transformation appears to have been originally part of the design of the projects. If the project's goal was to make computers a natural part of the classroom environment, so that students could access them at their will, just as they use pencils or books, then this goal was achieved.[192] However, as the BYTE article suggested, "nobody's watching" could also mean that there was a lack of attention to the actual role that the computers played in the education of the children, or in the process of lighting—and keeping lit—the metaphorical lamp that is the child. With the loss of the experimental status of the computer in the school came the loss of the reflexivity that Papert believed to be crucial to the process of learning with LOGO: no more dribble file to see on the printed page, as in a Rorschach image, how a student was learning and no teacher to interpret it and use it to inform the next lesson. With the expansion of LOGO to diverse computers and with the help of corporate or public initiatives to introduce these LOGO-running computers into schools, specific attention to LOGO and its educational effects waned and it became absorbed into teaching as usual. It is difficult to judge the

[192] This idea echoes that of people who have claimed that computer literacy will be achieved when people no longer need to be taught it explicitly, or when people will use computers without second thought.

extent to which this absorption was the beginning of a slow process of bottom-up transformation of schools and of each individual child's learning, as opposed to a process of naturalization leading to neglect and loss of innovation.

The fate of the computer fluent subject

In pursuit of the implementation of his vision of computer literacy at the national scale Papert considered the federal government and the computer industry to be his partners and he sought collaborations with both. He found both, however, to be relatively unreflective about the significance of computers in society. The definition of computer literacy created by the National Center for Education Statistics (NCES) to evaluate skills in students across the country treated computer literacy as a set of skills, knowledge, and understanding to be mastered (Lockheed et al. 1983) rather than as the kind of dynamic interplay with the computer that Papert envisioned. Meanwhile, the computer industry engaged in educational efforts such as the Apple Classroom of Tomorrow, but these projects' imagination of computers in education remained narrowly focused on throwing computers at students and teachers rather than re-thinking the entire educational system around computers, as Papert was hoping. Even Papert's own collaborations with the computer industry and with American schools, resulted, as evidenced by the Lamplighter School project, in a loss of the full capacity for interplay as computers became more pervasive.

Papert's manner of achieving national-scale implementation of computer literacy reveals a flexible vision of the individual's relationship to the nation-state. By flexible, I mean that Papert was neither for nor against state involvement. Rather, what mattered to him above all was the possibility of each individual to achieve her fullest potential. The state was capable, Papert believed, to provide this kind of fulfillment by fostering interdisciplinary (involving both engineering and the humanities, see Papert 1977b) and visionary research on human-computer interactions of the kind that Papert and his colleagues were carrying out at MIT. Moreover, Papert, and other advocates of computer literacy, such as Arthur Luehrmann, deemed the state to be not just capable, but responsible for responding to the challenges and opportunities presented by the apparently inevitable coming of micro-computers. The state, Papert believed, was responsible for ensuring that the public good be considered when the computer industry itself would not necessarily consider it. Public good, in Papert's understanding, rested with the individual human being rather than with any social institution as such. Thus, the role of the state, according to Papert, was to ensure the optimal learning conditions for each human being.

Papert was ready to work together with the federal government to advance this goal with the help of computers, even if it meant scrapping the existing educational system. In Papert's view, the micro-computer challenged the existing educational system and the state had the responsibility to rethink this system "holistically" and "globally" to ensure that the public good could be achieved. By challenging the educational system and extant mechanisms of funding for research to improve that system (which Papert called broken and incremental), he also challenged the state's authority over the education of its citizens. It was possible in Papert’s vision that the computer could make the educational system obsolete by replacing it with one-on-one learning with the computer, or learning not in classrooms but in the home or in another space, Papert daringly urged the government to ensure that this take place.

Although Papert believed that the federal government ought to be a partner in—and even leader of—this new form of education that he deemed to be for the public good, he also pursued this vision independently of the government, in collaboration with the computer industry. In Papert's collaborations with Texas Instruments and Apple Computer to implement LOGO on their machines and thus distribute LOGO to a wider audience, he pursued his idea of the public good independently of the state (though, of course, still using state funds to facilitate bringing about a particular sociotechnical future).

Papert’s entrepreneurial spirit was especially visible in contrast to Arthur Luehrmann’s approach. Unlike Papert, Luehrmann was not a technology entrepreneur and, perhaps in part because of this, he worked more closely with the federal government in implementing computer literacy as a nation-wide curriculum. He saw computer literacy as a new subject to be taught and did not necessarily believe that it had to revolutionize the school, but rather could be incorporated into the existing educational process (e.g., as a half-course taught in 9th and 10th grades, thereby changing only 3% of the existing curriculum) (Luehrmann at US House of Representative 1978). Luehrmann, in short, pursued the goal of national computer literacy together with the federal government and within the structures provided by the existing educational system. Papert, on the other hand, pursued the diffusion of his technology by collaborating with industry to use computers to transform learning outside of the immediate purview of the state.

In realizing his vision of transforming each individual's learning with the computer, Papert implicitly sought to change the idea of the citizen, or the subject of a nation-state. The school system, in Papert's view, was broken because it did not allow individuals to reach their full intellectual potential.[193] The computer could change this picture radically, not by repairing the school system but by circumventing it. People could learn on their own with the computer (see Congressional hearing on "self-teaching" machine), in the privacy of their homes or in clubs. Since becoming computer fluent for Papert meant individual flourishing through the interplay between the individual and the computer, this could take place within a transformed educational system, but it could also take place outside of the system. With the computer, the child no longer needed the public educational system to develop and flourish; a child could do so—in fact, maybe do it better—in one-on-one interaction with LOGO on a home computer. Yet, as the Lamplighter School project revealed, it was difficult to shepherd this vision up to the level of the nation without teachers or other form of supervisors and guides dedicated to supervision. Most teachers, occupied with the day-to-day of normal instruction, could not appreciate the holistic transformation to learning with computers that Papert envisioned. Without the educational system on board with Papert's vision of interplay with the computer to achieve a general transformation of learning, the ideal of computer fluency could not be implemented at the national scale.

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[193] The entire premise behind the 1977 Congressional Hearing was that the school system was failing. Papert shared this premise (see opening of his statement), however, he argued that the educational system's problems had to be addressed by rethinking the entire system, promoted by the computer. Others, like Luehrmann, seemed to think that computers could be used to improve the system from within.

France

As practiced in the *Hall d'initiation* of the Centre Mondial Informatique and in the Belle de Mai neighborhood in Marseille, Jean-Jacques Servan-Schreiber's strategy for bringing about the *culture informatique* in France relied on the creation of *informatique* environments. In these environments visitors and residents would have unstructured one-on-one experiences with computers without any direct instruction in *informatique*. Servan-Schreiber's ideal of interplay with computers seemed to work, or at least it inspired public curiosity and researchers' involvement, as long as the projects remained localized in short-term experiments based at the CMI headquarters or in a neighborhood. From the start, however, Servan-Schreiber's ambitions were national and even global in scope. In this section I describe the challenges his vision of interplay with computers encountered when he tried to extend it throughout France. I also show how an alternate path to the development of *culture informatique* at the national scale, which culminated with the *Informatique pour tous* (IPT) project (1985-1989) and involved the French Ministry of Education, was eventually more successful in the French context than Servan-Schreiber's endeavor.

Seen from abroad, the CMI and the IPT appeared to be part of the same national project to develop *culture informatique* in France. President Mitterrand supported both projects and they were allegedly supposed to contribute to the advancement of the same goal of computer culture: to "orient [*informatique*'s] progress towards miniaturization [of machines] and simplification of languages, in order to make of it a tool at the human scale" (Mitterrand 1977, 2). Mitterrand imagined that every French citizen, and also people around the world following the French lead and with French support, would reap the benefits of this tool's newly accessible scale. Mitterrand's vision of the computer becoming a tool of the "human scale" was simultaneously a vision for a "national scale" project, where the citizen participated in and benefited from the *culture informatique*.

Yet, the CMI and the IPT answered Mitterrand's call to make the computer into "a tool at the human scale" in two different ways. For Servan-Schreiber, the national pursuit of the "human scale" meant applying computers to social needs and creating "*informatique* environments" for the public (Chappaz and Vignaux 1983, 10). Servan-Schreiber believed that through playful interaction in these environments people could indirectly, and without explicit instruction acquire the *culture informatique* and develop as part of the nation's *ressource humaine*. Servan-Schreiber preferred to collaborate with foreign computer industry and computer scientists to produce the hardware and software technologies for staging these *informatique* environments. In contrast, the IPT pursued the "human scale" of computers by explicitly introducing computers into the educational system and instructing children with and about computers. Leaders of the IPT believed that by knowing the computer, people would come to control it, and that control was the means to empowerment and social and economic development at the national scale with the computer. The hardware and software used for IPT supported this instructional goal, with the belief that knowledge of the computer—ensured through the educational system that had traditionally formed knowledgeable citizens—would lead to control of the computer by each citizen.

The Centre Mondial Informatique (1981-1985)

From its inception, the CMI was supposed to be a "French project" (J. J. Servan-Schreiber 1985b; Mitterrand 1984). This label meant that the project put computers at the service of human development, both domestically in France and abroad. Servan-Schreiber used this label to distinguish the CMI from American computer initiatives, which he characterized as being predominantly market- or defense-oriented and not primarily concerned with serving the interests of the layperson or society. Identified as uniquely "French," the "humanistic" goal of the CMI to use computers to develop the individual human being and strengthen social relations and the economy through decentralization, both in France and as a model for other countries, combined two currents of Servan-Schreiber's thought: internationalism and an idea of the "personal" computer borrowed from the United States. These two commitments were at the center of both the original interest in the CMI's projects and key factors in leading to the Center's ultimate demise.

Servan-Schreiber envisioned France as a champion of the rest of the world in social applications of computer technology and a model for use of computers for development. Servan-Schreiber's work leading up the creation of the CMI defined the economic and social "world" crisis[194] for which personal interaction with the computer was the solution. He described the new global world order as one in which the problems encountered by developing nations would have repercussions in the developed world.

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[194]Servan-Schreiber identified 1979 as the year of "intellectual mobilization" that led to the CMI. Two years later, in the summer of 1981, he formed a group called the "Paris Group" (*Groupe de Paris*) which consisted of leaders from Europe and Japan as well as Africa and the Middle East. The group met in Paris to "define the ways and means of a global approach to a world that has suddenly become agglomerated, radically different, and submerged in the *informatique* revolution" ("CMI Informational Folder" 1982, 5).

Addressing these problems required a new approach.[195] It required the imagination of a global not overrun by competition for resources, for better technologies, and bigger economies, but a world of sharing and transfer of knowledge—defined as the most important resource of any state and key to its development ("CMI Informational Folder" 1982, 24). Servan-Schreiber repeatedly criticized the state of the world as a "zero sum game" in which nations competed for resources. He believed that *informatique* could help to overcome this narrow-minded world-order.[196]

Mitterrand echoed Servan-Schreiber's vision of France's leading role in this international effort.[197] In a speech at Carnegie Mellon University to Professor Raj Reddy,

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[195] In a 1984 speech at Carnegie Mellon University, Mitterrand evoked the Marshall Plan, and Marshall's remarks at Harvard, as an example of the kind of way in which the new crisis demanded a rethinking of the possible relations among nation-states: "...comme à ce moment historique du lendemain de la dernière guerre mondiale, il s'agit d'avoir le courage d'un nouveau regard" (Mitterrand 46, original emphasis).

[196] Servan-Schreiber expressed this critique very directly in a comment following his televised interview about the CMI. The anchor of the news program asked Servan-Schreiber to comment on Soviet use of satellites to observe American nuclear activities. Servan-Schreiber responded with outrage at the state of "competition between people that through the centuries has transformed into scientific, technological, and mental war and competition of scientific, technological" ("Centre Mondial Informatique" 1982).

[197] In 1981, Mitterrand commissioned Servan-Schreiber 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 (Mitterrand 1981). In this letter, Mitterrand asked Servan-Schreiber to give his recommendations (by October 30, 1981) about how to go about setting up such a center, to which Mitterrand now refered to in a narrower way as the "center of technological observation" (Mitterrand 1981, 20). Mitterrand laid out the goals of this center to include: collect information about global developments in micro-electronics for the medium- and long-run; 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 (Mitterrand 1981, 19–20). It is important to note that the responsibilities of the Center that Mitterrand wanted Servan-Schreiber to evaluate were not consistent with how Servan-Schreiber himself imagined the Center and what the Center actually became. Mitterrand's list is more instrumental and narrowly strategic. He seemed 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. Mitterrand never articulated these ideas in terms of the greater vision of the *ressource humaine*.

Later, after already being involved in the activities of the CMI for two years, Mitterrand would use more grandiose ways to speak about the role of the computer. This suggests that Servan-Schreiber's visions of *culture informatique* and the Center's role in forging it, had an influence on Mitterrand. For example, Mitterrand spoke of the development of France's "human capacity," with which he hoped to "arm director of the Robotics Institute at Carnegie-Mellon, scientific director of the CMI, and recipient (from Mitterrand) of the *Chevalier de la Légion d'Honneur* medal, Mitterrand described the need to "build at the planetary scale a vast [system] of knowledge transfer, of know-good [*savoir-bien*], of know-more [*savoir-plus*], that is today both needed and already the means of creation" (Mitterrand 1984). Mitterrand acknowledged that giving knowledge was more important at this historic period than providing financial assistance, which "we know the need of, but have learned the illusions and limits of" (Ibid.). Thus, Mitterrand echoed Tuan-Tzu's epigraph in the opening pages of the CMI, reflecting the CMI's mission to form people so that they might help themselves rather than giving them direct material assistance. The most important kind of formation was formation with the computer, and this is precisely what the CMI was engaged in doing at home in France and internationally.

The very same ideal of internationalism that defined CMI's mission to apply a seemingly universal *culture informatique* to all regions of France and even all countries of the world enabled Servan-Schreiber to borrow and (unsuccessfully) try to adapt an American vision of the "personal" computer into the French context. Servan-Schreiber picked up on the idea of the "personal" computer as defined by American computer scientist Alan Kay: "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," he wrote (Jean-Jacques Servan-Schreiber 1981, 29). Kay's vision of the micro-computer as "personal and universal"

France […] to an equal or superior to anywhere else in the world." This human capacity began with a foundation of "*culture informatique*" (Mitterrand 1983).

meant that it was an individual tool and applicable to all people and was similar to that of other notable American computer scientists whom Kay had occasion to work with, like Steve Jobs and Papert. As I suggested in Chapter 2, this vision of the micro-computer was distinctly American. JJSS made this American definition of the micro-computer into the backbone of his concept of *ressource humaine*. The idea of a *ressource humaine* assumed that the person was an individual with specific faculties and at the same time “universal,” or infinitely adaptable and transformable. Beyond such borrowing of ideas, Servan-Schreiber did not theorize what micro-computer should mean or how it would fare in the French socio-political and cultural context. Practically, the idea of the "personal" computer boiled down to a one-to-one ratio between person and computer, which itself was Apple's formula.[198] While JJSS was vague about how to actually go about achieving the development of the *ressource humaine*, he was adamant that interaction with Apple computers was the essential step in this direction. He described the Macintosh computer to be the "first instrument adapted to the mass *culture informatique*" and insisted upon its uniqueness as an easy to learn tool by saying that the high technology utilized by the Apple allows one to learn it "in a few hours, in a natural way" (Servan-Schreiber 1985a, 6).

In order to use Apple computers for his "French project," Servan-Schreiber tried

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[198] See Martin Engel’s, Apple Classroom of Tomorrow Manager’s statement about the “one computer-one person” as the core mission of Apple (Mitterrand 1981). Servan-Schreiber defended striving to reach the one-to-one ratio in the arrangement of the CMI showroom and while describing the success of the CMI’s youth unemployment program (Servan-Schreiber 1983b). More than 300 regional centers for the *informatique* training of unemployed youth had been set up throughout France by the CMI. Each center was to be equipped with six micro-computers for an average use by 15 people. "This ration [a little over 2 people to 1 computer],” wrote Servan-Schreiber, “is the key to the 'personal appropriation,' which is the foundation of the desire to learn" (Servan-Schreiber 1983b). Micro-computers in these centers were not Apples, but the following: 300 T 07 de Thompson (at 6,175F each), 30 Questar de BULL (43,000F), 200 PC d'IBM (17,483F), 150 PC de Digital (16,530F) (Ibid.).

to broker a deal with Steve Jobs in which Apple would create factories in France to manufacture Apple computers. Servan-Schreiber claimed that Jobs was willing to sell the Macintosh (released in 1984) to France for $1,000 dollars each, produce the computers with a French label, and allow France to control the distribution of the computers to other parts of the world (Servan-Schreiber 1984, 2). This deal, Servan-Schreiber claimed, would be a win for France over IBM, which threatened French sovereignty and economic power with its monopoly over computer hardware and software, requiring all software to be "compatible" with the IBM, but retaining the ability to revise the requirements of compatibility at any moment (Servan-Schreiber letter to Mitterrand).[199] Servan-Schreiber believed that IBM's strong control over the European computer market was a greater threat to France's computer industry than an alliance with Apple, whose philosophy of the personal computer he entirely agreed with.

Servan-Schreiber's strategy to advance French and global goals of development with an American vision and technology encountered resistance from other members of French society. The French computer industry argued against such collaborations as threats to French sovereignty and called the importation of foreign (capitalist) values a threat to the spirit of the development of *culture informatique* in French citizens. Apart from the question of the nationality of the technology, members of the French

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[199] The disagreements between Servan-Schreiber and other members of the French informatique community and industry about the relationship of technological compatibility to national sovereignty was one of the decisive issues that led to the dissolution of the CMI and the choice of BULL micro-computers compatible with IBM for the *Informatique pour tous* project.

informatique community did not share Servan-Schreiber's vision of the "personal computer," particularly in the identification of this concept with Apple.[200]

Industry leaders' grievances about the CMI's preference for foreign technology reached the highest levels of French government. In 1983, Christian Sautter, the secretary general adjunct of the Élysée, wrote to Jean-Louis Bianco, the secretary general, about his concerns that the CMI was importing VAC computers instead of using computers produced domestically by the French company CII-HB (although CII could produce only 15 bit computers while VAC computers were 32 bit). Sautter was concerned that this decision was compromising French industry (see Sautter 1983). Later, an investigation into CMI activities found that the CMI did buy American DEC VAX780 computers while the Prime Minister had asked explicitly to balance the purchase between the American company and the computers of the French company Bull (see Defferre 1985).

Following these episodes and the controversy over a possible deal between the CMI and Apple, various French ministries began to express their resistance to Servan-Schreiber's project by refusing to provide it with funds. The Center was generously funded[201] with publicly money that it received from a number of French ministries[202]

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[200] Terry Winograd and Fernando Flores, computer scientists at Stanford affiliated with the CMI for a short period of time, also disagreed with Servan-Schreiber's vision of personal computers as the way to pursue development in other countries. Instead of attention to personal computing, Winograd et al. proposed that what they called "community computing" was needed. They also critiqued the CMI for not adequately soliciting ideas from the "third world" while at the same time claiming to try to help these countries develop (Winograd 1982).

[201] The Center's budget was 50 million francs in 1982, 90 million in 1983; 150 million in 1984 and also in 1985 (Chandernagor 1985).

[202] Contributing ministries included: Ministère des Relations Exterieures: 4 million francs (MF); M. de la Cooperation: 2MF; M. de la Santé: 2MF; M. Education Nationale: 4MF; M. de PTT: 9MF; M. de

whose interests it was supposed to promote (Mandil 1981). The amount that each ministry gave to the CMI every year was personally decided by President Mitterrand (Defferre 1985). In an October 1984 meeting of French ministries, representatives expressed a desire to abstain from contributing to the CMI budget because they did not see their own interests reflected in CMI's activities. Among their complaints was that the CMI was neither producing new technologies nor actively teaching French people to use *informatique* (Chandernagor 1985). Gaston Defferre, Servan-Schreiber's friend (mayor of Marseille during the Belle de Mai experiment) and now Mitterrand's Interior Minister, defended the CMI and reminded the Ministry representatives that the President personally establishes the budget of the various public associations and thus they had no right to question this decision (Defferre 1985).[203]

The CMI was reluctantly funded for another year, but resistance to its projects ran deep. In January 1985 the *Plan Informatique pour tous*, also known as the Plan Fabius in honor of Prime Minister Laurent Fabius who spearheaded the effort, was announced and, under it, only French-made computers were to be used in the largest public *informatique* project in France's history. This decision to use French computers was made possible by an alliance of French industry with IBM (instead of Apple). That same year, a number of French ministries (including Postes Télégraphes et Téléphones (PTT), Ministry of Industry, Research, Industrie, Recherche, Formation, Education) signed a decision

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l'Industrie: 5MF; M. de la Recherche et de la Tech: 9MF; Agence pour le développement de l'informatique: 2MF (Mandil 1981).

[203] In response to the Ministries' requests for the Center to be more productive in their particular domains, Servan-Schreiber wrote the role of the center is the "diffusion of the culture informatique at all levels of French society and by all channels […] It is therefore out of the question to cut up the means of the Center in pieces to respond to the sectorial demands, no matter how justified they are, of the Ministries that contribute to the budget" (Conseil d'Administration 1984, 4). Servan-Schreiber opposed the universalizing mission of the CMI to the structure of the French public funding system and ministerial interests.

referred to as “IBM-Compatible” to make all French-made hardware and software compatible with IBM computers (J. J. Servan-Schreiber 1984). Although it was also an alliance with an American company, the Jean-Louis Bianco viewed the “IBM-Compatible” decision to be less of a compromise on French sovereignty than a partnership with Apple would have been (Bianco 1985). The Secretary General perceived the alliance with IBM to allow France to retain control over the kind of hardware and software it would produce, while an alliance with Apple was seen to be too totalizing, requiring France to capitulate technology and values to the American company whose leader’s “genius” he nevertheless recognized.[204]

CMI’s critics claimed that it engaged in corruption at public expense and had not met its objectives. An investigation into the activities of CMI employees over the years turned up evidence of unusually high salaries for Servan-Schreiber and large payments to foreign members of the CMI such as Nicholas Negroponte; a large turnover of scientific directors and other management; lack of co-financing of the Center’s international projects; and no “technical vocation” or production of technologies (Chandernagor 1985).

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[204] Bianco: “Mais que veut dire exactement 'compatible'? La compatibilité, c'est, soit la possibilité de relier les uns aux autres des matériels différents, soit la possibilité d'utiliser sur un matériel donné (BULL par exemple) un programme (ou logiciel) fabriqué ailleurs (IBM par exemple).

Contrairement à ce que dit M. JJSS, notre indépendance ne serait en cause que si tous les constructeurs français choisissaient une stratégie générale de compatibilité pour tous leurs produits (1, original emphasis).

[…] “BULL n'a choisi que pour certains ordinateurs (les micro-ordinateurs professionnels) une compatibilité avec IBM et il s'agit surtout d'une compatibilité entre matériels (pouvoir les relier les uns aux autres). Quant aux programmes dits 'IBM', ils sont commercialisés par IBM mais viennent en fait de fabricants très divers.

[…] “A la place d'une 'dépendance' (très partielle) à l'égard de l'américain IBM, il [JJSS] vous propose une dépendance (beaucoup plus large) envers un autre américain, Apple. Certes, Steve Jobs, son patron, est un génie! Certes, Apple attaque IBM partout dans le monde! Mais ce n'est pas une raison suffisante pour se lancer tête baissée dans une alliance avec Apple” (Bianco 1985, 2).

Following these allegations, Servan-Schreiber promptly resigned in 1985 and in 1986 Defferre proposed to fuse the CMI, or rather the activities of the few researchers still working on CMI projects, with the Agence de l'Informatique (ADI) (Gendreau-Massaloux 1986).

Informatique pour tous (1985-1989)

The end of the CMI, however, was not the end of national-scale projects to develop the *culture informatique* in France. In fact, it convinced researchers who were working on other ways to pursue the *culture informatique* that their approaches were necessary and right. Members of the French *informatique* community (teachers like Jacques Baudé and computer industry leaders) also wanted to promote the knowledge of *informatique* in French society. They had neither Servan-Schreiber's grand international development aspirations nor his vision of the personal computer and its role in the formation of *la ressource humaine*. Instead, for them the development of *culture informatique* in France was a gradual effort of teaching students with and about computers. They also experimented with different hardware and software and over the years ramped-up the number of computers in schools until a program at the national scale called *Informatique pour tous* (IPT) was launched in 1985.

Though it followed on the heels of CMI, the IPT was not a direct descendent of the CMI, but rather an independent project that had been developing for many years (since the early 1970s) with alternative ideas of how to make computers tools at the "human scale" and how to properly go about implementing *culture informatique* in the general population. If there was any relation between the two projects, it was that the dissolution of the CMI gave IPT further room to grow and strengthened the alternative approach that the project took to this end.[205]

The IPT was based on a vision of a need for firm training in the knowledge of computers as guaranteed and orchestrated by the French national education system. Its proponents' strategy was to work with the French education ministry and the French computing industry. The IPT had its origins in the post-1968 reconsideration of the French educational system. At the 1970 conference of the Organization for Economic Cooperation and Development (OECD) in Sèvres, France, the computer's role in education was seen as a possible source of rejuvenation and transformation of the educational system (see Chapter 1 for a more detailed discussion). In subsequent years, the IPT worked within and through the French education system beginning with the creation of educational software such as the one demonstrated at the 1970 SICOB convention and with the *formation lourde,* a summer internship in which French computer industry experts trained teachers to program.

The IPT developed according to a hierarchy of expertise. Experts from the computer industry were considered the top authorities on the uses and applications of computers. They were therefore the hosts and teachers of the school teachers who would then apply their new knowledge to teaching children in their care. Following the teacher-training internships, however, the teachers discovered that the computer skills they received from the experts in the computer industry were not enough for them to teach their own students effectively in the context of the school and the structure of the

[205] Another connection between CMI and IPT: Servan-Schreiber argued for Apple computers to become the computer distributed to schools as part of the IPT, but this fell through due to the French industry's different idea of dependence and also because of the failed deal with Apple.

disciplines. To remedy this situation, the teachers organized into an association for the advancement of *informatique* in schools, called *l'association Enseignement public informatique* (EPI). They decided upon a three-pronged approach to teaching *informatique* in school: as a subject of study, an object of study, and a tool for the study of other subjects (*EPI Bulletin* No. 1, 1971). One could learn *about* informatique in society (e.g., how airlines use *informatique* to make seat reservations), learn how to program, or learn another subject, say math, with the help of *informatique*. The three-pronged approach helped to diversify the approach to *informatique* and its uses in the school, but it did little to change the structure of authority and expertise (from teacher to student) in the classroom.

The IPT approach to the development of *culture informatique* was critiqued by Servan-Schreiber for its lack of understanding of the "personal" vision (Servan-Schreiber 1984) and by other members of the French *informatique* community, like Jacques Perriault, France's preeminent LOGO supporter and member of the *culture technique* movement. Perriault saw the process of introducing computers as part of the rigid French school environment as a waste of computer resources (just as Papert did in the United States) because of the strict hierarchical system of education in which these programs were implemented (Perriault 2012b).

Although LOGO was introduced in some classrooms, its fate serves as a case-in-point about the nature of learning *informatique* in the French classroom. Jacques Perriault described how teachers failed to understand the student-centered, constructivist approach to learning that LOGO rested upon and sought to develop. Perriault recounted how teachers would themselves program the LOGO turtle while letting the students look on, or (in an almost macabre turn) how, in an effort to prevent students from pressing the wrong keys while typing they would attach pins to the keyboard so that the students would prick their fingers if they reached for the key (Perriault 2012a). These practices went against the constructivist philosophy of LOGO and the opportunity to practice making mistakes and "debugging," which Papert and Perriault considered to be central to the experience of learning through revising, self-correction, and updating one view of the world with another. Perriault argued that the established channels of authority and antiquated classroom hierarchies in France prevented the teachers from grasping the approach to learning that underpinned LOGO. The story of LOGO's failure in the typical French classroom was for Perriault an example of how the truly revolutionary potential of the computer for transforming human relations and updating old institutions such as the school was impractical in the ossified social structure of France. According to Perriault, the promoters of the *culture informatique* in France did not understand the practical limitations to bringing about a true computer culture in France. Put differently, their view of *culture informatique* combined the contradictory wish for computer-enabled decentralization, or some level of distributed decision-making, with persistent hierarchical control.

Even IPT supporters acknowledged that one of the greatest challenges for IPT to overcome was the so-called "disruption" to the classroom that the computer was seen to create. Jean-Pierre Dufoyer in *Informatique, éducation et psychologie de l'enfant,* suggested that computers interfered with teachers' usual ways. The computer presents “a violation of customs and habits,” wrote Dufoyer, “In fact, no specific educational project [with the computer] has ever been truly carried out” (Dufoyer 1988, 19). Dufoyer pointed out the important but vague idea that introduction of the computer was a violation of habits and customs—the established ways in which teachers generally taught. Jacques Baudé, high school biology teacher, long-term member and one-time president of EPI, and Perriault suggested that "habits and customs" refers to, more generally, a transformation of the teacher-student relationship in the French classroom (Perriault 2012a). In support of this hypothesis, Éric Bruillard and Georges-Louis Baron, in their book *L'informatique et ses usagers dans l'éducation,* wrote that teachers frequently based their educational methods on interpersonal relations with the students and they were wary of technology "mediating" their lessons and relationships (Baron and Bruillard 1996, 256). Both Baudé and Perriault described the French classroom as being very hierarchical, with teachers always being in the know. Teachers and the French Education Ministry gave instructions "from above" and defined the exact curriculum of the student. Baudé and Perriault recounted the embarrassment of the teacher in front of the students, the loss of face and authority of the teacher, when the teacher did not know how to use a computer, if something went wrong in a program's normal functioning, or when the students themselves seemed to know more about the computer than the teacher (Baudé 2012; Perriault 2012b).

Perriault suggested that teacher training could be blamed not only for teachers' lack of computer literacy but also for their lack of preparedness for how to deal with the inter-human (teacher-student and student-student) dynamics of having a computer in the classroom. Teachers did not have adequate training in using the programs because they were trained by engineers with an engineering mentality and so were not equipped to deal with the more inter-human issues surrounding computer use in the classroom.

The space and time allotted for computer work also contributed to the perception that computers disrupted the traditional teacher-student relationship. Teachers frequently had to relocate their class to a designated space of the computer—the computer lab. This process took time away from the lesson and created a rupture in the class. The unity of the class was broken by the inability of the whole class to look at one computer screen like they could at one chalkboard. Therefore the very aspect of one-to-one interaction with the computer that Servan-Schreiber praised and which worked as part of the interplay relationship with the computer in casual *informatique* environments did not work in the classroom. The computer encouraged a kind of decentralization of the classroom, taking the emphasis away from the single authority of the teacher to the individual (or in-pairs) work of the students in front of their own screens, working at their own pace. Instead of embracing this, teachers tended to resist it.

Perriault pointed out that LOGO's emphasis on the computer as a tool for children's independent exploration, without strict curriculum, i.e., what Perriault calls the "bottom up" approach, was an additional difficulty for the teachers. Teachers felt that they lost control of the classroom and were uncomfortable with the "looser" style of education the computer seemed to bring with it.

While Baudé and Perriault were advocates of relatively different programs (Perriault as the supporter of LOGO, which he considers to have always been on the margins of the dominant *informatique* movement in schools and Baudé as the leader of the dominant, Éducation Nationale-supported strategy), they both perceived strong resistance to their respective projects. EPI represented the teachers' point of view, but the teachers writing for the EPI *Bulletin* and those that were EPI members had their own doubts and challenges about teaching *informatique* and, secondly, were themselves a minority of teachers. In other words, no matter the pedagogical approach taken, it seems that the very presence of computers-as-objects in the French classrooms was already perceived as disruptive to the traditional way of teaching and to the usual teacher-student relationship. In light of these challenges, IPT was abruptly ended in 1989. More than twenty years later, French teachers, computer scientists, and students who had experienced it first-hand in the classroom still recalled it with both passionate criticism and admiration as a large-scale experiment whose alleged failure no one could quite explain.[206]

Simulation-at-large

President François Mitterrand supported both the CMI and IPT efforts and, from his vantage point, it appeared as if they were driving at the formation of the same *culture informatique* that would help to advance the socialist project of decentralization—the distribution of economic and political decision making to more local levels and the parallel empowerment of these decision-makers and ordinary French citizens with knowledge of the computer. The leaders of the CMI and IPT, however, had very different understandings of the way in which the development of *culture informatique* served French national interest and different strategies for bringing it about. Domestic and foreign critiques of both initiatives leading up to their controversial ends revealed

[206] This was the spirit of discussion of IPT at the November 2012 conference, "Vers un musée de l'Informatique et de la Société Numérique en France?" (Centre National des Arts et Métiers) and also of during my conversation with Bastien Guerry, a French computer programmer who took part in IPT as a student (Guerry 2013).

how they failed to synergize with the interests and needs of the teachers and students whom they addressed. In this context of frustration and controversy, the emergence of one type of software—simulation software—as a widely taken-up and relatively successful technology in the classroom (and beyond) for the advancement of *culture informatique* contains lessons for the acceptable relationship between the person, the computer, and the French state.

Simulation software created as part of the IPT project most successfully navigated the difficulties of introducing computers into French classrooms and appeared to answer the teachers' needs. Simulation software comprised computer programs through which students could tinker with the behavior of natural or social phenomena (e.g., ecologies and economies). Such programs allowed students to use computers to explore traditional subject matter in new ways while also learning about computer capabilities and about how to use computers.

Jacques Baudé recounted the widespread success that simulation software had for teachers looking for ways to productively introduce computers into their classrooms within the temporal and spatial constraints of the classroom and of the school subject. Thanks to computers, the use of simulation as a pedagogical strategy took root in in France, noted Baudé. This strategy was previously little practiced, as illustrated by the anecdote in which one school supervisor thought that *simulation* referred to the French *simuler,* or to fake, rather than to a pedagogical strategy (Perriault 2013). The majority of the nationally circulated software programs in the IPT software catalog were simulation software programs ("Informatique pour tous: Catalogue des logiciels" 1985). The relative effectiveness of simulation software in the context of the IPT project and the teaching of *informatique* within the classroom (as opposed to through initiatives like the CMI or programs like LOGO), indicates that that the form of *culture informatique* appropriate to French society was one in which individuals could experiment using the computer with well-defined constraints set up or designed by experts (computer specialist or teacher).

Simulation software can be seen as a kind of pedagogical strategy that teaches students to be little scientists. It does not teach them to be "child epistemologists" in Papert's sense of being able to think about their own thinking through interplay with the computer. Yet, as users of simulation software, they also have come a long way from the girl at SICOB playing the yes-or-no guessing game with the computer. The users of simulation software have particular agency and freedom to explore the world of the simulation while also staying within expert pre-defined rules. For example, consider an example of a simulation software used to teach a biological principle of animal dependence upon one another in an ecosystem (early on in his involvement in computers in education, Baudé created such a simulation for his biology class (Baudé 2012). A teacher who knew how to program would set the parameters of the simulation, such as the rate at which foxes eat rabbits or rabbits multiply in the absence of predators, informed by her knowledge of the ethology of foxes and rabbits. These parameters formed a kind of scaffolding or comprised the structure within which students could experiment. They could input the starting population of foxes and rabbits (e.g., 1 fox, 50 rabbits) and run the simulation to see what would happen in a given period of time in the ecosystem. The point of the simulation was to encourage this kind of tinkering with the parameters, rearranging them like little metaphorical bricks, while staying within a fixed structure or scaffolding. By engaging with this kind of simulation, Baudé described, students within the confines of the classroom could virtually experience what a scientist might observe in the field. Simulation software helped students to learn disciplinary lessons with an added element of self-discovery.

The scaffolding-brick elements of simulation software could also be found in other French efforts to develop *culture informatique*. For example, the *Immatériaux* exhibit that featured the Robert Quesneau sonnet generator used a similar approach. There, a computer programmer developed the rules for the sonnet and museum visitors could experience sonnets constructed automatically from a database of words that fell together in new poetic constellations. The *Micropuce* "Marchand de ville" television episode also followed a similar principle. The Merchant's computer contained the algorithm for transporting children to different cities. Without being able to influence the statist and outright racist nature of that particular algorithm, the children became in effect re-arrangeable parameters inside the computer system.

Was the kind of interaction with the computer typified by simulation software the achievement of a national state of *culture informatique*? Did it contribute to the development of the *ressource humaine?* It does not appear so if we consider the original ideals of *culture informatique* and *ressource humaine* envisioned by Mitterrand and Servan-Schreiber in the 1970s. Interaction with a fixed scaffolding and changing bricks characteristic of simulation software was distinctly different both from the ideal interaction with LOGO, in which expert-designed scaffolding was minimized, and from Servan-Schreiber's ideal of the *informatique* environment. In relation to those ideals of interplay, the scaffolding-brick paradigm seems like it was closer to the conception of the human as computer user.

Soviet Union

In October 1984 the Board of the USSR Ministry of Education introduced a new school subject, "Fundamentals of Informatics and Computer Engineering" in the 9-10th grades of every school as of the 1985-86 academic year. Practically, this meant that on September 1, 1985, the first day of school, all 9th and 10th graders in the Soviet Union would start their lessons in school informatics, with teachers trained to teach them, computer labs set up with the necessary computer equipment, and textbooks with the course's curriculum available to students and teachers. Ershov referred to this decision by the Ministry of Education as the beginning of a "global offensive" ("global," in the sense of general across the Soviet Union, not international), in contrast to the "infiltration strategy" used to introduce computers into classrooms in the years from 1982-1985 which had proved to be unsuccessful (Ershov 1987, 5). The new "global offensive," backed by the organizational and financial support of the Central Committee of the Communist Party of the Soviet Union (CPSU) and the Council of Ministers, was consistent with the "ever growing tempos of world progress" and stood a chance "to overcome the inertia and inadequate level of public awareness" of the importance of the computer in society (Ershov 1987, 5).

In describing this decision and the actions that it set in motion, Ershov used battle language. He invoked the scale of the mission, the necessity to fight, and the uncertainty of the outcome of the Soviet engagement in World War II as a metaphor for the struggle to create a national-scale computer literacy course (*Igra S Komp'iuterom* 1986). Unlike in World War II, however, there was no single easily identifiable opponent in the process of creating a national-scale computer literacy course. It was not the Soviet government, which was an ally in the fight; neither was it the computer industry. Instead the parallel to World War II Ershov capitalized on was to fight for a social order (of a computer literate population) that had to be won at any cost and with the fully mobilized effort of the entire population. In other words, Ershov perceived the creation of a national-scale computer literacy program as an inevitable necessity—and a struggle.

Visions at odds

Although Ershov and his Novosibirsk colleagues' work served as the basis for the new course, there were important differences between how Ershov conceived of the second literacy and the way in which the Ministry of Education understood and explained the need to create a national course. The CPSU Central Committee's decision to define computer literacy as a "state task" that was to be achieved by creating a "separate school course taught at higher grades in special computer classes" (*Komsomolskaya Pravda* 1984, cited in Ershov 1987, 5) was made as part of a broad school reform announced by Mikhail Gorbachev in April 1984. "The basic documents on the school reform [communicated to the public in the April 14, 1984 article in the newspaper *Pravda*]," wrote Ershov, "have solemnly declared computerization to be one of the main directions of school development" (Ershov 1987, 4). In Part III of the reform communication, titled "The improvement of teaching and educational process," the computer was described as an essential tool: "'to arm pupils with knowledge of and the skills to use modern computers, to provide for a wide application of computers in the teaching process, to create special school and interschool laboratories for it" (*Pravda* 1984, cited in Ershov 1987, 4). In part VII "'The improvement of the material basis of education,'" Ershov wrote, "electronic and computing machinery was mentioned, for the first time in our history, as one of the most important provisions of teaching" (Ershov 1987, 4). In the school reform, the Soviet government considered computers as one way, albeit the one with the most promise, in which to modernize the school. It recognized the computer as an important tool for teaching. However, the main goal of the course through which the computer was supposed to come into the classroom was to teach students "skills of operating computers" and helping them on to careers (hence references to "national economy") that used computers. The school reform defined computers as yet another kind of "machinery" that the worker could operate whose skilled operation would lead to scientific and technological progress of the nation.[207]

Neither of these—computer as a teaching tool or computer as yet another machine for scientific and technological progress—described why Ershov considered it important for the general population to become computer literate. Both of these goals were too practical, and hence too limited in comparison with what Ershov perceived the computer was (as an entity) and what it could do for the human being. Ershov alluded to this difference between his understanding of the value of computer literacy and the Soviet government's when he described the decision to create the Fundamentals of Informatics

[207] "'The comprehensive mastering of computers by young people should become an important factor in the acceleration of scientific and technological progress in the country'" (Ershov 1987, 6, citing the end of March 1985 Political Bureau of the CPSU Central Committee); "...with a view to inculcating upon the pupils the skills of operating computers and to arming them with knowledge about the use of this machinery in national economy (Ibid., 4-5,citing CPSU Central Committee and USSR Council of Ministers, *Komsomolskaya Pravda,* 1984, April 29, p. 1-2).

course as a "political decision." "One has to admit frankly," said Ershov, "that so drastic a decision could not be shaped in the circles of scientists and teachers" (Ershov 1987, 6). Ershov immediately added that he agreed with this decision and that it was "well-timed and correct." The contrast between the political impetus for the new course and the way in which it would have been carried out by scientists and teachers, who had been preparing such a course for years, however, belies a difference of approach that materialized into practical challenges of adapting Ershov's and his colleagues' experimental work to the national mandate.

One example of this challenge was creating the textbook and corresponding curriculum for the new course. The Soviet government charged the Soviet Academy of Sciences with the task of determining how this reform ought to be carried out. The Academy of Sciences was given the responsibility,

> to provide for the elaboration of a special course for pupils, for the creation of textbooks, teaching, school and interschool computer laboratories, and also for the use of computing machinery at the basic enterprises and other institutions for teaching purposes. [...] [As well as] to organize the study of psychological and pedagogical problems arising with the introduction of computers in the teaching process at general education schools (*Komsomolskaya Pravda* 1984, cited in Ershov 1987, 4-5).

The approach to school informatics taken by Ershov and his Novosibirsk colleagues, which they had worked on since the mid-1960s and developed in the young programmers' schools, All-Soviet summer schools, and through correspondence courses, served as the foundation for the new course. Like all order-transforming battles, this one also had its "manifesto," as Ershov referred to it, in the form of the 1979 treatise *School Informatics* authored by Genadii Zvenigorodskii, Yuri Pervin, and Ershov. In the book the authors described the broad idea of *informatika* as an "emerging science destined to study the laws and methods of information acquisition, transmission and processing with the help of a computer" which emerged from their experimental work with children (Ershov 1987, 8). The authors also identified the programmer as the person who possessed the knowledge of informatics and could serve as a model of a computer literate human being or one who possessed an "information culture."

Part of the challenge of scaling up the formation of computer literacy to the national scale, was moving away from the idea that the programmer is the bearer of "information culture." Ershov considered this association between programmer and information culture problematic because he understood the role of the "Fundamentals" course to be more than professional training to form programmers. Thus, he was concerned about a professional being a model for the new literacy. "Now we are faced with a rather difficult task of elaborating a concept of information culture that would avoid the extremes of primitive amateurishness and snobbish professionalism in the teaching of Informatics," wrote Ershov. "In addition, this concept [*informatika*] must be flexible, wide and concrete enough, without losing anything of its fundamental content, to enable the learners to achieve an adequate level of mastering informatics in the post-school period" (Ershov 1987, 9–10). The task of coming up with the nation-appropriate definition of computer literacy and "information culture" was a continued struggle for Ershov.

Even when Ershov did create a revised definition of the two, he expressed his lack of satisfaction of having achieved what he wanted to. Reflecting upon the long list of technical skills and knowledge that comprised the curriculum of the "Fundamental" course[208] and the "requirements" of achieving the "first level of computer literacy" and which, "when taken in their maximum scope, [...] constitute the prospective task of inculcating information culture in schoolchildren," Ershov expressed his doubt that this list of skills was actually able to go beyond defining the skills of a good programmer ("Course Curriculum, Fundamentals of Informatics and Computer Engineering" 1986, reproduced in Ershov 1987, 9-10). "This formula," he said, referring to the list,

> may seem overloaded, insufficiently fundamental, or too programming-oriented. However, among its good points are its practical character, capacity, and frankness in admitting the fact that a good programmer is, so far, the most reliable bearer of information culture, although it is not yet expressed in universal human categories (Ershov 1987, 9-10).

Thus, Ershov aspired to find a way to create a curriculum that would teach computer literacy and information culture in ways that could be universally applicable. Until he could accomplish this, Ershov left the programmer, the programmer's bill of skills, and the programmer's alleged intuitive and playful relationship to the computer (recall how Ershov described the programmer to be to the computer as a jockey is to his horse) as the model for the general educational curriculum and for every 9th and 10th grader in the USSR taking the Fundamentals course.

Ershov's resulting national curriculum emphasized learning algorithmic thinking (or, "programmer's-style of thinking") and played down practical programming or interaction with the computer. Students would spend at total of 72 hours of classroom time in 9th and 10th grades (or 34 hours each year) learning the Fundamentals course.

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[208] This list of skills and knowledge comprised the curriculum that was published in an academic journal in order to solicit applications for a textbook competition for the course. Ershov and colleagues' own textbook, *Fundamentals of Informatics and Computer Engineering,* published in two parts (Part I (96 pages), in 1985 and Part II (143 pages), for 10th grade, in 1986) by the national education publisher *Prosveshcheneye,* was considered "experimental" and just a temporary means until the competition would produce a definitive version.

This amounted to one hour of instruction per week. Eighteen of the 34 hours of the 10th grade curriculum were reserved for an "introduction to programming," which included learning theoretically about algorithmic language (10 hours) and learning a specific programming language (8 hours). Four more hours were spent on the "role of the computer in contemporary society," eight hours on learning about the way the computer works, and the last four hours devoted to an excursion to a computer laboratory for students to apply what they learned (Minpros SSSR 1987, 6). This attention of the curriculum to theoretical lessons about algorithms and downplaying of practical application and computer use was the root of a lot of criticism of Ershov's and his team's course.

As part of the implementation of the government mandate to launch the Foundations course, about 20,000 computers were distributed throughout 1,500 school computer laboratories.[209] Three types of computers were used in the labs, Yamaha PCs (Japanese-made, 400 labs), Agat PCs (Soviet-made, 600 labs), and KUVT-86 computer complexes that included personal computers of the DVK-2 and VK-0010 types (Soviet-made, 400 labs) (Ershov 1987, 10). Many of the labs were used by a number of schools in the vicinity and a few dozen "travelling classrooms" were installed on buses that travelled to rural schools. In addition to these dedicated school computer laboratories, computer centers of universities (such as in Novosibirsk) offered their facilities for student's use (Ibid.)

In spite of this equipment distribution, and although documentaries such as *Game With A Computer* showed children working extensively with computers, interaction with

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[209] These numbers were estimates for the summer of 1987 (Ershov 1987, 10).

the computers was not at the center of the day-to-day student learning. Ershov estimated that among the three million students that took the Fundamentals course in 1987, only one out of ten had a chance to approach a computer and had somewhere between ten and twenty hours of actual practice with the machine (Ibid.). Practical work with the computer was further discouraged by the creation, applicable beginning September 1, 1987, of new "sanitary and hygienic" norms that recommended students spend no more than a total of twenty minutes per week typing on the keyboards of the Yamaha, Agat, or KUVT-86 computers (Ershov Archives f. 255 l.9).

Ontologies of computers, ontologies of humans

Ershov was genuinely glad at the "political decision" that mandated the introduction of a course in informatics for all 9th and 10th graders in the Soviet Union and he was one of the main people to develop this course. However, Ershov's general understanding of informatics as a science of informational processes in the physical and social worlds, the study of which could be helped by, but does not necessarily require, the computer, was theoretically and practically at odds with the interest of the Soviet government in launching the new course of study. For Ershov, a computer literate population meant an enlightened population whose members could better understand and articulate their own thinking because of the insights into informational processes gained during the course of learning. For the Soviet government, a computer literate population meant a workforce skilled in the use of a new type of "machinery" to contribute to the nation's economic development. Both found common ground in the project of developing the human-computer partnership with the nation-wide course. Yet, for

Ershov this partnership was unique, unlike any that a human being had experienced with technology in the past.[210] Interplay between human and computer, Ershov considered so powerful and yet mysterious that he likened the programmer, the computer program and computer to the Trinity. Learning the second literacy would induct one into the ranks of programmers—those ultimate decisive and action-capable individuals in society. Although Ershov never said so explicitly, the great value that he placed on the programmers' creative and leadership role in society implied that becoming computer literate in this way might lead to a revision of the relationship among individuals and between individuals and their state. For the Soviet government, meanwhile, this partnership was a continuation of other human-machine interactions and therefore could serve the interests of the same educational system (even reformed) and the same political goals.

Ershov began exploring the role of computers in education because he was interested in understanding what the future school would look like once computers became small and present on the desk of every student. The fearlessness and passion with which children took to computers in his Novosibirsk experiments surprised and delighted him and it became clear to him that people with the computer as intuitive partner could reach new heights of productivity, action, rationality, and decisiveness, qualities that he valued in the human being and citizen. Similarly to Papert, who viewed the computer as a tool that could fundamentally change the way that people learn and who considered anything less to be a loss of opportunity presented by the computer,

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[210] See Ershov's "Programming--The Second Literacy" UNESCO speech for an account of the unprecedented nature of the new literacy.

Ershov at times expressed that he saw the Soviet government to be undervaluing the computer's role in society. For example, Ershov was frustrated with how the Soviet government was trying to make sense of the computer in terms of older technologies in order to decide how to best regulate it (Graham 2006, 158–9). Was the computer to be considered as a printing press, a typewriter, or a telephone? Each technological ontology came with an accompanying regulatory paradigm:

> If they decide that computers are like printing presses they will wish to continue controls, just as they do over all printing presses at the present time. Individuals will not be able to own them, only institutions. If, on the other hand, our leaders decide that computers are like typewriters, individuals will be able to own them and the authorities will not try to control the actual machines, although they may try to control the distribution of the information produced by them. If, lastly, our leaders decide that computers are like telephones, most individuals will have them, and they will be able to do with computers what they wish, but their on-line transmission will occasionally be monitored (Ershov 1986 cited in Graham 2006, 158–9).

All of these ontologies into which the Soviet government was trying to inscribe the computer belittled what the computer actually was, according to Ershov. Moreover, this was not only a decision about what the computer was, but also a limit on who the human being with the computer could be. Because he considered the potential of the human-computer partnership in the Soviet Union to be underappreciated, Ershov predicted, as he said in a televised interview with Loren Graham, that the effects of interpersonal communication with the computer would be greatest in the Soviet Union (Graham 2006, 159).

These differences between Ershov's and the Soviet government's visions about the appropriate relationship of Soviet citizens to computers had practical consequences. Even before Ershov's and colleagues' experimental textbook and curriculum for the

Fundamentals course were put in place, notable scholars were critiquing the course and calling it unrealistic and impractical. For example, Leonid Shternberg, a Russian computer scientist and pedagogue, critiqued the textbook because it had no mention of programmable calculators—the devices that children were supposed to work with and with which their schools would be supplied in lieu of scarce computers (Shternberg 1985, 9). Shternberg believed this omission led to a substantive problem: while the textbook sought to teach an algorithmic language, it left out essential points about working with actual calculating devices, including teaching students how to input data and receive output of data from the calculators (Ibid.).

Another reviewer of the textbook, Russian mathematician and computer scientist, Aleksandr Shen, called the course of informatics “Ershov’s program” and anticipated a number of critiques, all pointing to the impracticality of the course: "Westerners" would critique the course, Shen believed, by saying that until everyone has a computer at home with BASIC nothing will be able to teach the students, and when they will have computers, then they will not need to be taught. "Practicals" will critique the course by saying that one must proceed from the reality rather than teaching students "toy" languages like Ershov’s *Rapira,* which are only used on "toy computers." "Computers (i.e., people)," or people whose occupation it is to compute, would critique the course by saying that programming as such does not exist—only calculating methods exist and these are the ones that need to be taught. Finally, "users" would critique it by saying that the society needs computer users rather than programmers and so they need to be taught about displays and keyboards rather than algorithms and how computers work. Shen concluded that teaching “ways of thinking” instead of practical skills may pass for earlier grades, but to do so in 9th and 10th grade, when students are in their last two years of school and oriented towards careers, it was a "utopia" (Shen 1985).

A review of Ershov's curriculum after running the Fundamentals course for two years (during the 1985-86 and 1986-87 school years) found that many students did not understand the theoretical concepts of informatics like "algorithm" or system of commands" resulting in a very rudimentary knowledge of informatics, according to the program reviewers (Minpros SSSR 1987, 2). In reaction to these findings, the review committee recommended revising the curriculum for the 1987-88 year to start directly with foundations of programming, to spend more time on the theory of algorithms, reduce and simplify the part of the course that dealt with the way the computer worked, and increase the number of practice problems the students needed to solve.[211] These reforms sought to align Ershov's curriculum, which he designed with his concept of human interplay with the computer in mind, with the more utilitarian visions of computer literacy of the Soviet government.

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[211] The revised program for 9th grade consisted of: 2 hours (2 weeks) on introduction to computers and their role in society; 6 hours (weeks) on learning about algorithms and algorithmic language, i.e. how to write down algorithms in programs; 5 last hours were devoted to creating algorithms with the goal of solving particular problems, in which 1 hour was devoted to applying what has been learned to computers and 4 hours to writing algorithms for solving problems from mathematics and physics. For 10th graders, the new program recommended to switch places of "the way the EVM works ("ustroistvo EVM")" and "foundations of programming." The recommendation is to put foundations of programming first, which is consistent with the recommendation of Shternberg (1985). The amount of time devoted to the "Way the EVM works" would be reduced and the material simplified. The goal is to familiarize students with the way the processor works (the commands the processor uses), but they do not need to learn these commands thoroughly/commit them to memory. The last four hours of the "Way the EVM works," and of the course as a whole, were reserved for an excursion to a computing center (Minpros SSSR 1987, 3–4).

Nations of users

Seymour Papert's, Jean-Jacques Servan-Schreiber's, and Andrei Ershov's ideals of the human interplay with the computer were a source of inspiration for them in their projects to scale up their programs to the national level. For Papert the pursuit of computer fluency at the national scale was necessary because he believed computers presented the responsibility to rethink education in a "holistic and global" sense. For Servan-Schreiber it was necessary because he considered all French people had to have the *culture informatique* so that they might be able to better serve France as it competed for economic and cultural influence on the international stage. For Ershov, it was necessary because he saw programming to be a natural capacity of all people and therefore he thought that each person had to learn it as part of general education.

Interplay with the computer was also a source of hope that national computer literacy and culture might repair a broken aspect of the social order: the rigid education system and the generation gap in Papert's case, alienation from the means and purposes of production in the case of Servan-Schreiber, and human productivity in the case of Ershov. Yet, in scaling up the experiments to the level of the nation, each pioneer's ideals of interplay with the computer, and the implicit visions of playful subjectivity present in each, were challenged by existing social and political orders.

The educational system in each country was a specific institution through which these orders were refracted and with which the pioneers' visions clashed. All three of the pioneers, in their efforts to implement their program at the national scale, worked with the institution of the school. Papert wanted to work within the school system because, even though he saw it as "failing" the majority of youth, he saw it as an important vehicle for the formation of people, one that had to be reformed holistically, or replaced, but which nevertheless could not be ignored. Servan-Schreiber, though he built an institution for the formation of *culture informatique* outside of the school, discovered that this institution was not sustainable and the actual national-scale implementation of *culture informatique* took place through active participation of the French Ministry of Education with strong teacher leadership. Ershov likewise, although he thought that more informal settings like the summer school were better for learning second literacy, went through the general education system as a vehicle because of the centrality the school system for formation of Soviet citizens. The educational system was a powerful system for teaching children and it also served as a vehicle for distributing computer hardware and software and so was used by the computer industry, upon which the pioneers depended and with whom they also collaborated.

Yet, schools challenged the pioneers' visions. Even schools with the seemingly most favorable environments, such as the Lamplighter School, whose educational philosophy corresponded well to Papert’s and his colleagues’ design of LOGO, difficulties of implementation emerged. Papert's vision was that computers could be tools to make people more flexible learners more generally—tools to help people to change their thinking, to move from one "paradigm" to another by gradually reforming one's beliefs about the world.[212] But teachers did not have time, did not sufficiently understand the philosophy of the LOGO approach, or did not know how to use the LOGO

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[212] Papert's long-time collaborator, Edith Ackermann described Papert's interest in learning in the following way: "...Papert is interested in the dynamics of change. He stresses the fragility of thought during transitional periods. His great contribution, as an educator, is to focus our attention on how people think once their convictions break down, once alternative views sink in, once adjusting, stretching, and expanding their current view of the world becomes necessary" (Ackermann 2004, 22).

software well enough to apply it to their teaching.[213] It is difficult to know whether children who used LOGO to explore micro-worlds on their own were able to learn from it without "anyone watching" and guiding them. Papert attributed the difficulty to people's established ways of thinking, in essence, to psychological "digging in," or preference for doing and thinking in ways that were difficult to change about children, about their potential, about education, and about the computer technology as well.[214]

Servan-Schreiber's interplay with computers ideal rested on a weak foundation of creating *informatique* experiences and was thus difficult to defend and grow beyond the scale of localized experiments. Yet even the strongest parts of his vision for the CMI—its global mission and the one-to-one notion of the human and the personal computer—were criticized by French ministries and were considered detrimental rather than helpful to French economic interests. Meanwhile, French developers and supporters of LOGO argued that French teachers did not understand it and French schools did not support it because LOGO stood for a decentralized, unstructured educational philosophy that ran against the grain of the traditional French classroom where the teacher was used to being the expert. One of the most prominent LOGO advocates in France, Jacques Perriault, gave numerous examples of such "misunderstanding," all to show, as he

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[213] Alan Kay argued for the latter: "Seymour Papert and a few others can use LOGO to do just what was promised long ago, but there is no Seymour packaged with the LOGO diskette, and most attempts by teachers who did not understand the pedagogy or epistemology were failures. (They naturally concluded that the LOGO idea was false or a lie, instead of them being inadequate to the task!) Now, it is clear from observing random programmers that programming per se does not come close to elevating their thinking. If anything, it only makes them more narrow and careful, because they can't get their heads beyond engineering problem solving and the quick fix" (Kay 1994a).

[214] The idea of the restricted ways in which teachers think about the computer was the central moral of the "Thanks to Teachers" Docudrama, "Everyday Heroes" sponsored by Apple Computer (Apple Computer Inc. 1985). It was also echoed by Alan Kay, who recommended that the solution to people's resistance to new ways of thinking was: "The best we can do with the new is to learn to make softer landings into the new belief structure so that we can enjoy them without blindly committing our entire being to them" (Kay 1994b).

believed, that Papert's vision of constructionist education through LOGO did not take root in France and the school system retained its 16th century foundation in the Jesuit *Ratio Studiorum* ("Plan of Study") program (Interview). And even Jacques Baudé, who had worked with and from within the French national education system to realize the *Informatique pour tous* program and who championed the successful use of simulation software in French schools as part of IPT, was disappointed that the national implementation of *informatique* education in schools did not result in the development of a *culture informatique* in France (Interview).

Finally, in the Soviet Union, Ershov's vision of the computer literate person as an effective and satisfied partner of the computer was persistently challenged by the more utilitarian interests of the Soviet government to make the person a skilled user of the new machine. Even though Ershov had tried to translate the theoretical lessons about the role of the new science of *informatika* into relevant curriculum for 9th and 10th grade students while still maintaining the core of the interplay ideal, key elements of this ideal were stripped away in the process of revising the course for student and teacher comprehensibility.

Taken together, these accounts present the national implementation of computer literacy, second literacy, and *culture informatique* as having largely failed in realizing the pioneers' visions. They reveal the difficulty of extending the bounded gaming terrain where interplay between human and computer could be flexibly reimagined to the level of the nation, with its more rigid rules of the game. Specifically, it does not appear as if the national programs achieved the envisioned transformation of the relationship between the individual and the nation-state: the computer-enhanced individual in the United

States, the formation of a new decentralized and yet unified culture in France, or the human-computer partnership in the Soviet Union. Each of these three imaginaries depended on unlocking of the capacities of the human being in interplay with the computer. Being "fluent" in computer use, imbibing the *culture informatique,* and having second literacy, meant, as I explained in the previous chapter, entering into a relatively unstructured, non-hierarchical, playful relationship with the machine (though even in these contexts some assumptions and power relations were necessarily built in). The pioneers' visions to form free and autonomous computer players confronted national constitutional orders—rules of the game of a sort—in the form of the educational system or industrial priorities that moved national projects toward more utilitarian purposes, with computers working to transform citizens into passive consumers of ready-made technologies.

Chapter 6:
Constitutions of the human in the computerized world

Computer literacy legacies

Computer literacy and computer culture, as concepts and as programs, peaked in the mid-1980s and by the early 1990s were already on the decline. Despite this, schools in the United States, France, and Russia (as well as many countries that comprised the now-dissolved Soviet Union) continued to teach various aspects of computer literacy and culture (and its many new and old cognates: computational literacy, information literacy, digital literacy, computational thinking, algorithmic thinking). And many of the pioneers of computer literacy whose visions and projects I have followed in this dissertation continued to work towards the realization of their visions.

In the United States, Seymour Papert remained active in developing computers as intellectual tools even after his retirement from MIT, until he suffered a serious brain injury in 2006. His many colleagues continue to honor and develop his work both at MIT and around the world. Although Jean-Jacques Servan-Schreiber did not continue the pursuit of *la ressource humaine* after quitting the Centre Mondial Informatique, Jacques Baudé and Jacques Perriault work to this day on developing the *culture informatique* in France. Andrei Ershov died in 1988, soon after aspects of his visions of second literacy become ensconced in national educational policy. His colleagues at the Novosibirsk Computing Center, however, such as Yuri Pervin, continue to develop educational tools and curricula inspired by their collaboration with Ershov.

Although a number of the original pioneers and their colleagues and students continue their projects to this day, the world of the 1990s was not receptive in the same way to calls for public computer literacy. The idea of computer literacy and culture no longer occupied a central place in the public imagination. Politicians who gave color to the imaginaries and advanced national computer literacy efforts in the three countries left the political stage (Congressman James Scheuer finished his last term in the United States House of Representatives in 1993; François Mitterrand's presidency ended in 1995; Mikhail Gorbachev's presidency ended in December 1991).

Technological changes also contributed to the decline in attention to computer literacy. The birth of the World Wide Web turned attention away from interaction with personal computers as such to creating and exploring branching on-line worlds, and to the new skills and habits necessary to do so. As in the Lamplighter School, personal computers became commonplace objects in homes and in public spaces, unremarkable objects that no one seemed to pay special attention to anymore. Children born in the 1990s, younger members of the Millennial generation also referred to as "digital natives," could push keys on the computer keyboard long before they encountered any formal instruction on how to use the computer.

The spread of the personal computer and the spreading knowledge of how to use popular software, even the ability to program, could be read as a sign that the unreflexive and inevitable information age that futurists as well as pioneers of computer literacy had predicted and warned about had arrived. Jacques Perriault and Jacques Baudé in France, for example, consider the loss of attention to the explicit development of *culture informatique* in French schools and society at large to be a defeat of the goals of the programs they worked on (Interviews). Without dedicated efforts to guide *culture informatique* in the right direction, they argue, people just fall back on habits dictated by the unreflective computer industry and persist in treating the computer as a black box (Perriault 2012; Baudé 2013).

Read differently, however, these developments could be seen as evidence of the achievement of public computer literacy or culture. By the end of the 1990s, computers had become so widespread and commonplace and many people in the three nations, especially the young, knew how to interact with them comfortably. The formation of thousands of students through the experimental and national computer literacy and culture programs in the three countries, no matter how short-lived or partial in the perspective of their designers, undoubtedly contributed to this present reality.

The pioneers' and their programs' influence can also be traced through the ways in which individual visions became collective imaginaries. Even without the leadership of the original pioneers, their ideas, I argue, have had an influence on the present by becoming embedded in technological artifacts and institutions that live on. For example, Papert's theory of constructionism and his work to develop concrete thinking can be seen as continuing in the icon-based design of the Apple computer (Turkle and Papert 1991). As such, the Apple computer carries the seed of Papert's strategy for building computer fluency, which today grows and takes on new lives not only in the minds of Apple users but also in all personal computers and smartphones that have adopted icons as a best practice of user-interface design. In France, where the distance between individual vision and collective imaginary was always the smallest among the three countries because of the way in which prominent figures of the French state and society were directly involved in the pursuit of *culture informatique,* evidence of Servan-Schreiber's *informatique* environments can be found today in every Wi-Fi permeated public square and museum.

Finally, though the Soviet Union no longer exists and the change of political order from communist to (in different degrees) democratic has resulted in drastic transformations to people's lives in the former Soviet Union countries. Today the Russian and Ukrainian educational systems continue to produce talented and subversive computer programmers—in the fullest sense of Ershov's jockey and horse metaphorical ideal, with humans as skilled partners of the machine. The persistence of these national imaginaries of computer literacy and culture with their discernible national differences, in spite of passing years and changing technological, economic, and political circumstances, is another testament to the strength and continuity of cultural traditions and ways of knowing that underlie sociotechnical constitutional orders.

Without discounting the practical interest in understanding the contributions of the specific programs described in this dissertation to present ways of thinking and being with computers, my comparative study suggests yet another way in which to look at the legacy of these projects. As they have figured in this dissertation, computer literacy and culture are states in formation that are always on the horizon—states to aspire to and work towards in the near future, but also ongoing sociotechnical projects that reveal societies' commitments in the present. Those commitments include at their heart the understanding of who the human member of society is, and how that human fits into and belongs with society's collective ways of being. As technology offers human beings new visions and imaginaries, a history of technology therefore becomes importantly a matter of tracing the changing constitutions of human-ness.

Constitutions of the human

The history of computers becoming personal and public around the world is a history of aspiration: of designing technologies and practices of use in ways that would help individuals and society not only to overcome contemporary challenges faced in the present but to achieve their fullest potential in the near future. The varied ways in which entrepreneurs in the different societies imagined their futures with computers suggest that, more than a tool of the intellect, the personal computer is a tool of the imagination.

When we take a close look at what being computer literate or cultured meant in three different cultural, social, and political contexts, we discover not the harnessing of computing power itself, but rather the possibility of seeing society differently through the role that the computer and the knowledge of the computer would play in it. The imaginaries of public computer literacy are at one level diagnostic tools of society. They reveal how societies perceive their weaknesses and their sources of decline. But the imaginaries are also of futures that societies have tried to strive for, revealing what they value, and allowing us to discern the commitments that societies have to the people who live in them. As such, computer literacy help to flesh out three key characteristics of the constitution of the human in the computerized world.

1. Constitutions of the human in the computerized world are future-oriented.

Constitutions are always future-oriented because they offer normative reasons to justify people's imaginations of how they should live. This orientation of constitutions to the future is particularly strong in the contemporary technoscientific world, where political normativity is always infused with imaginations of technologically mediated futures and what they can do for individuals and collectives.

The future was the starting point for computer literacy and culture programs. The programs described in this dissertation took shape in the context of imaginations of the already underway, but not-yet-here, information societies. In all three national cases, forming a new human-computer cyborg with computer literacy and culture programs was seen as the go-to answer to address an envisioned political breakdown. In the United States, the breakdown was primarily cultural, expressed in terms of a widening gap between the capacity of members of different generations to understand one another, and psychological dislocation caused by the speed of change. Computers were seen to be partly responsible for a cultural rift that threatened to tear the social fabric almost by a kind of speciation, or division of people into irreconcilably different categories. By enhancing people's malleable cognitive capacities—above all the capacity to imaginatively create and put oneself in the place of another, rather than simply to calculate—computers promised to bridge the generational gap. In France, the perceived breakdown was alienation, or the separation of the human from the means and purposes of production, including the social relationships that formerly sustained working communities. *Culture informatique* promised to invest people's work with new meaning and fulfillment by connecting individual passions and abilities to where they would be most needed by society. In the Soviet Union, the breakdown was seen as a kind of illiteracy and subsequent stagnation. Incapacity to participate in the new informational forces of production would lead, Ershov feared, to the loss of the nation's productive capacity. Second literacy offered the possibility for each boy and girl to become a programmer and feed the state (and the state's computers) with creative programs to advance the economy.

In addition to being the place from which the necessary capacities to address the various breakdowns were imagined, the future was also at stake in the advantages that computer literacy and culture were supposed to give their bearers. All of the national programs sought to develop in their subjects a certain future-mindedness, or capacity to be nimble and flexible and adapt to a quickly changing world in which the unfamiliar future was always at the doorstep of the familiar.

2. Constitutions of the human in the computerized world are constitutive of the self.

For the computer to become an instrument of human flourishing, it was thought, people needed to incorporate various aspects of the technology into their daily habits of thinking and being. It was not enough to merely use the computer, one had to become literate, fluent, or cultured in interactions with computers. Although what it meant to be any of these things in practice was different, overall it meant learning how to accommodate the computer into daily life—as a normal entity in one's home, in the classroom or work office. It meant, metaphorically, letting one's knowledge of the computer become as basic as knowing the alphabet, and, literally, learning to speak the language of the computer (whether by learning programming, mastering algorithmic thinking, or knowing how to interact with a given software). Above all, it meant entering into what I have called “interplay,” or playful interaction, with the computer: a relationship characterized by play (as opposed to use), an interaction in which both sides (the person and the computer) mutually influence one another.

In spite of the particular type of play privileged in a given society's approach to computers, the computer player in general was someone who became absorbed in the interaction with the computer. Structures for interaction set out by the computer hardware or software guided but did not bind the computer player. The computer player engaged in "free play" or exploratory relationship with the machine, through to discover new realities in microworlds as well as achieve greater self-knowledge. A playful interaction with the computer was one in which the metaphorical playing field, or opportunity for interaction, for teaching and learning, between human and computer was seemingly level.

Interplay was the ideal relationship with the computer as envisioned by the pioneers promoting computer literacy, fluency, and culture. "Ideal" because only through a playful relation, as described in Chapter 4, could one truly incorporate the technology into one's constitution (become computer literate or cultured); "relation" because interplay defined an interaction between the person and the technology, through which both were transformed, i.e., technologies could become more "personal" and "natural" (according to the particular cultural meanings of these terms), while people (their minds, bodies, and actions) could understand themselves and be understood in new ways in light of the technologies they were relating to.

Interplay with the computer was not just pleasurable but had the merit of unlocking various (seemingly natural, in the context of each culture) capacities of the human player: creativity and self-reflection (Papert's LOGO), self-fulfillment (Servan Schreiber's *ressource humaine*), algorithmic reason (Ershov's school informatics). Personal computers were a new kind of "technology of the self," in the full sense of

Foucault's term (Foucault 1988): a suite of instruments for producing the historical entity of the self—making the self into an object of concern and care (C. Taylor 1989). They were instruments that people could use to work on themselves and to make themselves into particularly able and disciplined beings (knowledge-able, cultured human resource, productive partner). They were also technologies that others (technologies' designers, teachers, politicians) used to form particular subjects out of these human-computer hybrids, according to culturally specific understandings of human and social flourishing.

This attention to the development of the self was particularly strong in the United States, where the personal computer was envisioned as an intellectual tool for cognitive enhancement and hence centered on developing the individual mind. Although in France and in the Soviet Union visions of human-computer hybrids were more collective in nature—implicated in forming a culture in France and a partnership in the Soviet Union—notions of the self (self-expression, self-determination) showed through. For example, in France the idea of the *ressource humaine* emphasized individual creativity, value to society, and granted the status of a quasi-human right of the person to self-fulfillment. In the Soviet Union, the ability to develop one's reasoning and productivity by acquiring the second literacy was considered a social responsibility as well as a source of individual satisfaction and the empowerment that comes from entering into the ranks of creator of powerful programs.

The contemporary attention to "I" and "You" (that loud "I" or "You" that figure so prominently today in technology brand names, such as iPhone, YouTube) did not come about as a result of the introduction of personal computers. Yet, the comparative perspective reveals that the self was, consistently across different cultures, an active site of construction through the acquisition of computer literacy and culture. Although the type of person presupposed by each program was different (a creative mind, partaking in a common culture, a member of the productive collective), these programs did focus on and promise to develop the individual on the other side of the screen.

3. Constitutions of the human in the computerized world entail changes in collectives.

Comparative study of computer literacy and culture programs of the recent past helps to understand claims about computers, subjectivity, and citizenship in the present. There is a popular assumption, especially strongly present in the United States, but also shared by people in France and in the countries of the former Soviet Union, that relationships among people and between individuals and collectives, including the nation-state and the global community, are different today because of the ubiquitous presence of networked computing at everyone's fingertips. At the core of this assumption is the recognition of what I have called the playful subject, or someone whose self (uniqueness and individuality) and humanity are unlocked and amplified by the personal computer and, as a result, whose relationship to the collective has been redefined. My study shows how the realization of the playful subject comes about not so much through the advent of any technology (like the personal computer or the internet) as much as through a culturally situated, imagined, ideal relationship of human beings to technical artifacts. Comparison also shows that the playful subject was an ideal of the pioneers that was never fully realized at the scale of the nation state, although it is certainly possible that some individuals achieved the imagined levels of fluency, culture, or literacy.

One of the foundational assumptions of this dissertation has been that there is a mutually constitutive relationship between the constitution of the individual mind or body and the normative constitutions that hold collectives together, such as a national polity. The ubiquitous self-definition, transformation, exploration, equilibration (Schüll 2012), and enhancement achievable with the computer—even just the *expectation* that interaction with the technology will provide these benefits—underwrite a set of expectations, rights, and responsibilities regarding who we should be as members of a political order. In other words, it is fair to assume today that the information technologies that enter and shape our intimate thought processes not only affect how we flourish as individuals but also transform us as citizens.

A recent advertisement of the latest version of Microsoft Windows Office, for example, promises that its software will provide children of the next generation intuitive tools to be the best they can be and to help to resolve the world's problems (The Windows Team 2015). The aspirational presumption of computer literacy or culture – i.e., that playful relations with information technology will lead to human flourishing and forge people and society in the image of what is deemed right and good—has a flipside. Publics and leaders around the world who accept the imaginary that computers make good subjects increasingly expect solutions to the world's problems, such as poverty, hunger, or climate change, to come from the technology rather than from innovations in modes of being together.

As a consequence of the imaginary of playful subjectivity, today in the United States and increasingly around the world, we expect more development of the self, of communities, and of the globe from technological fixes, such as greater access to computer hardware, than from involvement in social pursuits such as artistic expression, education, or the law. Of course, the history of computer literacy and culture reminds that technology is imbricated in these other activities, and there is no such thing as a purely social innovation, just as the *culture technique* movement sought to establish that there is no humanism without technology. However, there is still a significant difference—even if it is merely a difference of attitude—between these two expectations of where flourishing comes from. Compare, for example, the following two attitudes to the alphabet, the foundation of literacy:

> (Stoop) if you are abcedminded, to this claybook, what curios of signs (please stoop), in this allaphbed! Can you rede (since We and Thou had it out already) its world? (Joyce 1939)

> We are creating a new company, called Alphabet (http://abc.xyz). [...] We liked the name Alphabet because it means a collection of letters that represent language, one of humanity's most important innovations, and is the core of how we index with Google search! (Page 2015).

In the first case, a character in James Joyce's last novel *Finnegans Wake* invites the reader, "abcedminded" (a neologism that alludes to the literate person as absentminded) as she is to humbly attempt to read the world as if it were a book made of clay. In *Finnegans Wake*, as well as all of his other works, Joyce bent the rules of language to find a way to use it to communicate realities usually hidden from view by language's very structures. He played with language in the sense of play used throughout this dissertation. Here, more specifically, Joyce used the invented word "allaphbed" to suggest how letters make up a soft, primordial riverbed through which the ever-changing events of the world flow and upon which they leave their mark, in the form of claybooks. Knowledge of the alphabet, Joyce appears to suggest, is at once the key to making sense of the world and yet, in making the bearer of this knowledge abcedminded, prevents an accurate reading of it.

In the second passage, Larry Page and Sergey Brin, CEOs of Google and arguably two of the most computer literate and computer cultured individuals now on the planet, announced on August 7, 2015, that they were forming a new technology company that they called "Alphabet." For Page and Brin, the alphabet is a technical innovation created by people; it is a "collection" of useful tools. This understanding of the alphabet makes it a suitable name for an ambitious new enterprise, one that would string together Google's subsidiary companies developing information technology solutions for addressing different areas of life (from organizing information to transportation and aging). Page and Brin wish to claim the foundation stone of literacy, the technology of the alphabet, as the name for their totalizing adventure in creating, and controlling, how the twenty-first century subject accesses and uses information for any and all purposes.[215]

These two examples represent two different ways of thinking about the alphabet and about literacy. Most deeply, they stand for different attitudes and demands towards one of the central givens in the human condition: the human capacity for language. One treats language as embedded in the world, the other as a technology invented by people. One sees language as an unavoidable aspect of the human condition to be constantly wrestled with and renovated to make new meaning, the other as a useful tool for changing the world. One adopts an attitude of humility, admitting the malleability and even mortality of words, the other of hubris in seizing control of the fundamental technology

[215] It is no small irony that this move may run up against trademark or domain name claims by other companies, such as BMW, that have already captured the name Alphabet for some of their operations (Ewing and Hardy 2015).

of language. Though both ways of thinking about the alphabet and literacy coexist, Google's way of thinking about it is undeniably enabled by the movements to develop the culture of computer literacy around the world, with its faith in human-made tools (especially informational ones) to address impending catastrophes by adapting the self to imagined sociotechnical futures.

By expecting more from technology—more for the self and more for society—we transform our expectations of key elements of citizenship rights and responsibilities. We saw this happening already in Papert's statements in front of Congress in 1977, when he said that in considering what is the best possible education for the handicapped, lawmakers had the responsibility to consider the opportunities presented by information technology (US House of Representative 1978). The handicapped should have a constitutional right, Papert implied, to computer technology. This right would empower them vis-à-vis other people and vis-à-vis the government. They would not be as dependent, as a result, on the law or on the government to provide them with an appropriate education, but could take what they need on their own. They would be able to help themselves, in effect overcoming their handicap. They would gain control and power over their own lives and the capacity to participate in world-making as equals with other members of society.

In 1976 Ira Goldstein and Seymour Papert suggested that humanity was on the cusp of defining a new type of human being, formed in relation to the personal computer as a "tool of the mind" (Goldstein and Papert 1976). By examining the computer literacy and culture programs that sought to bring about this new human being, I have sketched three dynamics that came together to define this human, though I have also shown that each person lives out these generalities in irreducible cultural particularity. First, that the person in the computerized world will be generally comfortable with the future and with living by imaginaries, which, like the imaginary of playful subjectivity, need not necessarily become hard reality. Second, that this denizen of the information age will be preoccupied with the self and the self's development, which will becomes the central pillar of the individual's world-making activities. And, third, that this flourishing of the self will be pursued with technologies, which, like the personal computer, will be incorporated into the human mind and body, permanently altering what it means to be human.

It is no surprise, therefore, that in 2006 *Time* magazine came out with yet another unusual cover for its "person of the year" issue. This time, instead of the "machine" replacing the "person" of the year, the most influential person was "you." This anonymous "you" was also defined through and through with the computer. The cover image showed the word "You" playing (as in, to play a video) on a reflective surface representing the screen of the YouTube interface. From this insider position, fully in the world of bits, the imagined "you" was "in control of the information age" (*Time* 2006). "Welcome to your world," the caption read: a world forged as the image suggested through incessant games of masquerade with notions of self, and modes of interaction with other computer-constituted selves, by creating and disseminating ideas in the subject's microworlds of choice.

Time's imaginary of playful subjectivity supports the existence of a relativistic multitudes of worlds in which we are always thrown back upon the self and the self's point of view. These are private worlds (an oxymoron, according to Hannah Arendt) instead of one common world that unites and also separates its inhabitants, as a table does with a group of people who share a meal or discussion around it (Arendt 1958). Sherry Turkle took issue this state of radical selfhood in the computerized world as the experience of being "alone together" (Turkle 2011), for her a state of loss rather than a state of fulfilling play, while her critics describe it instead as "networked individualism" (Rainie 2012). In both cases, however, linked selves have replaced the common world, which still existed as a reality for the authors of twentieth-century computer literacy programs when they imagined the need to adapt people to the coming information societies from their vantage points of the 1970s.

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