Going Critical:
Perspective and Proportion in the Epistemology of Rob Kling[1]

John Leslie King
School of Information
University of Michigan
Ann Arbor MI 48109
+1 734-647-3576
jlking@umich.edu

Suzanne Iacono
National Science Foundation
4201 Wilson Boulevard
Arlington VA 22230
+1 703-292-8930
siacono@nsf.gov

Jonathan Grudin
Microsoft Research
One Microsoft Way
Redmond, WA 98052
+1 425 706 0784
jgrudin@microsoft.com

Abstract

One foundational element of Rob Kling's body of research and writing is its critical perspective on the nature, role and dynamics of computerization. His main argument was that one should view as dubious any statements that are not grounded in empirical evidence or theoretical analysis, particularly when the implications appear to benefit those making the statements, such as vendors, the public press, and government officials. Rob's work was replete with successful instances of critical refutation, in which he challenged assumptions or statements about computerization and provided convincing alternative interpretations. Much of his work delivered powerful indictments against sloppy conjecture and hyperbolic statements that claimed either utopian or dystopian outcomes from computerization. At the same time, some of his own assessments of the implications of emerging technologies tended to be dismissive and marginalizing, revealing in his own thinking some of the weaknesses he relished in pointing

[1] In deference to our close associations with Rob Kling over the years, we refer to him simply as Rob throughout this paper. We do not extend this familiarity to others. Authorship order is proportional to years with Rob.

out in others' rhetoric and writing. This paper identifies intellectual traps inherent in critical perspectives that can catch even the most acute practitioners. The objective is to help elucidate and stabilize the epistemological foundations for Rob's critical perspective on the role of computerization.

Keywords: critical perspective, social informatics.

We'll understand it better in the sweet by and by,
All will be one, all will be one.
We won't have to worry and we won't have to cry,
Over in the old Golden Land.[2]

1. INTRODUCTION

In 1966, Rob Kling began studying Artificial Intelligence at Stanford. Arguably the most famous member of his cohort was Shakey, the mobile robot system that appeared in the Stanford Research Center the same year. By 1968, Shakey performed route-finding and object rearrangement tasks perhaps on a par with a human two-year old, earning a mention in the *New York Times*. Two years later, *Life* magazine declared that Shakey was "the first electronic person" and *National Geographic* (1970) included a picture of Shakey among its lineup of exotic indigenous peoples.

The *Life* article quoted Marvin Minsky: "In from three to eight years we will have a machine with the general intelligence of an average human being. I mean a machine that will be able to read Shakespeare, grease a car, play office politics, tell a joke, have a fight. At that point the machine will begin to educate itself with fantastic speed. In a few months it will be at genius level and a few months after that its powers will be incalculable." (Darrach, 1970, p. 60). Other AI researchers consulted by the *Life* writer found this timetable somewhat ambitious: "'give us 15 years' was a common remark—but all agreed that there would be such a machine and that it would precipitate the third Industrial Revolution, wipe out war and poverty and roll up centuries of growth in science, education and the arts." Based on such conversations, the author concluded

[2] The opening and closing quotes are from the poem, "Job's Tears," by Scottish bard Robin Williamson, set to music by the Incredible String Band in 1968.

that “computers could free billions of people to spend most of their time doing pretty much as they damn please” (Darrach, 1970, p. 65).

Rob parted ways with the un-self-critical AI mainstream in 1973 with two papers -- an editorial titled, “Notes on the Social Impact of AI,” that appeared in the *SIGART Newsletter* and a paper titled, “Toward a Person-Centered Computing Technology,” in the Fall Joint Computer Conference.[3] In those papers, Rob adopted a critical analytic perspective, foreshadowing one of the most important aspects of his career as a student, teacher, and researcher on computerization. The root of the critical perspective is "critic," from the Greek *krites*, or judge -- a person who offers a value judgment or interpretation of what is witnessed or heard. A critical perspective, from Rob's point of view, entailed a strong inclination to view as dubious any statement that was not grounded in empirical evidence or theoretical analysis, particularly those that encouraged people to take actions that would ultimately benefit those making the statement. If Rob had a personal motto, it might have been, “Think it through.” He was a true student of the enlightenment, with a deep belief that power corrupted and that reason could prevail.

It is not a coincidence that Rob’s critical perspective evolved during an era of exceptional hyperbole surrounding AI. Only a few years after Minsky’s prophecy failed utterly, AI was back with reborn enthusiasm for production systems, knowledge engineering, and neural networks. Rob’s Ph.D. advisor, Edward Feigenbaum, was one of the loudest cheerleaders for knowledge engineering. He all but predicted imminent Japanese dominance of computing in the highly influential book, *The Fifth Generation: Artificial Intelligence and Japan’s Challenge to the World* (1983). AI has been highly seasonal, with summers of exaggerated prediction followed by winters of disappointing results, but on the whole the summers seem to take the upper hand (e.g., *The Age of Spiritual Machines* by Ray Kurzweil and *Robot: Mere Machine to Transcendent Mind* by Hans Moravec, both published in 1999).

[3] SIGART is the Association for Computing Machinery (ACM) Special Interest Group on Artificial Intelligence. The AFIPS Fall Joint Computer Conference was the most important conference in the computing field at that time, run by an umbrella organization that included ACM and similar socieites.

Rob's critical perspective was not biased against technology; he was personally in love with technology, as anyone who ever heard him talk about high fidelity stereo equipment can testify. Still, critical refutation was a hallmark of his scholarly work. He routinely challenged assumptions or statements about the nature or role of computerization and provided convincing alternative interpretations of the issues at hand. Much of his work delivered powerful indictments against sloppy conjecture and hyperbole claiming either utopian or dystopian outcomes from technology, in general, and computerization, in particular. His critical perspective had a strong influence on others, generating a field of studies related to the complex social contexts that could constrain, alter, or negate predicted effects of computerization.

Although a valuable corrective, such a strong critical perspective can be non-reflective and too quick to dismiss other points of view, and in this way display some of the same weaknesses of the positions Rob challenged. In a sense, Rob became invested in dismissals of what he called "breathless" accounts or "glossy" images of large-scale social and economic transformation brought about by digital technologies. He took a highly protectionist stance toward the common person and regaled against class advantages that technology might have for the rich and powerful, at times before such advantages had been demonstrated. In addition, some of his assessments of the implications of emerging technologies, at least as seen by his co-workers, tended to dismiss and marginalize trends that later proved to be important. It is instructive that a person as brilliant and perceptive as Rob could fall victim to the trap of letting a critical perspective dictate what outcomes would be realized. This is not a matter of weakness in Rob's scholarship; he was a disciplined scholar. Rather, it is a cautionary note about the siren's call of critical perspectives in general, and particularly when applied to the rapid change in computerization over the past quarter century.

This paper addresses intellectual traps inherent in critical perspectives that can catch even the most acute practitioners. Our objective is to help elucidate and stabilize the epistemological foundations for Rob's critical perspective on the role of computerization movements. The purpose of the paper is to highlight the strengths of the critical perspective as it evolved in Rob's

work, while at the same time to illustrate the problems with an uncritical critical perspective. In essence, this is a narrative of achieving and sustaining critical balance.

2. ALL'S FAIR IN THE SUMMER OF LOVE AND WAR

Rob brought to his work his own formative experiences. In the United States, Rob's generation grew up in a heady, but frightening, world. The great Allied victory of WWII had spawned the realization that technology, instrumental in the prosecution of the war, was an essential component of national welfare. President Roosevelt's wartime science adviser, former MIT Vice President and Dean of Engineering, Vannevar Bush, had set the stage for major national investments in scientific research that led to the creation of the National Science Foundation. The hot conflicts of the late 1940's and early 1950's were followed by the chill of the Cold War, and Rob, like many American school children, learned the ritual of "Duck and Cover" in preparation for a Soviet nuclear weapons strike. Reaction to the launch of Sputnik redoubled the US focus on science and technology, and by the early 1960's had transformed US science education and spawned the Space Race. Science and technology were not merely important to material progress, they were regarded as vital to the triumph of good over evil. Their incorporation into a complex morality play opened the door to profound soul-searching regarding the relationship between long-term human welfare and the power of science and technology.

This concern was not new: Anxiety was evident in speculative fiction by the early 19th century[4] and had entered scholarly discussion by the 1930's. Lewis Mumford published his pathbreaking *Technics and Civilization* in 1934, providing one of the first serious historical assessments of the

[4] Mary Shelley conceived her masterpiece *Frankenstein* in 1816 , providing one of the earliest explorations of moral hazard from the power of science, an iconic symbol that survives to this day. Jules Verne's *Twenty Thousand Leagues Under the Sea*, written in 1870, explored the moral dangers of technology embodied in war-making power. H.G. Wells' *The Time Machine,* written in 1895, foresaw a future in which not even advanced technology could prevent the demise of human life. E.M. Forster's *The Machine Stops,* written in 1909, considered a future of humans dependent on a great provisioning machine that suddenly stops, with catastrophic consequences. Evgeny Zamyatin's *We* (1920), arguably the first dystopian novel, explored the power of technology for social control and influenced Orwell. Huxley's *Brave New World* followed in 1932.

relationship between technology and the human condition. Two years later, in the film, *Modern Times*, Charlie Chaplin's satire of technological efficiency gone awry reached a larger audience. WWII interrupted the discourse, but only briefly. The Nazi's appalling use of chemistry in the Holocaust gave visceral meaning to the concept of the *Wehrmacht* (War Machine) that Hitler had let loose upon the world, and the nuclear attacks on Hiroshima and Nagasaki deeply unsettled traditional notions of war in a way that equally destructive fire-bombing had not.

In examining the era in which Rob formed his research perspectives, we see a rising spectre of fear about life in modern times. In 1956, unintended consequences of chemical advances riveted world attention through accounts of horrible deformities in people exposed to mercury-tainted industrial waste dumped into Minamata Bay, Japan. That same year scientists at Caltech proved that the Los Angeles area's ubiquitous and noxious combination of smoke and fog, nicknamed smog, was created by sunlight acting on chemicals introduced into the atmosphere by emissions from automobiles and other combustion sources. In the late 1950's, thousands of deformed babies were born to women in Europe who had been prescribed the drug thalidomide as a sleeping pill and antidote to morning sickness. By 1961, scientists proved that thalidomide stunted the growth of fetal arms and legs, triggering public concern about drug safety in the US that had not been seen since the passage of the Pure Food and Drug Act in 1906.

In 1962, Rachel Carson's landmark book, *The Silent Spring*, raised the first serious popular doubts about the beneficence of technology; in 1964, the US Surgeon General concluded that smoking cigarettes caused severe health danger to the two-thirds of US males who smoked; in 1965, Ralph Nader's *Unsafe at Any Speed* raised questions about passenger safety in automobiles; and in 1967, Paul Ehrlich's *The Population Bomb* popularized the idea that extreme growth in the population would lead to global catastrophe. In response to these rising concerns, a number of social movements emerged, including the environmental movement: The first US "Earth Day" was April 22, 1970.

During this era, it became increasingly clear that science and technology were not always beneficial and in many cases could be horrific. Many accounts of modern science and technology

played on people's fears, creating a groundswell of concern that was often lacking in sober judgment about cause and effect or cost and benefit. Rob's career began during this era. He focused on empirical research to demystify technology and dispel the free-floating anxiety so common in the discourse about science, technology, and society. He was an activist researcher, often far ahead of what others were doing in the 1970's and 80's.

His university training at Columbia and Stanford focused on technology, especially electrical engineering and computer science. He arrived in the San Francisco Bay area in 1966, just months before the Summer of Love that marked the beginning of the national counter-culture movement. At the same time, the American buildup in the Vietnam War was underway. Rob was a draft-eligible young man. Being a student working on militarily important technology helped him avoid conscription. His views were strongly shaped by his experiences in this period. He took part in activities at the Esalen Institute, a center of counter-culture thinking. He began to question modern technological society and its materialistic biases.[5] These experiences did not immediately alter the technological trajectory of Rob's work: His innovative dissertation research brought together AI planning systems and fuzzy logic, and was cited for many years (Kling, 1973). However, his experiences in this period were soon to reshape his career.

After finishing his Ph.D., Rob spent two years on the faculty of the Computer Science Department at the University of Wisconsin-Madison. Madison was deeply engaged with the anti-war movement. Rob's research interests shifted from building AI systems to understanding social impacts of AI and, more generally, social issues related to computing. He read broadly about social aspects of science and technology and came to believe that he could not pursue this new line of research at Madison. Wanting to return to California, he struck up negotiations with Julian Feldman, then Chair of Information and Computer Science at the University of California - Irvine. Feldman was himself influential in artificial intelligence and held a broad view of the

[5] This account is based on personal communication between Rob and John King.

social issues involved.[6] Feldman agreed that Rob could devote his attention to the social issues of computing if he came to Irvine, and Rob joined the UCI faculty in the fall of 1973.

Rob's reading at this time strongly influenced the development of his critical perspective.[7] He read the 1967 English translation of French sociologist Jacques Ellul's 1964 book, *The Technological Society*, which characterized technological development as a powerful and almost self-governing force that would eventually dominate everything, including the humans that produced it. He also read Lewis Mumford's update of his earlier work in *The Myth of the Machine: Technics in Human Development*, which gave historic context to the concerns raised by Ellul and other critics. With the Cold War at its height and a growing sense that industrial pollution threatened human survival, basic questions about the efficacy of technological change were raised in many quarters. Alternative views of technology seemed necessary. Rob was particularly taken by the work of the social commentator, Ivan Illich, whose 1973 books *Deschooling Society* and *Tools for Conviviality*, sharply critiqued both the technologically-oriented bent of American society and the social institutions that fed upon and nurtured this bent. These books were especially important in helping Rob to formulate what later became his "package" view of technology, in which the full set of complements or enabling infrastructure involved in technological change must be considered.[8]

Rob was strongly motivated to engage the problematics of artificial intelligence and social change in 1975 after reading Joseph Weizenbaum's *Computer Power and Human Reason* and Abbe Moshowitz's *The Conquest of Will.* Although quite different in character, both books raised questions about the dark side of human behavior and the tendency to use technology in ways that could fundamentally work against individual freedom. Ken Laudon's 1974 *Computers and Bureaucratic Reform* was important to Rob and his colleagues on the Urban Information Systems (URBIS) Project studying computerization in U.S. city governments (Kraemer, et al,

[6] Feldman co-edited an early landmark AI book with Rob's former Ph.D. adviser (Feigenbaum and Feldman, 1963).
[7] We are aware of what Rob read because he told us about all books he read, and made us read them, too, if we hadn't done so already.
[8] This idea is particularly clear in Kling and Scacchi (1980, 1982).

1976; Kraemer et al., 1981).[9] Unlike some commentaries on technology in society, Laudon contested the popular notion that use of computer technology would transform organizations by replacing traditional elites with a new elite of technological experts. Instead, he argued, social processes shape computerization toward the ends of existing elites; a position that found strong empirical support in the URBIS research (Danziger, et. al. 1982). Finally, Rob was strongly affected by Langdon Winner's 1977 *Autonomous Technology: Technics-Out-of-Control as a Theme in Political Thought*, which concluded that social forces, including individual action, were essential in shaping the development and application of technology.

Rob's facile mind did not miss the contradictions inherent in his interests and work. On one hand, he was a true technophile -- a quintessential teenage nerd, ham-radio operator, and champion at high-speed Morse code. He went into Electrical Engineering because he thought it had something to do with ham radios.[10] On the other hand, he was acutely mindful that technology was complicit in many aspects of human suffering, and he could not abide the dismissive or disinterested attitude of many technologists toward the growing body of empirical evidence that technology often had unintended consequences. The beginning of Rob's critical perspective was the recognition that these contradictions were the heart of the technological conundrum. In executing his critical worldview, he opened the eyes of many people to the complexities of problems that seemed relatively simple on the surface. At the same time, however, Rob's own struggle with the contradictions reveals the risks inherent in "going critical." The balance of this paper explores these risks.

3. APPROACHING THE SLIPPERY SLOPE OF A CRITICAL PERSPECTIVE

In the late 1950s, the sociologist, Robert Dubin (1956, 1979), developed an influential theory of work in which "central life interest" is a key concept in explaining commitment and values. He argued that individuals who hold work as their central life interest also become fulfilled by their work, and as this central life interest increases, the work-life balance blurs, and the two merge. Those who knew Rob recognize this in his personality. To a greater degree than many scholars,

[9] For background on this project and Rob's role in it, see King (2004).
[10] Based on personal communication with John King.

Rob's work *was* Rob's life. Rob loved to party, he liked adventurous activities such as sailing, but he never hesitated to jump into work-related discussions in the midst of these activities. This feature of Rob's personality was a great boon to his scholarship, for it kept him focused and working hard toward ends that he cared about. At the same time, this quest was the source of a persistent challenge in getting closure on his work of generating practical findings and generalizable theories from key research projects. This persistent quest for new knowledge and understanding about IT throughout the three decades of his professional career led him to study every new form of IT as it emerged, from AI and urban information systems in the 1970's to electronic publishing and digital photography in the early 2000's. These studies were a direct consequence of Rob's commitment to personal values regarding technology and society, coupled with his intense desire to rise above simplistic explanations of what he saw going on in the world.

Rob himself was aware of this tension very early in his career. For example, he interspersed among the pages of his AI working papers at Madison drawings from *Alice in Wonderland* and other children's tales.[11] A transgressive attitude was instrumental in Rob's evolution as a critic. It manifested itself primarily through a technique of discourse analysis, in which Rob took the stated positions of those he saw as either proponents or opponents of technology and contradicted them with empirical evidence or logic. This was seen first in his construction of "optimistic/pessimistic" analyses of computerization (e.g., Kling and Iacono, 1989), which later became "utopian/dystopian" critiques. At this stage of his career, Rob was disaffected by extreme positions on either side of the technology-and-welfare debate, seeing such positions as naïve, substituting hope or despair for a deeper and more systematic understanding of how technology affected people and society. Unlike strident critics of technological change, and especially those who saw technology as some kind of exogenous force bearing down on the human race for good or ill, Rob saw technology as a consequence of deliberate human action in the context of social process. The problem of technology "out of control" was a design problem: When designers made foolish decisions, the consequences surprised them. The challenge for design, as Rob saw it, was in understanding the "socio-technical configurations that structure the

[11] Based on personal communication with John King, who saw some of these papers.

ways that people can access and use a technological system (Kling, 1996a). For example, managers in the late 1970's and early 1980's, wanting to extract the full benefit of new and expensive word processing technologies, reorganized the clerical workers who would use them into sequestered, monitored groups (Mumford, 1983). Nothing about the equipment demanded that such a socio-technical configuration be implemented; vendors advocated such arrangements for organizations to gain quick return-on-investment and, not coincidentally, to promote sales.

This view is apparent from Rob's early papers (e.g., "Toward a Person-Centered Software Design" of 1973) through his seminal work on computerization as social action with Walt Scacchi in the early 1980's (Kling and Scacchi, 1980, 1982). His work aimed squarely at naïve deterministic predictions about technology use and outcomes, and at virtually *any* unproven claim about technology's effects. Rob's penchant for empirically-grounded inquiry into technological and social change was a hallmark of his work, and it was far from coincidental. It was required, in part, by his training as an engineer, and, in part, by his sense of duty toward the technological realm he loved.

Rob's skill at this is illustrated by two instances arising from the URBIS Project in the late 1970's. One involved the effects of computerization on the quality of work life experienced by what Rob referred to as "instrumental users" of computing, such as clerks. Rob's family had been closely tied to leftist labor movements in the New York-New Jersey area in the mid-twentieth century; many of his older relatives and friends had experienced first-hand the struggle to bring dignity and affluence to laborers and tradesmen. Rob was concerned about possible negative outcomes from the computerization of work and used the URBIS surveys to collect data on this issue. He found that users were generally delighted with the effects of computerization on their work. He concluded that outcomes varied depending on the choices that organizations made about computerization. At least for the users of urban information systems in local governments, computerization had not yet created the problems so widely anticipated by critics (e.g., Mills, 1951; Braverman, 1974; Gregory and Nussbaum, 1982).

The second instance had a different outcome. Rob visited the city of Chattanooga, Tennessee in 1974 to examine a computer system intended to integrate the delivery of social services across numerous public and private non-profit welfare and health agencies to insure that no client "fell through the cracks." Rob discovered that although the system met its design specifications, it was seldom used by social workers in the relevant agencies. The key objective of the system—to integrate operations—ran counter to the cherished independence of the various agencies to be integrated. The agencies retained autonomy by simply ignoring the system (Kling, 1978).

This critical perspective works well when pointed at the past, as in the tradition of Mumford and Ellul, or when aimed at a relatively stable present, as in the tradition of Carson and Nader. However, the gold standard of critical perspectives is the degree to which they can inform speculation about the future. As with forecasting the weather, the best predictions of technology suggest that tomorrow will be the same as today. Critical theorists who emphasize the overlooked inertial constraints of organizational, institutional and societal conventions have an advantage because such conditions change slowly. Rob demonstrated his understanding of this by forecasting with remarkable accuracy the fate of the Department of Defense effort to develop Ada, a common, high-order programming language (Kling and Scacchi, 1979). Ada was designed mainly by academic computer scientists to facilitate programming for real-time systems used in weaponry and other specialized defense applications—software produced by professional programmers working in defense contracting companies. The paper suggested that the naïve assumptions of academic computer scientists would run afoul of the realities faced by defense contractors, which is exactly what happened. Ada was deployed and energetically promoted by the Department of Defense, but fell far short of its goals and is now all but dead.

Rob's extraordinary skill in the "here-and-now" of computerization could yield insightful predictions of this kind. Other times, his predictions went awry. This is not a criticism of Rob's scholarly acumen: Scholars need not make predictions, which, as Yogi Berra noted, "are risky, especially when they're about the future" and thus open to refutation. Careful consideration of causal patterns might enable near-term predictions, but even small, incremental shifts over time make long-term prediction nearly impossible. The important question is not why many of Rob's

predictions about computerization failed, but rather, how he might have avoided zealous false predictions. Those of us who follow his lead in the study of computerization in society would do well to consider weaknesses of Rob's critical perspective and, by extension, risks inherent in any program of critical analysis.

There are nuances in this narrative, some of which are explored in the next section, but the core issue is the problem of balancing sober, even somewhat detached, assessments of empirical evidence with a powerful set of beliefs and convictions that initially mobilized a scholar to pursue a particular domain of science. We argue below that the critical perspective can be a slippery slope. It proved to be one of Rob's greatest challenges, and so it may be with others who follow this path. In fact, it may be an even greater challenge to those who apply his critical methodological approach of "close readings" and "years of observation," but who do not read as closely or observe as acutely as Rob did.

4. ZENO AND XENO

Rob's early critical work was fairly balanced, examining all elements of discourse about the role of computing in society. As time went on, however, his critical perspective focused increasingly on promotional claims for computing. This is captured well in his articulation of "the seductive equation," in which he noted that expectations of technological progress can entail expectations of social or economic progress (Kling, 1996b). The criticism of the rhetoric of promotional arguments about specific computer-related technologies became an effort to disabuse the world of such notions. In some cases, this perspective appeared to blind Rob to changes that were in fact taking place.

Rob was among many observers who failed to capture the significance of the Internet and other technological developments that came of age in the 1990's. In papers and in a series of email exchanges with the authors, he made a number of predictions that were soon proved wrong. He argued that the Internet would remain a "niche activity" that could not possibly reach 100 million users by 2001, yet Internet growth far surpassed that number by that date. He claimed the Gopher file transfer system was superior to the Mosaic web browser in terms of interface ease-

of-use, yet the browser is global and Gopher is all but gone (Kling and Elliott, 1997). He argued that organizational investments in computerization had not increased organizational productivity (e.g., Kling, 1999; Kling et al., 2000), even as evidence was mounting that it had. He said the so-called digital divide, in which computerization benefited the haves over the have-nots, would persist indefinitely even though evidence showed it might be declining. He was not unaware of potential improvements from computerization. For example, he cited in his own papers (e.g., Kling, 1996a) research that found that those on the periphery of social groups were most likely to benefit from collaborative systems (Hess et al., 1993). He just did not incorporate those possible improvements in his own world-view very often. He was a humanist and a protector of the have-nots; his role was to deflate grandiose claims of social and organizational transformation arising from computerization.

Rob adopted this role despite his being a technophile at heart and in an unusually strong position to understand the remarkable advances in computer technology. His career paralleled the successive "hardware generations" of early computing. His early academic career coincided with the large-scale commercial application of semiconductor-based computers (e.g., the IBM 7090 and System 360). While in graduate school, he was a heavy user of advanced timesharing systems such as the DEC PDP-10, a key machine in AI research.[12] He was in Silicon Valley when the first large-scale and very-large-scale integrated circuit computers were developed. He saw first-hand the dissonance between progress across hardware generations and the generally slower progress in operating systems, programming languages, and applications. His grasp of technological progress was strong, and his suspicions regarding the "seductive equation" were well thought out, but unlike his predictions regarding Ada, his predictions about how other technologies would transform the world were seriously mistaken. The broad explanation for this is his inability to stay open to the question "what might happen here?" when his values and beliefs—which served him well in many instances—had set him on a course that made him say "that will not happen here." More specifically, it is the general difficulty entailed in understanding technological changes that move quickly toward "tipping points" (Markus, 1987;

[12] Rob once remarked to John King that his "personal computer" in 1968 was a 36-bit KA-10 processor with a maxed-out main memory of 256Kbytes. He often did his work in the middle of the night, and was the only user on the machine.

Gladwell, 2000) and which only then have significant social and economic implications or even large-scale transformations.

It is worth spending time considering this problem, using a familiar example. Intel's Gordon Moore made his famous observation about the number of transistors per integrated circuit in 1965.[13] Since then, it has been invoked to the point of annoyance, but its significance still has not been fully worked out. Although Rob literally "grew up" with Moore's Law and understood the technology and logic behind it, his critical perspective had difficulty accommodating the kind of social and economic implications that might emanate from it. To understand this requires consideration of the dynamics of exponential change. Human beings rarely encounter sustained exponential growth in ways to which they can relate. Some of us recall the childhood fable of the Chinese emperor who agreed to reward the inventor of chess with a grain of rice on day one for the first square of the chess board, two grains on day two for the second, four on day three for the third, and so on for 64 days. A seemingly paltry reward is revealed to require more rice than has been produced in the history of civilization. Nature occasionally produces exponential doubling—cell division in an embryo, salmonella in hospitable environs—but we don't see and develop intuition for the underlying dynamics. Linear effects we see all the time.[14]

As noted earlier, the late 1960's saw a growing concern about a "population explosion" as seen in Ehrlich's *The Population Bomb*. Willem Wagenaar and colleagues conducted a remarkable series of studies examining common understanding of the issues implied by such growth (Timmers and Waganaar, 1977; Wagenaar, 1978; Wagenaar et al., 1975, 1978, 1979). They found that people greatly underestimate the implications of exponential growth. More mathematical training does not improve our reasoning, and techniques such as providing additional data and graphical presentation do not help. Inability to reason clearly about exponential growth is almost inescapable. This should alert us to possible problems in anticipating the consequences of exponential improvements in hardware price/performance. It

[13] "Moore's Law" stated that the number of transistors that could be put on an integrated circuit chip doubles every 18 months, and became a paraphrase for a range of technology advances that follow a nonlinear or exponential growth path (with exponent greater than one).
[14] For a nice discussion of exponential growth, see Eriksen, 2001.

upsets a key assumption of the critical perspective, i.e., that tomorrow's weather will be like today's, and, thus, makes it difficult for the critic to find a sensible place to stand.

Consider an argument by Hoffman et al. (1996) that the "…time has come to raise the bar on the reporting standards for publicly released studies of who is on the Internet." They argued that more accurate information on Internet use was needed to guide planning. To demonstrate their point, they reanalyzed data from an August 1995 Nielsen Media Research survey on Internet use. They concluded that actual use was 16.4 million people rather than the 19.7 million claimed by Nielsen. The authors agreed with the estimate that Internet use was doubling annually, but they did not reason through the implications. Their article appeared sixteen months after the Nielsen survey they reanalyzed, by which time, even if they were right, Internet use was 43 million—more than twice the level the article denounced as an exaggeration. Ten years have passed since the article appeared, and the Internet now has about one billion users.[15] It made no sense to quibble over a few million users given that rate of change: Exponential growth simply swamped their critical perspective.

Moore's Law is so embedded in the lore of the computing field that fear of its demise has become more important than its implications. But the steady change has had major effects. The AFIPS National Computer Conference, where Rob first published his work on the social dimensions of computing, was tied to a trade show centered on mainframe computing. AFIPS went into a terminal decline in the mid-1980s when suddenly and unexpectedly, no one came.[16] Most mainframe companies (Burroughs, Univac, Honeywell) disappeared as minicomputer companies moved to the center; later, the minicomputer companies (Data General, Digital Equipment Corporation, Wang) were squeezed out by PCs, workstations, and software. Issues that drove the economics and organization of computing use shifted as extremely expensive mainframes gave way to much less expensive minicomputers and microcomputers (King, 1983). The productivity paradox argument that computerization costs more than it generates in benefits

[15] (http://www.glreach.com/globstats/)

[16] Because of the hasty demise of AFIPS, at the time of writing, no one seems to know who owns the copyright to hundreds of seminal papers by Rob and others, which for this reason have not been reproduced and are unavailable outside of the few libraries that collected them.

was a major concern for IBM and other computer makers in the 1980's and 1990's (Greenbaum, 1979; David, 1990), but within the last five years the substantial beneficial effect of computerization on U.S. productivity is more widely accepted (Dedrick, et. al., 2003; Jorgensen, et. al., 2002).

Why did Rob resist the evidence that some of the outcomes he predicted would not occur had, in fact, been achieved? The case of improved productivity from computerization might provide a clue. Declining cost of computing hardware had apparently stimulated increasing investment in computerization, but Rob had long emphasized that hardware is a small part of the cost of a system. Even major declines in hardware cost, he argued, could not affect productivity. It seems that he failed to see the larger ecological effect of hardware costs that declined at astonishingly fast rates of a factor of 100 or more within a decade. These cost declines leveraged the economies of scale in software such as operating systems, which could be replicated at essentially zero cost, thus spreading the cost of their development across vastly more buyers. In addition, the technology that drove hardware costs down was also making hardware more reliable. As use of computers grew, software cost less and did more, administrative costs declined as improved management policies were developed, and training costs fell as more users obtained computer experience. Hardware costs might have been a small part of system cost at some point, but rapid declines in those costs played a catalytic role in reducing the rest of system costs. As costs dropped and use grew, innovation in application increased. New ways of doing things were developed, and productivity improved. It took a while, but it did happen (Brynjolfsson and Hitt, 2004; Pilat and Wyckoff, 2004).

Critical perspectives on computerization are often overtaken by new information, a condition experienced repeatedly in the history of information technologies considered broadly. Printing began in China well before the era of Gutenberg, but was used only sparingly under the control of the emperor. A critical perspective might have considered it inconsequential. Yet, in the west, printing reached the masses, contributing to the Reformation, the Enlightenment, the scientific and industrial revolutions, and other shifts in power (Eisenstein, 1979; Edwards, 1994). The critical perspective often has difficulty accommodating change when the underlying mechanisms

of change are difficult to discern. It defaults to a world-view similar to that of Zeno of Elea, a Greek philosopher of the 5th century BCE, who believed that change was impossible and that the passing of time was an illusion. He defended this view with a famous paradox involving a race between Achilles and a tortoise. Achilles gave the tortoise a head start to make the race fair. In order to overtake the tortoise, Achilles had to cover the distance of the tortoise's head start, during which time the tortoise would have moved yet farther ahead. The distance between Achilles and the tortoise would grow ever smaller, but Achilles could never catch up.

We return to the Chinese emperor and the rice. The doubling proceeded steadily toward the nine weeks promised by the emperor. But consider the nature of the progress. At the end of one week, the emperor owed less than a teaspoon of rice! At the end of two weeks, he owed less than a one-pound bag; at three weeks, a market shelf. Even at week six, two thirds of the way to the end of the process, the emperor owed only one-tenth of one percent of China's current annual production. At the end of week seven, the cost to the emperor was finally becoming noticeable: 15% of China's current annual production. Then things happened very fast: Within a few days the amount exceeded the world's annual production. For forty days it was below the radar, then suddenly it was critical. This kind of threshold effect can sneak up on even the most careful analyst. This may explain why so many film and photography companies have gone bankrupt or sustained huge losses rather than glide to a rest with the rapid growth in digital photography.

When DRAM (dynamic random access memory) capacity went from 1K to 4K to 16K bits per chip, it had few consequences—teaspoonfuls of bits. Decades went by with this growth in the background. People got used to it. With microcomputers, some things did change. In particular, *discretionary* computer use by individuals spread. Graphical user interfaces accelerated the pace of discretionary adoption when they succeeded, first with the Macintosh, launched in January of 1984 with Apple's famous Super Bowl ad depicting drones freed from Big Brother.[17] Computer 'operators' were out, hands-on discretionary computer 'users' were in, and human-computer interaction became a core part of computer science (Grudin, 2005). Even hardened computer

[17] The ad can be found on several web sites using search terms such as Apple Macintosh 1984 Super Bowl. Apple followed it with an infamous 1985 Super **B**owl ad showing lemming-like office workers following one another off a cliff.

scientists, raised on command-line interfaces, embraced the hugely expanded design space (animation, color, sound), and began building systems and applications for diverse users and uses.

The critical view of utopian and dystopian computerization that characterized Rob's work in the early 1980's was grounded primarily in the assumptions of bureaucratic organizational computing (Crozier, 1967). While he did focus on top down (mandatory) versus grass-roots (discretionary) computing in the organizations he studied (LePore et al., 1991), he typically found that organizations would try to control discretionary uses. He did not focus on the spread of consumer or home use. But even if he had, most likely he would have assumed that public discourse or the vendors would have more control over what people did with their computers than the individuals themselves. His attention was on the "seductive equation," and his critical view concentrated on refuting utopian views of computerization. He tended to see even discretionary computer use through the lens of organizational computing use, with its presumptions of social control in the service of organizational missions, such as in his studies of digital photography and the Internet.

In his closing plenary for the ACM CHI (Computer-Human Interaction) Conference in 1987, Rob's discussion of organizational control and routinization of work seemed out of place to an audience focused on embedding human values like autonomy and diversity into tools and applications intended to appeal to discretionary users. The following year, on a panel at the ACM Computer Supported Cooperative Work conference, Rob criticized the presumption that work was "cooperative," asking why not computer supported conflictual or coercive work? His challenge was fair: It was grounded in a hard-won view of real rather than idealized workplaces. However, it did not match the issues confronted by audience members designing (for example) collaborative writing tools to help co-authors write papers like this one, and doing so in highly collaborative work environments. Rob's generalized problematic of technology and work-life assumed that actors at higher levels of analysis (societies, organizations, commercial vendors, etc.) had more power and influence over social transformations than the people using the technologies did. In other words, change moves down the levels of analysis rather than flowing

up them. While the designers of collaborative work systems believed that use of the new systems they were developing would result in better, more collaborative work environments, Rob did not. He wanted to remind them that the bureaucratic organization would win out; for him that is where the power resided; to think anything else was naive. These beliefs were held deeply despite some of his research findings that, for example, grass-roots communities of practice could succeed in making technological and organizational change (George et al., 1996). And of course today, we know that the Internet can provide critical social, political, and cultural infrastructure in getting news out to the world about pro-democracy movements in totalitarian states, for example, and in spreading western norms and conventions within them. While the government of China has currently blocked its citizens from access to the Wikipedia, one has to ask, "for how long?" The authorities may well realize that they are just buying some time.

By the mid-1990's, when Rob's second edition of *Computerization and Controversy* (Kling, 1996b) came out, most of his ideas about computerization had solidified. In Part I he states, "… transforming these technological advances into social advances has not been straightforward." One of his most telling examples is from a *Los Angeles Times* story on "Life in the Year 1999" and a couple who lives in a smart house. He says:

> "During the last decade, the housing market in Los Angeles became among the most expensive in the country. Many working people cannot afford a house, even a "stupid house." And there are tens of thousands of homeless people in this region alone. I am struck by the way in which the news media casually promotes images of a technologically rich future while ignoring the way in which these technologies can add cost, complexity, and new dependencies to daily life" (1996b, p. 23).

His beliefs and convictions cannot be more noble. He is right to ask these questions: What are we doing about the homeless? And what about better salaries for working class people? On the other hand, can't we imagine a different future? And isn't this the role of newspaper—to sell news and new ideas? And in 2006, some homeless people make regular use of computing.

Rob loved to counter the discourse coming out of the White House. In Part I of his book, he talks about Al Gore, then Vice President, and his role in the popularization of the "information superhighway." Rob claims that because of Gore, "The Internet, which had previously been an arcane set of services monopolized by …researchers in high-tech firms, [had] become an idiom of upper-middle-class conversation." Isn't it the role of executive branch leaders to mobilize industry, academia, other parts of government, and the citizenry to adapt new ways of working, learning and conducting business? Rob fell into the trap of taking literally the rhetoric of public discourse. In contrast, in his early years, he frequently admonished the Marxists: "Don't believe what the vendors tell you about what the technology will do! It will lead you to believe the wrong things!" In Rob's view, the news media and elected officials were biased in their predictions and their aspirations were ill-conceived. The slippery slope of the critical perspective had led Rob to a position in which anything that did not fit his critical frame was alien and suspect. The paradox of Zeno, in which change seemed impossible and therefore unthreatening, shifted to *xeno*, the Greek root of "stranger," in which the prospect of change seemed real and risky.

5. ACTIVE/REACTIVE

In slides prepared for his last talk (Kling, 2003), Rob reviewed themes from his career. Much of the talk focused on the current revival of robotics and AI, especially on its predominantly military orientation. It also included an elegant analysis of the restructuring of copyright law, arguing that it was driven by the needs of entertainment and sales rather than science and education. He continued to contest the claim that technology increasingly influences institutional and cultural contexts (i.e., transformation up the levels of analysis), arguing instead that "…technological determinism is a poor predictor, (and it is) institutional processes and local social process (that) influence outcomes." Rob defined his perspective as "socio-technical, constructivist, institutional, and ecological." He declared that "…institutional processes explain how social actors are channeled to perform legitimate actions and interactions within socially structured arrangements."

Technology was barely a factor in his causal model. Moore's law, he said, applied only to hardware, and he declared it "unfettered fantasy" to think it would bring improved software and systems. He did not consider the likelihood, explained above, that radically improved, low cost, widespread hardware might provide the scaffolding for generating new knowledge, increased experimentation and exercise of choice, and economies of scale that would accelerate the development of more congenial software and systems. Yet, this is what has happened: better tools and infrastructure have enabled many researchers and designers to disseminate results and products more quickly, creating new capabilities that have spawned huge markets.[18]

A balanced critical perspective would note limits to how effectively developers will achieve particular goals, but it would not discount the intensity with which dedicated people labor to improve search engines, exploit memory sticks, create software for blogging, or build open source software. It would not discount the possibility that the combined effects could be transformational. Like the case of the Chinese emperor, who for six weeks took little notice of his rice payment, these efforts had modest effects at first. Today, major industries including film cameras and photographic, analog audiotape and videotape, wireline telephony, recorded music, and traditional gaming have reached week seven: shutting down, transforming, or struggling to cope with displacement by new digital technologies.

Rob appreciated evidence that earlier technologies, such as the telephone, led to social consequences, but he resisted indications that digital technologies would do the same. In conversation, he linked such suggestions to AI hyperbole, not separating claims that computers can deliver immortality to people living today (Kurzweil, 2005) from observations that technologies were delivering unprecedented access to information to unprecedented numbers of people, or were on the verge of transforming entire industries. Again, the balance of critical perspective is difficult to attain and sustain. It is no surprise that Rob struggled with this challenge. Like Achilles, it sometimes seems to take forever to overtake the tortoise. Consider the following quote:

[18] Thirty years ago Xerox PARC made an investment that gave it a computing infrastructure a decade ahead of virtually everyone else. Today, anyone can purchase an up-to-date moderately-priced system and get capability that rivals that of a typical researcher with a 3-year-old system.

> "A machine with vast logic power, capable of storing enormous quantities of information… A much greater growth rate than an exponential increase… The dam is bursting… Mankind today faces an information deluge of unimaginable complexity… We must protect computer users from the vast and overwhelming mass of data… the computer files of current IBM customer orders contain more than 100 billion bits of information."

The author was James Martin, writing in 1973. Today, when a small laptop contains more than 100 billion bits, we consider 1973 to be part of the era of information scarcity. Rob saw Martin as an unreconstructed utopian,[19] and in a sense that was fair. Today we hear much the same thing, albeit from more voices. Thirty years from now, today will probably seem to have been part of the era of information scarcity, and people will still be announcing that the dam is bursting.

What explains the mixed analytical record of this brilliant analyst, whose views were socio-technical, constructivist, institutional, and ecological? This is a difficult question to answer; it requires speculation about personal features of Rob's worldview that, of course, are not readily accessible. Some of it was a failure to factor in the unparalleled nature of growth in this technology: Had Moore's Law been repealed in 1975 or even 1985, Rob's tendency to forecast unchanging weather might have remained tenable. The intensity with which his work was a central life interest suggests that Rob allowed his strong convictions and beliefs about power and technology to overshadow contrary evidence and open inquiry. Ironically, the answer may lie in the paradox between Rob's love of technology and his deep commitment to social values. Rob may have over-compensated for his attraction to technology by being exceptionally doubtful of its potential for enabling social betterment. Knowing why the "seductive equation" was so seductive, he guarded against it with zeal. He set an extraordinarily high standard of proof for claims that technology had resulted in good outcomes, and even in the compelling cases he attached cautionary conditions.

[19] From personal communication with John King.

Rob's deep social convictions certainly played an important role in his work. His Jewish working-class post-WWII childhood made him mindful of the dark side of human nature. He knew the downsides of the capitalist system in the exploitation of the working class. He understood the intellectual appeal of Marxist worldviews, with their simple but powerful explanations of dialectical materialism, historical determinism and class politics. Rob was too strong an analyst to accept them uncritically; he was at heart an empiricist who required causal evidence of the sort Marxist interpretations seldom provide.

Rejecting simple, covering explanations for the complexities of socio-technical change, Rob embraced a broad, systematic view. He was adept at tracing the causal connections among complex relationships, but even the most capable minds succumb to the combinatorial complexity of sufficiently large and complex systems. With neither simple ideology or omniscient systematics to back him up, he asserted his critical perspective on computerization as a guardian over social values he cared about so deeply—compassion, fairness, equality, understanding. Rob was at heart an activist, but the inherent difficulty of mastering systems beyond the scope of one person forced a choice. He could take the route of dispassionate observer, thereby avoiding the slippery slope but abandoning his activism; or he could accept his critical view and become reactive. He chose the latter.

6. SALVATION THROUGH SENTIENCE

Some might view this discussion as a criticism of Rob's work. If to acknowledge is to criticize, we stand guilty of the charge. We do not see this effort in those terms, however. We worked closely with Rob, and were deeply influenced by him in every respect. It seems appropriate to emphasize Rob's humanity by observing that he was only human. His ambitions were exceptional: He tried to understand phenomena so complex that few around him even recognized the phenomena in the first place. He did this with dignity and grace, and if he was occasionally petulant or obtuse, he was certainly no different than most scholars. The truly extraordinary feature of Rob's scholarship was the consistency of his purpose. Whether or not he believed it

was possible to “think it through,” he acted as though he did. He refused to admit defeat, and in the absence of omniscience, he was willing to settle for sentience.

He left a legacy for his students, a community far larger than those who worked directly for him or with him. This legacy includes his writings, of course, but more importantly, it includes the attitude with which he pursued his work. He accepted the limits of the world as he struggled to understand it, and he refused to foreswear the central interest of his life. A thoroughly secular person, he accepted and respected what could not be explained. His inquiring nature survives him in those whose work he influenced, and through them he undoubtedly continues to ask questions now, even if he doesn’t have to.

In the golden book of the golden game,
The golden angel wrote my name.
When the deal goes down I’ll put on my crown,
Over in the old Golden Land.

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