JOHN GAGE
ORAL HISTORY

COMPUTERWORLD HONORS PROGRAM
INTERNATIONAL ARCHIVES

Edited Transcript of a Video History Interview with John Gage
Chief Researcher and Director, Science Office, Sun Microsystems

Recipient of the 1999 S.A.P. Information Technology Leadership Award for Education

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Interviewer:	Daniel S. Morrow (DSM) Executive Director, Computerworld Honors Program

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Growing Up in Southern California

DSM: It's March 26, 1999. We're interviewing John Gage, Chief Researcher and Director of the Science Office for Sun Microsystems. The interview is being conducted in San Francisco, California in the Tobin Room of the Huntington Hotel on California Street. This interview is part of an ongoing series of interviews in oral histories with leaders of the global information technology revolution in the field of education. It will become part of the permanent research collection of the Smithsonian Institution's National Museum of American History to be held in trust by that institution and made available for use by future generations throughout the United States and, indeed, throughout the world.

This interview is made possible by a generous grant from S.A.P. America, which in partnership with the Smithsonian, bestows each year the S.A.P. Information Technology Leadership Award for Education. Mr. Gage will on June 7, 1999 in ceremonies in Washington, D.C., join Vice-President Al Gore, Seymour Papert, of M.I.T., Governor Gaston Caperton, the former Governor of West Virginia, Linda Roberts of the Department of Education, Ina Beth Miller of CTV, Sharon Bell of the New Orleans School System, Professor Ron Thornton, Gail Morse and Robert Tinker as recipients of this award.

Without objection, this interview in its entirety will become part of the public record, held in trust by the Smithsonian. You can stop the interview at any time and request that all or part of your remarks being embargoed, withheld from the public record for up to 25 years. And all of those present here are honor bound to honor those conditions.

Let's begin by please having you state for the record your full name and when and where you were born.

JG: I'm John Gage. I was born in Long Beach, California on October 9, 1942.

DSM: Tell me about your parents and your family.

JG: There are two of them.

DSM: You were born at a very early age.

JG: That was true. I was born just as the war was beginning. My father came to California from Texas at the age of 15 and entered UCLA. He met my mother there at UCLA. As the war began, he joined the Navy and was dispatched to Astoria, Oregon. I spent the first two or three years of my life in Astoria, Oregon and he, a lieutenant in the supply corps, managed to supply people across the Pacific during the Second World War.

Then we moved to Los Angeles, where my mother's mother had a house and we lived in Hollywood until I was about 14. At that point I moved to Newport Beach, a small beach community in Southern California.

DSM: Did you know all of your grandparents? Were your grandparents still alive?

JG: My grandfather was not alive. My mother's mother and my father's mother were alive; the fathers were not. So I knew my grandmothers but not my grandfathers.

DSM: What about siblings, brothers, sisters?

JG: I have a younger brother, three years younger, and a sister ten years younger.

DSM: What were you like as a kid?

JG: Oh, that's a difficult question.

DSM: Well, let's do it this way. What would your parents have said you were like as a kid?

JG: I grew up in Hollywood. We lived in the Hollywood Hills, so I was an athletic kid. I was out climbing the mountains and wandering the hills with my dog. I was lost one time for a significant time—enough to get the neighbors out on a search. When I moved to Newport, I became an athlete. I swam, was on the beach all the time, surfing and swimming—a Southern California idyllic life. My brother was also a swimmer and an athlete, and my sister's a horsewoman and a rower and started the rugby team at UC San Diego. So we're sort of an outdoor Southern California family.

DSM: With your father coming back from the war—I know in my own neighborhood there were a zillion kids and all of our fathers had served in the Army or the Navy. Was Newport that sort of community?

JG: Yes, as I was growing up in Hollywood in the Cub Scout pack, most of the parents were of my father's generation. They'd all been in the Army or the Navy. Because it was Hollywood, it was a little bit different. Our Cub Scout pack play had the talents of Universal Studios and the theatrical experts of Hollywood making the sets and all of the other parts of the play. So it was a very special time, I think, in Southern California. This was before Los Angeles fell beneath the pollutants and was a crystal clear wonderful Southern California outdoor environment. Today there are far more people there.

DSM: Who were your heroes when you were growing up—imaginary or real?

JG: In high school I was very interested in mathematics and physics. I wanted to go to Cal Tech because Cal Tech is a center for people like Richard Fineman and others. Those were my idols. Then I went to Cal Tech to visit and discovered that it was so intensely based, as the French system is, on excellence in mathematics. There was very little concern for literature. People didn't care about poetry and I was in classes where they ripped poems out of books. I said: "I'm not going here, I'm going to go instead to a place where we have the Nobels of the world and we have an excellent mathematics' department. I'm going to go to Berkeley." I decided to and I did.

DSM: We've heard some wonderful stories of people in the industry talking about early hints in the childhood of what they were going to be when they'd grow up—Bob Metcalfe making computers out of his electric train parts and that sort of stuff. Are there any sort of family stories involving your childhood and some precursors of your current career?

JG: Growing up the in the 1950's in Southern California, the most intricate devices you could play with were radios. I played with radios and bicycles. The skills in creating imaginary devices, are the skills of imagination for those in software today-- people that make computers dream of things that you can't touch. They create software verse form that's executable. They create machines that are strings of symbols that actually execute. The only domain to do that in the 1950's in Southern California was the domain of mathematics. So I'd read mathematics; that was very interesting to me. But you couldn't build something from it that executed. That was the missing part, only made possible by the arrival of computers.

The change today that's made possible by the arrival of cheap computing and the Internet—is a million kids in China, as an example, writing Java programs which are small objects that can move across the Network and execute on any computer. It's a completely different vision of what's possible today than in the 1950's in California.

You could think about what they did at Cal Tech. They could analyze the structure of matter; they could look into the stars. You could do that. But the word hadn't reached us in Southern California about what was being done by people like Ivan Sutherland at M.I.T., who in the 1960's was creating inside machines drawings helped by the machine that could be replicated at a millionth of a meter width of a line—the notion that the computer could draw in an infinitely thin way, a line which could be turned into a copper trace on a circuit board or a polysilicon deposit on the surface of silicon would become a transistor when you crossed it with a different kind of chemical. That kind of building something by an intelligent drawing was not in our mental vision in the 1950's. Only began to be thought of in the 1960's.

Visualizing Mathematics

DSM: When did you discover your interest in mathematics? Were you doing things visually or geometrically before you got to this school or was there a teacher when you went to grammar school that really made a difference in bringing that out?

JG: Oh, that's a good question. I think the first visualization ideas I had came from finding Darcy Thompson's book on growth and form, a wonderful collection of essays. Simon and Schuster published them, the four volume "World of Mathematics." Those four volumes, hundreds of separate essays, just sparked ideas. And Darcy Thompson's essay and Haldanes' essay on being the right size –that pointed out that as you increase in size, your volume increases cubically. But the strength of the bones, for example supporting an elephant, only increase as the cross section, that is as a square. That means you cannot have a 200-meter tall elephant, you know. It just won't work; the bones will break. So just an insight into the relationship of the mathematics with the operation of the physical world captured me. And I thought there's enormous power in this.

DSM: I know that set of books well. How did you stumble across them?

JG: You know, I still have them, yellowed-paged as they are. I think I joined a book club, a mathematics book club or a science book club at age nine or ten and the books flowed in. I can still remember Korzybsky's book on semantics; there's an exact name. I can't remember the name. But it was one of these intriguing books; I've seen a few since. You wonder, did this book come from space? I mean where did this thing come from? Dense, filled with notation, every different field examined—you know, sort of the polymath's dream of something complicated.

DSM: Who did you share this fascination with? Were there teachers that really made a difference? Or was there a group of friends that was interested in the same thing?

JG: In junior high school—I was still in Los Angeles, still in Hollywood—I had a teacher of mathematics who taught geometry and algebra who formed the math club. Now when you joined the math club, Mr. Heinkel taught you that if you wanted to multiply by 25, it was faster to add two zeros and divide by four. You suddenly felt, well, are there more tricks like this? He had a hundred.

Suddenly you had a way of doing things quickly that gave you a power of understanding. You suddenly had a way of estimating things. Memorize the first logarithms. If you do that, then you can do multiplications very easily, simply by adding some numbers together --in the same way Fineman thought about integrals and thought about the way that the mathematical and physics world interrelated. He'd learned that by playing with gears and the way the gears interrelated.

Somebody gave him a transmission. Heinkel gave us these tools of mathematical quick computation so that you startled and amazed your parents, and get a grip on facts in a way that served you well. When someone told you something was true, you could quickly calculate in your mind whether it was true or not and then say: “You know, that doesn't seem to be right.” The power of saying, that's the power of realizing the world outside that's telling you things doesn't always get it right and that gives you the independence to make your own mind up.

DSM: Were there particularly close personal friends? Some people talk about intense rivalries they had with people in high school, grammar school that made a difference in their lives.

JG: I don't recall any. In elementary school there was one friend of mine I suppose. He and I were interested in science and nobody else was particularly. He made telescopes and mechanical devices; I thought that was great. So I'd spend a lot of time at his house. And in junior high school I had a few friends that were sort of science-minded. But there's a bifurcation, the athletic crowd doesn't usually associate with the scientific and scholarly crowd and I was sort of in both.

Swimming on to Berkeley

DSM: You were a swimmer, right?

JG: I was a swimmer.

DSM: Where did you go to high school?

JG: Newport Harbor Union High School in Newport Harbor, California, a small idyllic town, seventy miles south of Los Angeles on the beach.

DSM: So this was literally Norman Rockwell's America.

JG: Well, Norman Rockwell had an East Coast America. West Coast America was the beach and the ocean, surfing, spending time on the water, sort of a mixture of the beaches of Iran, the Algerian beach life, and at this point for me, reading Camus and other people about the impact of the sunlight on what your life was like in a town was very meaningful. Because Southern California beach life is very, very different from East Coast city life or even Northern California mountain- and lake-life; it's a more spare world.

If you grew up in the desert, that's Los Angeles—a desert populated by several million people—you're concerned with water and simply how do you make things grow. You're not familiar with the leafy walkways of Norman Rockwell.

DSM: About the time you were turning 18, John Kennedy was coming into the White House and you were making a decision to study mathematics at Berkeley. Can you just talk about that period?

JG: Oh, my, that's a--

DSM: How did you decide to go to Berkeley?

JG: In a way, it was difficult because during high school I swam and set the records in California in my stroke. I wanted to go to a school that had a decent swimming team.

DSM: What was your stroke?

JG: The breast stroke. I swam for Newport Harbor Union High School and I swam for Los Angeles Athletic Club. I wanted to go the 1960 Olympics and I missed in qualifications. They only took two and they should have taken three in my sport. I might not have been that third, but I was close. I was within three or four of making the Olympic teams.

The next thought, well if I want to make the '64 Olympics, I should go to some place where they know how to swim. Unfortunately, most of the places that knew how to swim didn't know anything about mathematics. I could go to USC but that wasn't going to do me any good in physics and mathematics; Cal Tech was hopeless. Berkeley was the best combination and so when I arrived at Berkeley— Yale was a possibility, but then of course, it was on the East coast and it's cold on the East coast and I thought that wouldn't do.

DSM: How was Princeton? Princeton people thought it was pretty good.

JG: Princeton was good. Princeton had some very good people. A number of my friends that I competed together with at LA Athletic, some went to Yale; a large group went to Yale. Evanston, at that period of time in swimming, Evanston, Illinois, Newport, and the Southern California area, there was one set of teams up in Northern California. They were at least dominated the national records, and so a small group of people knew where everyone went and SC was a major center of swimming. Illinois. Yale. Anyway I picked Berkeley. I decided since I swam breaststroke, I could at least find some back-strokers that I could train with, you know.

But my focus at that point was more in subject material. As I came into Berkeley I was put in the honors' course in mathematics, which was both good and bad. I realized I was not as smart as I thought I was. And I met a lot of brilliant people. Mario Savio was in my class, a number of other people.

DSM: What year did you enter?

JG: I entered in 1960.

Enlightenment & Activism

DSM: American society was highly segregated in the South by law at that time. What was it like in Newport Beach?

JG: Newport was highly segregated. The only Blacks and Hispanics in Newport came in as domestics in the day and left in the evening. So the schools that were combined together at Newport Harbor had one segment from Costa Mesa where the people that worked in the rich homes of this beach city lived at night. So that was the place the different communities met. For the first time I was in a school where there was a Future Farmers of America chapter as well as the water skiers and the surfers and the swimmers. You could see it in the athletic teams. There was merger of these different worlds, but at night everybody separated. Orange County, Newport Beach was a de facto segregated environment. Very, almost carefully, excluding outside sources of news.

It was an immigrant world. People came from the Midwest; people came all around, to this wonderful environment. But the *New York Times* arrived only at one place in Orange County; it was hard to find. You simply had no outside news. The journalism was essentially extremely conservative; there were no other political voices. Just at the moment that the Civil Rights movement and the music was altering the attitudes of young white Americans about what was going on in the rest of the world, just as that hit, the resistance to it grew.

As I went to Berkeley, I was introduced for the first time to the Civil Rights, the core groups, those that had been active in marches in Montgomery, in marches throughout the South. For the first time I saw boycotts. For the first time I saw the House Un-American Activities Commission, their effects in the hearings they'd held in 1960 in San Francisco. For the first time, I became aware of the political fights that undermined in some sense this view of a happy and healthy outdoor American that had been imbued in me by growing up in Southern California.

DSM: If you would, tell me about your involvement with the free speech movement at Berkeley.

JG: During the initial 1960's, I went to Berkeley for a year in mathematics and I thought, you know, I'm not sure I really want to continue in mathematics. I like it. I like the intellectual challenge, most of the people I'm with are. I'm not sure I really get along with them—there was sort of this division between the intellectual world and the athletic world. I left and I went to France for a year.

This was the period of time when Algeria was sending plastique bombs to Paris and the thought of the arrival of the paratroopers back from Algeria into France or from France back to Algeria—that entire period of the Algerian revolution was very, very powerfully evident in Paris when I was there.

When I returned from Paris I had a number of friends then in Berkeley from Algeria and they viewed the American political scene as a calm, domestically tranquil, simply an arena in which nothing was discussed seriously. There were no serious political divisions. Even the racial divisions, even the struggles in the South, the Civil Rights movement, the Algerians thought—they'd say: "Well, has anybody machined gunned a large number of people in the South? Aw, well then you're not serious, that's not serious. In Algeria we have a much more serious form of politics. Many people get killed for having ideas that don't correspond with the ideas of the government."

From that vantage point, the disputes about card tables in Sprawl Plaza and freedom of speech seemed, in the American context, relatively innocuous but from the Algerian point of view, fundamentally important. I mean people died in Algeria for doing something as simple as expressing an idea, and so if the University administration felt that they should remove that capability from the Berkeley campus, clearly they were worth resisting. And so that's how I became involved in the free speech movement.

DSM: Because the East coast, it's interesting the Civil Rights was so much a part of our lives in Virginia and North Carolina. Resistance to the war came very, very late, very, very late.

JG: It's interesting. My father tells me stories about UCLA where there was a lot of political discussion. The Bay Area's political discussions were different again. The Longshoremen centered in San Francisco had this grip on the West Coast and so Harry Bridges you know, would shut down the West Coast and for a variety of social causes, it was really a new world to me.

DSM: Lets talk now about the growing impact of the Vietnam War on Berkeley. You were heavily engaged in the free speech movement, you'd come back from France and when did you really become aware that something was going on in Southeast Asia that should be of some concern to you?

JG: I began a project. This is as the Civil Rights movement became more and more evident and it became clear to me that the history of Berkeley and of Oakland reflected the state of the United States. The Second World War had attracted an enormous number of people from the South—from Alabama, from Georgia—to the West Coast to work in the Navy, the Oakland Army Center, the Navy facilities. Hundreds of thousands of people—Black—had arrived, found jobs in the shipyards and in the Army bases during the Second World War. The war finished; the jobs went away. These areas became the ghettos of West Oakland, the ghettos of Richmond, the ghettos of Hunters Point, the places where the jobs vanished. But the people, family, everyone was there. They couldn't leave.

When I came in the 1960's to the University, there were working volunteer projects in Oakland and a variety of other places. They weren't very well organized and I thought, "Well, why don't we organize them?" I organized a volunteer center that would take all the resources of campus and provide tutoring. And as Sol Solinsky and ideas of organization emerged, that extended to neighborhood organizational skills, university students, arriving in a housing project that needed to establish an elementary school and aid, go to meetings, see if you could help.

DSM: Where did the motivation to do this come from? Did you just wake up in the middle of the night hacked and say something's got to be done about this?

JG: No, I don't think so. Because of that experience I had had in France and the experience of the free speech movement, where this coalescence of a simple idea transformed a campus filled with busy people who didn't talk, into a intense conversation focused on deep questions. Did I do something yesterday that opened the dialogue? Did I do something that closed the dialogue? Who's on the right side? Is this professor, who in the past has taken positions quite antithetical to student involvement, changed his mind because of what's been going on on campus? Who actually is engaged here and who's retreating? Who's in the conversation, who's not? Those issues were deeply sensitized by this clash, this struggle of ideas, which turned into a struggle of political ideals. Looking around, where were the next frontiers of interest?

My girlfriend at the time, who had been deeply involved in the issues of organizing, she came from a school that was almost 70% black in Oakland, from Castlemount High School. She knew all the black students on campus. Suddenly, I met a lot of people who could tell me what an odd experience it was for them to come to this predominantly white--how hard it was for them, how difficult, how invisible they felt. I thought, "If we take the resources of the campus and begin to work in communities that need help, maybe something of value will come from it."

As in most things, you're led to seeing in a new way by those that are close to you. Barbara Walsh changed my mind about things. And she organized. In fact, her field was Afro-American literature and history and her thesis was widely used. I think, at one point, Bobby Seal and the Panthers were citing her work about Eugene Dubois and the Harlem Renaissance and Moms Mabley and other figures that were little known at the time in the White community, but were very powerful in the Black community. Then the contradictions emerged. What's a White middle class student doing in a Black housing project? Helps to some degree in negotiating with housing authorities, perhaps, just by some knowledge of the legal structure. But the communities are very different.

These contradictions emerged and just at this point, the war in Vietnam became a serious issue for people because first, people were dying. Second, the visibility of it was ever more intense. And third, there was the beginning of a political change in the 1966 congressional candidacy when Robert Sheer, a graduate student—a strong opponent of the war—had written an enormously influential analysis of where the Vietnam war came from and why we were involved in Vietnam. He decided to run against Jeffery Cohaland, the incumbent Democratic congressman, a liberal Democrat, a union democrat from Oakland.

We took the entire set of people involved in the community organization in Oakland and the free speech movement organization, turned them into precinct workers, and canvassed throughout Berkeley and Oakland, throughout Alameda county and came within 2% points of toppling the incumbent congressman. That was a powerful realization that you could actually use the existing electoral system as it functioned and change things.

The Presidential Campaign of 1968

DSM: This is 1966. Very soon, you're going to leave Berkeley though, and go East.

JG: It was odd. Because of my organizational work for getting thousands of students organized from the Berkeley campus to work in the communities, followed by the anti-Vietnam work, a recruiter from Harvard Business School showed up on campus. At this point, for some reason, the Business School decided to leaven the mix and they wanted to bring in people from a variety of other backgrounds, other than the normal backgrounds of those attending the Harvard Business School. They offered me a scholarship to leave Berkeley before I received my Bachelor degree and go to the Graduate School of Business in Cambridge.

DSM: This was 1966-'67?

JG: I was to begin in the fall of 1968. In that period I'd been one of the organizers for Robert Kennedy and a delegate for Robert Kennedy to the Chicago Democratic Convention. In that campaign, terminated by Robert Kennedy's death in Los Angeles, we had organized very effectively, again using the same set of community organizers, the same people. Now we had many conversations going to use the electoral system in 1968 to replace the President of the United States who supported the world.

When he [Lyndon Johnson] decided not to run, then this changed the structure of American politics. We thought, well, we could. Robert Kennedy. I was a Kennedy supporter because of his work in the Black community. Robert Kennedy could change the country and he would have changed the country had he lived through the presidential campaign. But in any case, he didn't.

I went as a delegate in 1968 to Chicago and ultimately voted for George McGovern as the stand-in candidate for Robert Kennedy. We lost,. Hubert Humphrey won, and then stupidly all of those organizing to attempting to bring the voice of those not part of American society into the mainstream of political activity, decided not to support Humphrey because of his stand on the war. He lost, of course, to Nixon.

DSM: Where were you when Robert Kennedy was killed?

JG: In the Robert Kennedy for President campaign headquarters on Grove Street, now Martin Luther King Street in Berkeley, where 300 volunteers, Bill Lockyer, now the Attorney General for the state of California and I were co-chairs of Alameda County for Robert Kennedy. We won with a great majority in Alameda County. And watched on television as Kennedy was shot.

DSM: Where do you remember being when his brother was killed?

JG: I was in the laundry room that was my house, my bedroom in a house up in the Berkeley Hills. It was 1960, I was a sophomore by then coming back from Paris. So I was in my study room, bedroom, laundry room, redone in the basement of Professor Joe Cearney's house in the Berkeley Hills.

DSM: When you went to the convention in Chicago in 1968, for many of the people there that was quite shocking—the behavior of the Chicago police. But you'd been in situations in which there had been confrontations. What was it like, what did it feel like in Chicago?

JG: As a delegate in 1968 to the Chicago convention, you went from the hotel to the convention center in buses that took carefully planned paths through carefully groomed streets where all the fences had been beautified by Mayor Daley so you couldn't see anything. You'd arrive inside the security fence inside the center for the delegates and then you couldn't get out until the end of the convention day, which was late.

They tried to bar television sets from the floor of the convention. But on the California delegation, we had Shirley MacLaine, and you don't say no to Shirley MacLaine. She brought her television set onto the floor and then we could see what was going on on the streets. But by the time we'd get back, John Vasconcellis and Bill Lockyer and I would go out down on the streets to try and find out what had happened. All the National Guard and police by that time—seven, eight, nine o'clock at night—would have moved everybody out of the park so you couldn't see any of the episodes that were so shocking to the television audience. You could see them on television. It was difficult and every attempt on the convention floor to do anything to bring up the events from outside was either drowned out, the microphone was cut off, or something would happen, because Daley was in complete control of that convention hall.

DSM: This whole period marks a time in which technology, information technology, was really beginning to have an effect in terms of making it difficult to hide bad things that were going on in the outside.

JG: The first evidence that the television camera could convey to you, no matter when, no matter where, what was going on politically came in that period. This is the period when you moved from film to video tape. This is the period for the first experimental efforts to allow a camera to take pictures on the floor, linked by microwave—very expensive to do—showed that a mobile camera can convey pictures to a watching audience, globally. Big change—the very beginnings of the instant visibility, making the invisible visible occurred. When you realize in on the convention floor, your microphone can be cut off, you begin to think of pathways around that. How could you find a way to be able to speak to anyone anytime with absolutely no ability for someone to cut you off? Hence, the Internet.

The Vietnam Moratorium

DSM: This technology was also bringing for the first time pictures into U.S. homes from Vietnam—same effect. You're on the East Coast and had become very active in that Vietnam moratorium. Could you just talk about that?

JG: Yes, well what happened then after 1968, I went on to Harvard, went to the Business School. I found it very interesting. One of the deepest lessons I learned was that people in business work very hard. That's not fully appreciated by those that oppose business and often don't think very rigorously about what you really want to do that would cause a change, rather than complain about what's not happening now. I was very impressed with the focus of people in the Business School and how the analytic tools of business could enable you to do more with less. Do things more--be efficient in trying to cause change.

DSM: Were there professors there that particularly stand out in your mind?

JG: One professor, Tony Athos, who was Professor of a course they called Human Behavior in Organizations. The deep lesson is don't be too quick to understand why people are behaving the way they're behaving. People are complicated, it takes a lot of understanding before you can truly criticize or attempt to shape.

Many of the difficulties I'd seen in the organizational efforts in Oakland or the anti-Vietnam war demonstration organization came from people who simply didn't understand where the other people were. In setting up the Vietnam moratorium work, which began in 1969, moved on to 1971, in retrospect, it was easier than we expected, to mobilize a lot of people with the simple idea that if you oppose the war you can take a one-day and not do anything. It started as a very simple plan, that we would have a food strike. Who are the best candidates for food strikes--young women in Catholic colleges, because you're moral and you're thinner. It's an unbeatable combination, so just skip food for a day. That turned into this notion, let's call it American general strike. General strikes work when you have a centralized trade union movement in Europe. They don't work in the United States very much. But if we could just call the general strike anyway, perhaps we could add to the young Catholic. We called them the SCWC's—the small Catholic women's colleges, easy places to organize and expand it into the general population.

At this point, many of the people that were opposed to the war, were also in some general sense, opposed to the structure of American society. If you had long hair and if you smoked dope, you had a tendency to get arrested so you didn't like the policemen that arrested you. If you're going to oppose the war, it was a good idea to get the policemen to agree with you. But you couldn't do that starting from these confrontational and oppositional predicates that you had. So I learned a lot from Athos about thinking about the structure of belief that motivated those that were involved in the same organization that you worked with.

DSM: When you were a swimmer, I've read that you were an All- American crew cut swimmer. Did you grow your hair long during this?

JG: It did grow longer. The reason you cut your hair short when you're swimming is just to cut down resistance. Very rarely did they say those shaved legged swimmers, but that's what we are were because you want to go faster. It's just operational. Yes, my hair. I think back with great fondness.

The Power of Communication

DSM: During this period was your move from the Harvard Business School to the Kennedy School all related to this work you were doing?

JG: In a way--there I was at the Business School. It was interesting, but I think when I hit the peanut butter marketing case, I decided this is really not my arena. How silly I was later not to realize that though the subject material might be peanut butter marketing—which seems frivolous—the analytic methods of thinking about how people buy and sell and view something. It doesn't matter whether you're discussing peanut butter or whether you're discussing to the Vietnam war. People's minds have to be changed. People have to see things in a certain way. It's not that there's a casual selling of complicated ideas, but, at base, human beings, complicated as they are, make their minds up based on thousands of influences. To be able to see clearly what they are is a very powerful skill. So empathetic understanding, which is the basis for film and movies—empathetic understanding, the foundation of literature—is a critical component for political organizers.

DSM: It would be a good time to talk, I think, about the tools for communication, the differences in the tools that we've had for communicating, educating, and mobilizing in the 1960's and early 1970's and the ones that are available now or even available in China.

A: There's a massive distinction. When you think about what we were trying to do with the Vietnam moratorium, as an example, the only way to reach tens of millions of people was through the press. How else? It became very important what Dan Rather or what a particular reporter would write. It became very important to spend time trying to break into the *Washington Post* or the *New York Times* and to counteract whatever had been said by someone else. The power of television was on the rise. The print press was enormously powerful. The photo magazines—to get a full spread in the center of *Life Magazine* of my stage on the Boston Common for the Vietnam moratorium that filled the entire Boston Common with people going back as far as you could see—that was powerful. That carried in that graphic image a statement by normal Americans, by the world of Americans. The Gloucester fishermen, the candle vision around the Gloucester fishermen, captured for many Americans an image of an opposition that was not the easily dismissed radical, but the core of America opposition to the war. The same for the candle vigil where each person marching from Arlington National Cemetery over the bridge, past the White House and up to the Capitol where the coffin waited for the deposition of the name tag of one of the Americans that had died in the war. That had a symbolic power that was enormous and it reached people who otherwise really weren't thinking about things.

Today, the ability with a camera the size of my hand-- to take pictures of broadcast quality and convey them across an Internet that crosses passes every national boundary and to do it as zero cost--completely alters the ability of people to persuade, for better or for worse, to understand, to see things, they would never otherwise see. At this moment in Kosovo, with the bombing going on, there's a little group in a building in Belgrade, called B92—the Internet access providers in Belgrade, who are providing news across the Internet from Belgrade after the expulsion of all foreign journalists.

They'll be shut down at some point, but as long as there's a link by any pathway, the world can look through the eyes of those in Belgrade and into Kosovo in ways not possible ten years ago, twenty years ago with that structure of media.

DSM: Do you think that now as opposed [to then and there] a program to people have shut down the means of communication is much, much greater?

JG: I think that the sophistication of those immersed in media—the Europeans, the Americans, the Japanese—as you begin to see the structures of what's presented to you, you begin to appreciate more and more how those can be shaped in ways maybe designed to influence you to think a certain way. If you're in Singapore and you watch the news, you realize that there is a code of conduct for Singaporean news reporters that may not be the same for a reporter in Europe or the United States. There's a self-censorship. You begin to notice the gaps in what people say. You begin to notice the lack of clash of ideas and I think that will be increasing as every form of media begins to cross, because the pathways now are free to carry it around the world. The news is that by the end of this year, 1999, one thousand Chinese universities will be on the Internet. It means there's a fundamental change in China whose repercussions will be felt forever. There simply is no way to keep those boundaries closed that have been closed in the past by national governments, political parties, by businesses with particular interests. The invisible is becoming visible.

Faxes, Politics & the Press

DSM: Mobilizing the great march on Washington, antiwar in the 1970's reaches a peak. Nixon is re-elected for the second term. When did you make a decision to leave the East coast and go back to Berkeley and finish the undergraduate degree and work on a Ph.D.?

JG: We decided right at the moment that I was most involved in learning about the East Coast, both at the Harvard Business School then at the public policy school, the Kennedy School of Government, we had a chance to elect a President. We thought, well, George McGovern does have a chance to at least state the anti-war position and possibly a chance, if we're clever, to use the rules of election in the primaries to become an influential voice for a part of the American political spectrum that's not really been heard from.

With the death of Robert Kennedy, ideas that had been on the march had been lost. I left Harvard to go work on the George McGovern campaign. My first job was to organize in Arizona and in California the universities, the students, the antiwar elements, the various voices in communities up and down the West coast that might allow George McGovern to win the necessary number of votes to become the Democratic nominee. Straight political organizing—day in, day out. Phoenix, Tucson, Arizona primary and McGovern does well. Organize California, McGovern does well. On to Miami, win the nomination. Oh, my gosh, startling! We suddenly have a presidential candidate and what chance do we have with these ideas that are against war and support of feeding poor children - all the ideas that McGovern had—which today are commonplace and accepted, but at the time seemed somewhat extreme. Well, we lost badly in the 1972 McGovern campaign.

When we lost, I'd been on the road then traveling with McGovern as the deputy press secretary in charge of the traveling party and organizing all these events, three or four cities a day. Ten months of this flying from city to city. And we lost. So I went back to Berkeley. I went back into academic life and went back first to get my Bachelor's degree and then continue on in the doctoral program in economics. I was in a way, back in the mathematics' world because I was in the mathematical economics program at Berkeley.

DSM: You were working, organizing—this was really with telephones, right?

JG: Yes, 1972 was the first presidential campaign with faxes in it. Faxes were a revolution in information technology for a campaign. Because the hard part in moving a plane, we had three planes, redone, loaded with people like Hunter Thompson and you name anyone in American media, they were on these planes. To make this entire traveling entourage follow the logic of American media, which was their media markets, they don't have the capability of exchanging pictures taken at each media market with each other; it's hard. So you had to physically go there. So you begin by going to New York and then you'd fly from New York to the next media, maybe go to Chicago. Then from Chicago you'd go to Iowa and then from Iowa you'd go to someplace, Indiana, and that would be the end of one day.

I still remember one McGovern campaign projectory that was essentially Washington to Iowa to Indiana to Maine—one day. In doing that you tried to maximize the amount of television time in each of the media markets. Today, with instant communication and live remotes from anywhere in the world, that changes fundamentally. The mechanics of making this work when you have to have schedules and itineraries and manifest lists of people on the plane and press releases and speeches and drafts moving from one place to the other and that heavy fax machine that had a spinning cylinder that people don't remember today, revolutionized the conduct of day to day political campaigns.

Embracing Econometrics

DSM: We'll now move back to working in mathematics. What were you working on and who were you working with?

JG: I came to a split. I'd been working with Debreu. Debreu is a mathematician. His Nobel in Economics was for a theory of behavior of very large numbers of independent decision making elements that would come to an equilibrium point. And essentially, it was a topological theory—a theory of the shape of a variety of different entities that as decisions were made would evolve and come to some common equilibrium state. The assumptions for this theory to work—it was a beautiful and elegant theory—but the assumptions were very strong. The assumptions were that human beings behave in a very smooth manner. If you drop the price, you bought a little more and kept going. Well human beings, clearly politics shows, there are certain discontinuities; people suddenly change their minds. Things alter very quickly.

It was clear to me that the elegant mathematics of equilibrium theory did not capture the behavior of human beings. So I moved into a very discipline of economics into econometrics. Dan McFadden, himself from physics and a very powerful mathematical mind, had great insights into discontinuities of human behavior and went through factual analysis to attempt to derive what really was going on. How did people really behave? Once you begin to confuse economics with facts you have lots of problems, because you can't make continuous functions fit discontinuous data. You try very hard. So I began to learn a lot about statistical estimation and the behavior of functions that were step functions or discontinuities; functions that behave very differently than the normal set of functions in economic theory. Microeconomic theory is based at the heart on the calculus, on incremental changes causing other incremental changes.

My political experience said to me this is a more interesting source of powerful thought than the analytic stuff was. So I moved more and more into that. That was the field in economics I was in at the moment that I ran into my friend who had been my computer helper forever—Bill Joy.

I'd become involved wit the computational part of economics and how the metric worked huge data sets so I had to use the computers. So I began to learn how to use the computers and then I met Bill Joy. Bill Joy is the smartest person in computing and remains the smartest person in computing in the world. Bill as a graduate student reorganized how everything worked and added enormous amount of capabilities to the computer systems at Berkeley.

Bill Joy is my system administrator. Bill gave me my first account on the machines at Berkeley and Bill then, I've asked well, what do you think will happen? Bill would tell me what he thought would happen and I thought, well, Bill is not going to go to the meetings on the Berkeley campus that will reform the computational structure of the university so I'll go. I asked Bill what he thinks will happen or what should happen and then I'll go do the committee work and the politics inside the university to make it happen. And that's a partnership that's remained for the last twenty years.

Newspaper On The Air

DSM: While you were doing this, you were again re-engaged in politics in a general sense, being Bill's grunt politician in the committee's that are making, taking these decisions. What else are you doing during this period? I mean you were a serious graduate student, working on a dissertation. You're good at committee meetings for Bill Joy, making music, getting married…

JG: Got married.

DSM: Tell me about getting married.

JG: I met this wonderful woman who was a journalism student, who was making television at the time, and very, very smart. She was just a wonderful woman from Berkeley. Many of the people she knew had been people that I'd known because of the work in the McGovern campaign. She knew the journalistic world; I knew the journalistic world. We hit it off and decided we hit it off so well that we ought to get married. We did. She began her career as a television journalist on a program on a public television station in San Francisco that had been the result of a strike in San Francisco. All the newspapers in San Francisco went on strike. The journalists from all the newspapers went on television and they created a show, the first in the United States like this, of creating the newspaper on the air.

You'd begin with an editorial meeting. What happened today? Instead of the kind of television journalists you often see today—the slick ones that read the teleprompter—you'd have serious journalists, interesting people, but not pretty people, talking about ideas and conflicts. Should this story be on the front page or should it be further back? Or, did we understand the story? Did we have good sources? All the while in this complicated conversation, that's at the heart of what really goes into making good journalism, the political cartoonist would take an idea and make a cartoon about three of the different possible stories and then they'd argue about the cartoon. It was funny and people would disagree and you'd begin to see what lies behind the hard problem is telling the truth. You learn that nobody tells the truth; everybody tries to get it as close as they can. And there's an ethic to it and there's a style to it.

Anyway, that was a wonderful intellectual experience for her, the newspaper of the air. She's never forgotten it and neither have I. Because I think today we have the capability of doing it again in the Internet.

DSM: Do you have kids?

JG: Yes. Peter is now 20—so that must have been 1979. We'd been married for three years, four years, when Peter came. It was a hard thing because Peter came in 1979; I was still a graduate student. The call came from Ted Kennedy that he was going to run against Carter and wanted to put together a presidential campaign. United States presidential campaigns are complicated. They involve thousands of people and the logistics are very complicated. And the usual maxim about the news, that half the money is wasted, but you don't know which half. You have details you have to take airplanes and refit them. I knew how to do that and so they called me. Would I organize the airplanes and the traveling party to pick Kennedy up at the Faneuil Hall announcement and carry him on for the next ten months of the presidential campaign of an incumbent Democratic president with an insurgent Democratic Senator running against him? Not a good formula for success. I felt I owed the Kennedys and so I said I would and with a newborn son, I went off on this odyssey to attempt to defeat the seated American president with another candidate.

Building Tools for a New World

Things had evolved. At that point, the computer networks were beginning. No one understood this in politics; no one understood this in the media. You could talk forever to people at CBS and ABC and NBC about how things were changing. They didn't understand it, so there wasn't any real point in discussing it with them. But you could see the beginning signs of it. Certainly the Internet at that point, as far as we were concerned, was a full-fledged living entity linking hundreds of thousands of people globally. That was the world we are in at Berkeley. Bill had placed a source code for all of the UNIX operating systems and his implementation of the TCPIP, the network protocols, freely out on the Net. Everyone had this code; everyone could make it work.

A graduate student, not bound by intellectual property laws at the University of California, Bill had signed nothing giving away rights. Bill gave away the software so that anybody could have it. That freedom allowed everyone to join the conversation. Suddenly, you had the technical tools; you had the software. These little machines were given to you for free. You could just run them on any computer. Powerful.

DSM: Were you actually communicating from the University using what is now the Internet?

JG: Yes, the first round of it had started in 1968. By 1972 there were twenty or thirty universities—Berkeley and a number of others. It became an enormously powerful tool and we're just now, in 1999, seeing the impact of the ideas everyone had in the 1960's and 1970's.

To make a chip, to make a processor is a design problem. You're going to make a very complicated street map of circuitry; it's going to implement logical functions. You could describe this all by drawing it, and the drawing is converted into a file that sits on the computer. You could send the file across the network. Somewhere else you can convert that file into the actual schematics—the mask—the lithographic masks that you make the chip. I can design a chip in one place, send it to you, and you could make the chip somewhere else. I don't need to carry any pictures to you; I send it across the Net.

The Advanced Research Projects Agency in the Pentagon funded the ability for any student—select students of select universities—to design chips and the defense department would pay Hewlett Packard or Texas Instruments or Motorola to fabricate them. The student can design a chip and three weeks later get a physical working chip back. That's a design cycle that lets you really innovate, create new things. That notion—that you could send the operating instructions for chip fabrication around the Internet to anyone—suddenly opened up the ability for anyone from Beijing to Seoul to Paris to New Delhi, anyone can be in this design conversation.

What will transform the world of computing in the next ten years is the arrival of under a dollar enormously powerful processors that do specific things: make a camera's image sharper; make a telephone clearer; make the lighting system in a room respond to the change in outside light; alter the electrical usage of a motor; and transform the way the entire industrial structure by making the ability to create intelligent small devices be available to anyone and make the cost of them come down to zero.

DSM: 1979 to 1982. I'm trying to lead up to the momentous decision to leave the academic world and jump into this…

JG: It wasn't so momentous actually. There we were drinking—in retrospect, things happen. But the seed ideas of open availability of source code and making the common rules for devices to work with each other: the rules for the Internet, the rules for Ethernet. Bob Metcalfe came up with a way for small devices to speak with each other. Common rules. No one owned the rules. That meant that anyone could implement them; you'd have to pay for it. Suddenly, the tide rose. Everyone could share technology and you could eliminate issues. Simple solutions to things that everyone could share, means you don't have to think about them anymore. The goal is to eliminate the simple problems and move on to the more interesting problems, build a rich environment with new things.

Now we're at a point—the 1960's into the 1970's—there began a group of intercommunicating computer people that all shared ideas. The ideas fed one on the other and combined in new and unexpected ways. This community was based on the Internet, because you at that moment could send anything from anywhere, play games with people, talk to people, you never saw them. You had a relationship with them. This is new. You had a professional relationship because you exchanged things that both of you had worked on that could be demonstrated to work or not to work. We were building new tools for a new world. And we're doing it with people who became anonymous friends. It was very interesting, quite a different world.

That became more and more prevalent through the 1970's. And I think Bill, by placing the UNIX software and the networking protocol on the Net, made it suddenly legitimate. You could buy something from a company and deal with their time schedules and what they thought was important. Or you could take this software from Bill at Berkeley and you had all the interior workings of it. If it didn't work properly the way you wanted it to work, you could fix it, change it, give it back.

Common engineering across the world became a new way for innovation to take place. It was much more powerful than that old idea that a company or an army or something could contain all the intelligence they needed to design something. Wrong. Somewhere out there somewhere—this is Bill Joy's maxim—somewhere out there, somewhere is a kid who will invent something new that will change everything you do. The skills that allow you to move forward are the skills of deciding what's good—understanding when an innovation is something that should be incorporated in what you're doing.

So appreciating what's good becomes an extraordinary powerful skill. Also, the power to innovate. There are innovators everywhere. We have a million kids this year on the Internet writing Java programs. One of those Chinese kids, maybe two, is as smart as Bill Joy. So watch for them!

"Two tall, skinny, fast-talking, brilliant people…"

DSM: Were you thinking this way in 1982 when you made the decision to leave and join Bill Joy?

JG: At that point coming out of the political campaign, a funny thing happened. Coming out of the 1980 political campaign, which is politics city by city, county by county, state by state, suddenly another interesting campaign began. The campaign of cable television companies to place cable systems in the cities: Sacramento, Brooklyn, the Bronx, Staten Island, Dallas. Each of these cities decided this cable television stuff was important.

The cable television company hired all those advance people from the political campaigns to put together teams of twenty or thirty people to prepare proposals for a 50 or 100 or 200 million dollar networking project. The Internet crowd goes—those of us trying to make all the networks— were fascinated by the notion that suddenly we could have halic bandwidth networks inside cities that would be paid for by "I Love Lucy" and provide the data pathways for the hospitals and the schools and for everything else to communicate and form a digital library underpinning.

We plunged into this. Then we found the cable TV people knew nothing about networking. They had no idea of the power of this; thought they'd make money by selling, many of them by selling porno on the cable or something, which they did. But our goal, and we didn't succeed in this, was to have them design properly from the beginning so it could be used as a data network.

In the proposals I ended up working on in about ten different cities, I always put in the notion that every city service could be accomplished in reaching out to the homes by using this network. Sometimes the TV engineers would take these sections out in the final bid. "Crazy people; it's all come true now." But the goal was at that time—to take the power of this high bandwidth—is a physics' trick that coaxial cable carries more than phone wire and use it for these interrelated databases of how things in your community effect you. That idea has remained, it's just now that we can do it without the expenditure necessary in the early 1970's, early 1980's.

That early 1980's push to get the cable systems in generated a lot of discussion about what the future of the Network would be. And at that moment, suddenly we had these microprocessors—Motorola, AMD, National—little processors that did everything a big board of components did inside these very expensive computers that we'd all been using in the university. You couple the power of the microprocessor that could enable you to make a single board computer.

Andy Bechtolsheim, a graduate student at Stanford, bound by no intellectual property rules, took the small Motorola processor and the Stanford University design system (SUDS) and drew on the screen the circuit boards that would allow you to view—the technical term is scrunch—the components down so you could fit a lot under one board. Later we discovered, you couldn't fit the test probes in very easily. That's what a graduate student does when they design things; they move it to the absolute limit. Andy jammed as much stuff on to a board as you could think of, all in this academic program at Stanford. And the boards together could make a very powerful workstation that could be used to replace a device that costs ten times more from the existing computer companies. No software, but beautiful hardware. And then Andy Bechtolsheim met Bill Joy and the combination—two tall, skinny, fast talking brilliant people—created SUN Microsystems.

DSM: Who actually got you to make the decision to leave and join? Was it Bill Joy?

JG: Bill. One of the projects I did, I worked for a while as a graduate student in Cody's Bookstore, a great, beautiful bookstore—wonderful bookstore. And Fred Cody, who was interested in Latin American history and in literature, didn't realize that there were people who viewed mathematics as the most elegant poetry of all. And would spend money on those books. I built the mathematics' section at Cody's. Fred was not enthusiastic until one day this out of the elbows graduate student walked up to Fred with one the Bourbaki Set Theoretic books. This was a French collective that wrote the most pure mathematics. The books are expensive, $80-$90. The guy brought the Bourbaki Set Theory book out, put it in front of Fred Cody, who looked at it as an alien object. What is this? The kid pulls out $80, says I've got to have this book.

Fred suddenly realized that there's another literary community that's not part of the one you normally know that lives and dies by understanding these symbols. So the mathematics section at Berkeley became the world's best mathematics' collection: better than anything at Princeton; better than anything at M.I.T. or Harvard; better than anything in Paris; better than anything in Moscow—the world's best mathematics' collection. I'd put that together and I'd automated it also. I didn't have to be around; the little punch cards would automatically reorder the books. I walked in one day to sort of tend the garden and there's Bill. I said, "I just met this guy from Stanford, brilliant guy, first hardware guy I'd ever met that understands something about software. We'd been talking about this company he started that I think would be interesting to go." We went across to the Mediterranean Cafe and on a napkin drew the pictures of what's now the Sun workstation. It took us some years to build this thing properly. But we designed it in early 1982 on a napkin at the Mediterranean Cafe in Berkeley.

DSM: Does someone still have the napkin?

JG: I can't find the napkin, I don't know. We moved later, so the napkin's somewhere. Who knows.

The Elegance of Language

DSM: That's a national treasure. When you're talking about mathematics as poetry, when you're thinking of mathematical terms, are you thinking of it in visual terms, are you a doodler, or…

JG: It's a mixture. For me, there's sort of a shape for a mathematical statement. Some things are impenetrable. I went off because of the statistical interest into measure theory. There's a theorem in mathematics—Caratheodory's theorem in measure theory, which talks about how different sets can be divided into very small pieces and can they be added up into something that actually has a limit or not. Oh, my God, the statement of a theorem is as if God spoke in some impenetrable way. You have no idea how someone, a human, could think of this. Well, in reality what happened, someone had an idea and modified it and rewrote it and rewrote it and polished it and then reformulated the theorem in its most elegant simple form. No one conceived of them in the way it was ultimately stated. But those you couldn't see through, that for me, those were hard. Some people could. There are those, Steven Snail, there are few people who have the ability to truly see things in a different way. For me, the interest in theorems was sort of the way the theorems build upon each other. If you work very diligently on particular idea, suddenly it seems clear. All those months you spent trying to understand this idea seemed just to be totally wasted, because it's such a simple idea. Why couldn't I see it before? Then you move on to the next step: where that idea's going to combine with another one to become something even more elegant. There's no end to it. That's the charm of it. There's no end to it.

Bill's way of thinking—he really does think, I think, in the poetry of the way the language is formed. He spent twenty years thinking about creating computer languages that capture a way of thinking about things, because if you use different computer languages, you think differently. The language I learned first was APL. It's a language that describes matrices, data structures. It's a language used in statistics; it's a language used in modeling. The essential element of it is an array. If you're Fortran or worst less, worst still, BASIC, you think about iterative machinery that runs along. If you think about a matrix it just iterates an index: "Ank can't think clearly about the object." So Bill's focus has been on ways to create languages whose native data structures are enhancements to thought. There are many more to be invented; many more to be deployed. It's an elegance; it's creating a universe that allows others to write poems. It's as if you're inventing a completely new human language that has powers of expression that other human languages simply don't.

DSM: A whole new universe of players.

JG: A new universe of players. I think what's happening now, given new computing power that creates imagery, we're allowing the kids to think in a way that we simply have no access to—to a visual way of combining complicated data structures that is going to give them insights into the way the physical universe works; or at least, the way that the models we make of the physical universe work—that give them instant insights. I've watched kids see things that took me a long time to understand. They saw it instantly.

The goal, as with mathematics is to move forward in the notation. Notation is everything. If it's necessary for you in understanding how physical phenomenon works, well to begin with, you don't know what the important elements are. How could you abstract from the behavior of these things to the essential components? Do I need only to know where the center of gravity is to predict where this ball will bounce? If you simplify, it gives you power in being able to predict.

In computing, the structure of the devices—the disks, the little areas on a chip where you store things, the register areas on the chips, the arithmetic units on the chip, how they actually carry out adding two integers—they do it in a way that's different than adding two fractures. There's different way the circuitry does these things. Twenty years ago, everyone had to know how that worked. Now you don't think about it. You use a higher-level, more abstract language. Still people think about things today: file systems, you don't think about the sector of the disk anymore, you think about giving a file a name. In the next round, you don't think about those things anymore.

We have, unfortunately because of the ugliness of these PC's, 200 million people that actually know about the file name, that actually think about a dot DLL or some insanity. They even think about an Internet address. You know, that should matter. So the next generation—that's the generation that today's 13—they're going to think about much more interesting things. How do I capture the behavior of human beings, or how do I capture music? How will I create a new literary form? How do I link together ideas? If I really wanted to trace the influence of a powerful idea through forty years of American technical history, how would I see who studied with whom? Who corresponded with whom; who transmitted ideas; who transformed the ideas; who made those ideas into devices?

That flow of ideas—that understanding of the interrelationships—is at the heart. We talk about technology transfer: it's idea transfer and it's human to human. You can't have an abstract transmission of ideas without human interaction. Instead people today—reading either literary reading, mathematical reading, physical science reading—read as part of an ongoing conversation, models in the universe change. People that had an idea twenty, thirty, fifty, one hundred years ago, those ideas are still relevant in new models. You just have to rearrange your thoughts as new evidence comes in. Most of today's computing are based on ideas that were very clearly expressed in the 1940's. We're only now making all these things turn into devices. At the moment because of the arrival of the Internet, we're able to change the way we think into a world of distributed devices.

We've been thinking in the past about a box with a disk in a particular location with a particular name at this moment. No more; now they're all linked. We, for the first time, begin to create almost living entities that have long-term permanent memory for what's been recorded in the past. As you take this video tape—the bits that are transmitted from the light into the receptor and down on to the storage device, which will ultimately go out on to the Internet and rest on a disk or on a solid state memory—there's a sort of possible long life for these bits. And they will be bits that are intelligent; they'll be linked by ideas, by personal links. They'll be indexed in new ways. So we're creating a new kind of text, a new kind of book, that's only made possible by this new technology.

The Power of Music

DSM: I'd like to talk about music and it's impact on your thought processes. You've had a very interesting relationship with music.

JG: I think that all of us—certainly those of us in the last half of the 20th century in the United States, immersed in radio, immersed in television, immersed in this popular music—had a thread of associations that are more powerful than any of us realize. If you think about it, I could probably hum two or three notes of a song and you would recognize the song. We're in the same age; there's a certain set of associations. The social statements made by music, when music from the black community moved into the white community, when the teenagers were listening to music that was very different than the music their parents listened to, it caused social tensions. It caused different perceptions of what was going on. You can't argue perceptions with someone who feels a particular kind of music. You can't tell him it's wrong. That conversation carried by music, by popular songs, is immensely powerful.

I think many of the feelings of bonding of the generations of the 1960's and the 1970's came through the music. What's startling to me today with my 16-year-old daughter who knows the music of the Beatles better than I do, who has as her most popular favorite music songs that I loved when I was in the 1960's in University, that's a change I think. It bonds young generations in some new ways. When I travel to places where the music's common across all age groups, I realize how odd we are where the generations are defined by music. If you go to Brazil, the samba roots, the practice of those do well: as Richard Fineman, when Fineman was the parade master in Brazil for Carnival—a Nobel Laureate physicist comes to sit on a float because he'd been a bongo player in the one of the samba groups. Here's this cross generation, cross nationality, single music language that bonds people together. You can a 12-year-old and an 80-year-old dancing to the same music in Brazil.

DSM: On a personal level, what was your favorite music? You had intimate relationships with…

JG: …intimate relationships with many rock and roll people, yes,

DSM: Yes. You worked on Rolling Stones concerts and knew Janis Joplin. What's your favorite?

JG: I must say Janis Joplin still just moves me. When you hear this Texas kid start yelling out those songs, it just—I love hard rock and roll: the Rolling Stones, Janis Joplin, that entire period of time in San Francisco where the bands played together and played forever - the Grateful Dead. Those are my favorites. Blues music strikes—just gets to me because much of that.

When Janis Joplin sang she was reinterpreting songs from Robert Johnson and a lot of people who came from the Black rural South. Those songs moved through Detroit. They moved through Oakland. They moved into the common vernacular of the British bands and the American bands. When Huey Lewis sings "Power of Love", there's a long string of songs that go through fifty years of American music.

The Appreciator

DSM: I've heard your job described as "cultivator and protector of genius." Do you think that's accurate? Do you see yourself as a cultivator, more of a cultivator or more of a protector?

JG: I'm an appreciator. I think what I discovered that in mathematics. I was good, but I was not a mathematician at the level of the true creators. There's a level of accomplishment of some people that is just breathtaking. So I became an appreciator. It's hard to become an appreciator of the outer reaches of an art form. I know I'm not a true appreciator of a symphony. I can understand some of it, but I have friends who know every nuance and who thrill to things I simply don't perceive. The same with art. I'll see some things, but I'll miss a lot. But in the area of science and technology and in some narrow parts of that, I'm an appreciator. In computer science to appreciate what Patrick Naughton does, to appreciate what Bill Joy does, to appreciate the creation of some new idea, this coruscating fountain that some few people can be with new ideas. I suppose my contribution is to try to take those ideas that others can create so quickly and elaborate them; try to see that they're made fruitful; try to see if the conversation that would allows those ideas to spread rapidly can take place. That's happening now in ways I would never have anticipated.

Empowering People Through Net Day

I'm a very happy person because at any moment now I can immerse myself in a stream of conversation in a dozen areas that are becoming richer and richer and richer. The voices are rising in the field of creation, in new technology, in the fields of innovation. If I had ever had to think back on everything that I've been doing, making it possible for people to create new ideas, I think is my greatest legacy of some sort.

That's the foundation of why the Net Day project began. I became fascinated by the thought that each individual school could organize itself to take part in the conversation. And I was convinced it's necessary, because if kid can't be in this stream of conversation, he can never appreciate it.

Growing up in Orange County when you had very little access to the flow of ideas, growing up in society that blocked from you any perception that others had different lives, now we can erase those boundaries and allow people to participate in anyone's life. So I thought the project to bring the schools up on the Internet was really a worthwhile one.

As it turned out, they had the power of the Network to allow anyone to see what their local circumstances are and to do something about it. Just make a Web page for a school and allow anyone interested in that school to put their name on that Web page, form a community, commit themselves to doing something, that's self organizing capability in this new distributed world, I think is a politics that's new. It's something that's going to alter the way we perceive our relationships with our governments, with our societies, with ourselves.

DSM: What were the biggest obstacles?

JG: Oh, my, well the Net Day project was simple one. My view of it was if I could make a Web page for every school, allow someone to find a particular school, urge them to do something, they'd do it. I could have been wrong; turns out I was right. People want to do something that affects their life and generally they want to do something that affects the institutions that are most important for them. What's most important for a parent—the institutions where their kids are.

DSM: Describe, since someone is going to be looking at this three hundred years from now, exactly what somebody does when they volunteer at a school for Net Day?

JG: The idea of Net Day was to allow anyone to find, across the Internet, a particular school. That means a page, a web page, for that school would appear, describe the school, say what the school needed. Then that person from anywhere in the world, could add their name, say what they'd like to do to help, and commit themselves in fact to come out on one day. We picked today just arbitrarily on Saturday, come to the school, or send money to help the school connect itself to the Internet.

I turned the Internet into an organizing tool—not a tool that allowed sexual powers to organize subservient entities, but instead a tool that allowed any school to organize itself. People put things on the Web page that I created for them. They'd put things on the web page that summoned others interested in the school to come join them, become part of the committee, show up on Saturday morning, bring a ladder, bring the cable, and connect the classrooms in the school together. One thing I think, that differentiated it from other attempts to have people do things, since this is an engineering world, this world of computing. Engineers regard the world as a problem. That's all it is, just a problem. Things are problems; you solve problems. I'm an engineer. I solve problems.

I said, “I lied.” I said to every engineer, first in California, then in the United States, and now across the world, it's okay. I give you permission to go to your school and wire it and connect it to the Internet. Don't ask permission from the Principal; don't ask permission from the Ministry; don't ask permission from the police. You're the parents, it's your school, it's your children, go do it. In just saying that it was all right to do that, I unleashed the power of hundreds of thousands of engineers in California, who all, crazy people, believed me. I got up on Saturday morning and went to their kid's school with a ladder, and said hello, I'm here to wire the school. The principal said, “well, uh, all right” and it just happened.

I discovered that if it's a good idea and it will help the school, that people really can't argue much with it. The initial responses of all human institutions that currently have budgets and power and responsibilities to say no, we're in charge, really we ought to have a lot of meetings. If you say, you know, in fact, you don't need to have meetings, you don't need to ask permission, you can just go ahead and do it, it's something we all agree on. Then you can have something emerge from self organization that's far more powerful than could arrive from central organization.

In fact last week—three days ago—I was in Rome. We had everyone in Italy involved in the information society: all the European commissioners; all of the ministers; the Prime Minister; everyone in the room, discussing how can Italy, a country which perceives itself as behind the United States in linking the poorest parts of the country in for economic development. How we can change?

I said one step we can take is ignore the Minister of Education (who I'm sure would support this but doesn't matter); ignore the telephone companies (who I'm sure would support this, doesn't matter); call upon the engineers in the Army, in the Navy, in all of the engineering societies, in the telephone company, in the power company, to rise up on one Saturday and go out and wire the schools. I'm sure we can do this. One of the ministers said,” If you just went to the school, I'm sure the police would be very unhappy about that.” And I said, “Well the police are parents too. They'll come organize and go into the schools; the unions will.” Turns out they will. One of the unions came up and said, “We'll do this.” I think that we're going to see a sense, as the Internet allows everyone to participate in the conversations of communities that until now, haven't really had much of a chance to understand much about their life.

Expanding the Conversation

When you think about it, if you live in a city today, you live not only in San Francisco, you live in a park district, a school district, a rapid transit district--dozens of different governmental entities who all have meetings and budget. You'll never go to their meetings. You have no idea of the decisions they take that affect you. There's no way for the newspaper to cover it, because there's so many of them. You'll never know. Tonight, something may have happened in a school board meeting in your home that alters how your school works. You don't know about it yet—with the Internet you can know.

There's suddenly the ability to do in some sense what "Newsroom" did for my wife when she began working in journalism: to bring in front of people the machinery of describing their own lives to them. People can describe their own lives to each other. We're starting conversations that are very local about what in fact happens here. And that's going to alter the way the governments work.

DSM: Is there anything that perhaps gives you a pause about the impact of IT?

JG: The deepest problem—as you add intelligence, as you bring things to life—they begin to converse. What do they say? They're telling new facts about people. So any hope that there's privacy or that there's an ability to hide something from someone else—after all, lives in private, things go on, that are not shared with other people. That's why there are marriages. In fact, that's why marriages dissolve; sometimes people have incompatibilities that they discover over time. If everything's suddenly very public, it alters how people relate to each other. But there are more devices that will be conversing and more things will converse than human beings, as intelligence goes into motors and intelligence goes into sensors and we're seeing where pollutants are entering. We're noticing the temperature rise in Antarctica and we're seeing ozone holes form and we're seeing the implications for all of the earth of every act taken by industrial society. It changes our perceptions; it changes in what we do.

Dangers are that the movement toward ubiquitous information about everyone is inevitable. If a television camera costs a penny and is the size of a postage stamp that can be placed anywhere, they'll be placed there. The estimate today is in London—the *London Times* said two weeks ago—your picture is taken thirty times a day in London. The cameras at the bridges, the cameras at the intersection, the cameras at the bank cash machines, the cameras in the stores, the cameras in the elevator, your picture, your privacy gradually and invisibly is going away. And why do we give up our privacy? For convenience. People will give up an element of the privacy they have in what they buy for the ability to be told about sales and special prices. I don't mind if everybody knows that I drink this kind of beer, if the people that make the beer will send me mail telling me I can get it more cheaply at another store. We're trading convenience for privacy. At some point, we're going to go through a position that is irreversible. I think, in fact, the danger that we all face is moving into a world where the ubiquitous eyes tell us more than we want to know about ourselves. And there are points in which society does flounder.

On the one hand, wars can be averted if those that are out to declare war on each other regard each other as human beings, rather than regard each other as aliens or less than human. So the thrust of the Civil Rights' movement, the thrust of movements for equality is to make people feel that human beings share common aspirations and share common dreams and therefore shouldn't be killed.

If the human race falls apart in a lot of places—Serbs don't like Croats and Albanians and these have these explanations for it, which don't make much sense to someone who's not a Serb or not an Albanian—but it's enough explanation for them to kill each other. Getting the conversation started may be able to slow down those kind of ethnic and religious differences that cause human beings to kill each other. It also may give us an ability to sense the pain of the earth, as we alter it in ways that may not be reversible.

So we're into some complicated conversations and I think we're into societal transformations that may not be reversible. Is global warming reversible? That's an interesting ecological question. Is universal visibility reversible? It may not be. We may not like it, but we're moving in directions which require humans to change the way they relate to each other. We've not yet even touched the questions of biological determination as we understand more and more the manipulatability of the components of information in our systems that create our bodies and our children's bodies, the bodies of all living things. We can change those things now. New powers bring new responsibilities and it's hard to access precisely what the moral and ethical boundaries should be for this new direction.

In education, I think, as we move into these new and complicated worlds, the kids have to be exposed to the choices they'll be forced to make as adults. Sometimes people will say that the universal digital library that has the magazines with naked people in them, next to the magazines of sports' stars, next to the magazines that concern politics, well we better not have those naked people magazines available to the kids. It's a choice. Kids today are adults tomorrow and kids have to be able to make choices when they move out of school, so they have to be prepared with guidance from their teachers and their parents, guidance from their churches and their ethical authorities, in how themselves, as they become adults to make choices.

I would invent new tools to help people learn to make choices. So I emphasize always the positive side of the difficult questions: that you can learn and you can engage yourself and you can choose in ever better ways what you do. You can't do that if you're not exposed or in the conversation. I believe fundamentally the expansion of the conversation lies at the heart of the expansion of civilization.

In spite of wars, in spite of famines, in spite of the way we treat each other, overall, the human race is doing better. Now is the rest of the living mass of the earth doing better? That's a complicated question but I think that we're developing the tools that may make it possible, fifty years from now, to look back on this moment as the moment of giving us the new tools that might make it possible to have the earth survive. And make human beings as a whole, healthier and happier and perhaps wiser.

There's a line that I love, which I won't get accurately, but Ezra Berlin has a wonderful line about how things go forward. And I'll find you the exact quote. Essentially it says that in studying the history of philosophy there are many ideas that clash. Ideas come from life. Life changes; so do the problems. And new ideas come, not so much from--how's he says this, he said, oh yes—in these clashes of ideas, old ideas die away, not so much from being refuted by argument as from inanition.

People cease to find it an interesting issue. The idea dies, and we move on to the new--that life brings new problems and we move on. I think that's my evolutionary theory of intellectual direction.

DSM: Well, that's a great way to end this interview. Thank you so much for your time!

JG: Thank you.