

**John Gage**

**Director, Science Office  
Sun Microsystems  
Laboratory**

**Open Sources, Open Systems**

- Multiple domains of intellectual technology
- Fundamental response to basic question how to incorporate change
- How do we think about our world?
- Technical changes that drive the world order

December 1992

**Open Sources**

- New York Times, Thursday, December 3, 1992
- New York Times, Wednesday, December 2, 1992
- Wall Street Journal, Thursday, December 3, 1992
- Financial Times, Thursday, December 3, 1992

December 1992

*"Philosophy comes from the collision of ideas which create problems. The ideas come from life. Life changes, so do the ideas, so do the collisions. The collisions breed puzzles, but when life changes, these puzzles are not so much answered as die away. Ideas perish from inattention far more frequently than as a result of being refuted by argument."*

*Isaiah Berlin, Recollections of a Historian of Ideas, Scribner's, 1991*

*"Two people need, if they are to understand one another the ability to converge on passing theories [about total behavior] . . . we have erased the boundary between knowing a language and knowing our way around the world . We must give up the idea of a clearly defined shared structure which language users master and then apply to cases . "*

*Donald Davidson. 1984 Oxford Blackwell*

*"Davidson lets us think of the history of language, and thus of culture, as Darwin taught us to think of the history of a coral reef. Old metaphors are constantly dying off into literalness . "*

*Richard Rorty, Contingency, Irony and Solidarity, Cambridge University Press, 1989*

**Laws of Technology**

---

- First Law the more you change, the more you need to change
- By supporting freedom to change, we guarantee change

December 1992

**Laws of Technology:**

---

- Second Law. Innovation will occur
  - Corollary it will occur elsewhere
  - No matter how big your organization is, incredibly important innovation will occur outside your organization
- You must be ready to incorporate it, or you don't survive in the new world
- Don't bet against innovation
- Technology is easy, human beings are hard

December 1992

**used by people to make sense of the world around them**

---

December 1992

**Computing as an engine of economic and intellectual change**

---

- At the same point today as the automobile or the fractional horsepower electric motor in the 1920's
- Need infrastructure to develop the mass market that cars, washing machines, and refrigerators developed. we need the roads and power generating stations [READ NETWORKS]
- Provides technology for reducing fundamental social costs . education and health care

December 1992

**Computing as an engine of economic and intellectual change**

---

- Diffusion parallels that of other technical advances
  - Book                      •Telephone
  - Motor                     •Television
- Enters all other infrastructure technologies

9  
5

December 1992

**What changes the world?**

---

- Shifts in language and metaphor
- Individuals create language and metaphor
- New objects, and their interaction, inspire individual insight and the creation of new metaphors

December 1992

**How do we organize a system so thousands of individuals and organizations can contribute?**

---

- Central question how to incorporate change?
- Draw upon the talents of all human beings
- Allow everyone to participate
- Open access to central elements of technology
- Allow everyone to contribute without asking permission of the bureaucracy
- Make sharing easy, with rewards

December 1992

**Tenets of Open Systems**

---

- What matters is individuals
  - Individual Users
  - Individual Developers
- Open systems means you can do things without the permission of the bureaucracy a critical point in a high-change world

December 1992

**Tenets of Open Systems**

---

- Allow the user access to everything
  - All interfaces
  - All levels
- User empowerment brings more rapid change
  - Workstation movement
  - Revolution in telecommunications

December 1992

**Tenets of Open Systems**

---

- Price products based on cost, not on extractable value
  - Allows rapid technological improvements
  - Allows technology to drive
  - Brings demise of closed systems

December 1992

**With open systems, where is the value added?**

---

- Highest new metaphors
- Next. New software to implement them
- Next New, generic hardware
- Least Labor-intensive service/support

December 1992

**Bet on Innovation**

---

- Last ten years saw the development of one way to do this Open Systems
- Open Systems is an answer to the fundamental question: How do we bet on innovation?

December 1992

**Empowering Bright People**

---

- Truly bright people are a non-renewable resource
  - Most are happier in small organizations
- Large organizations must have bureaucracy

December 1991

**Empowering Bright People**

---

- Number of bright people =  $\text{Log}_{(\text{base } n)} [\text{Number of Employees}]$
- In a very large company you have many bright people, but less densely distributed; they spend most of their time in meetings persuading others to get out of the way

December 1991

**Empower Small Companies**

---

- By default, the answer is yes
- Publish interfaces, license technology
- Get bureaucracy out of the way
- Practically, ship cloneable platform in large volume so innovators can afford it

December 1991

**Multiprocessor Industry: A Goal for Sun**

---

- First 100,000/year Multiprocessor in 1993
- Only volume will make large numbers of applications possible
- The software for the expensive MP supercomputers will be written on the MP desktop
  - Only by allowing many people to work on interesting problems will we have a chance of solving them

December 1991

**How do you know the future?**

---

- Get it under nondisclosure
- This is February, 1995
  - Things take longer as technology becomes more expensive
    - One billion dollars and three years for DRAM facility
    - Even IBM must partner to survive
- 1994 is decided, 1996 is in constrained envelope

December 1990

**How do you approach the future?**

---

- Open systems are the key to staying close to the curve
- Accept outside technology in both physical and organizational systems
  - Technology is relatively easy to change
  - Organizations are very hard to change, especially those without focus

December 1991

**Emerging Struggle for World-wide Industry**

- Systems with over 250,000 shipping annually
  - Windows 3.0/DOS
  - Macintosh
  - Unix/SPARC RISC

December 1992

**Emerging Struggle for World-wide Industry**

- In two years
  - Windows NT
  - Unix/SPARC RISC
  - Apple/IBM
- Suggestion for small software company do two

December 1992

**What changes the world?**

- Change comes by shifts in language and vocabulary, by adopting new metaphors
- New metaphors are created by individual insight
- The most critical thing is the investment in an idea, which begins with an individual

December 1992

*Are we creating a new intellectual technology?*

**Arrival of new intellectual technology**

- Oral civilization
- Writing civilization
- [New Object ] civilization

December 1992

**Libraries [Open Sources] are:**

- Windows looking in on treasures France Bibliothèque de France
  - Containers of precious objects
- Windows looking out to the world
- Conversations among people
  - A babble of languages, of passing theories
- Networks

December 1992

*We are creating ways of seeing and understanding that have not been possible in the past, and that allow actions we could not imagine before.*

1  
1  
1

December 1992

**How do we know something new is here?**

- Uncomfortable words to name new objects
- Uncomfortable terms. Multimedia, Hypertext, Hypermedia
- Cataloging and taxonomy are difficult, cloudy
  - Creation of new categories, new metaphors, new similes

1  
1  
2

December 1992

**How do we know something new is here?**

- Change in how we think about time and distance
- Difficult, but increasing collaborations of different communities, with different goals and understandings
- Observe the coexistence of speaking and writing
  - Different metaphors, styles of thinking, modes of expression, memory methods

1  
1  
3

December 1992

**Forms of Human Intellectual Technology**

- Marks
- Sounds
- Hierarchical notation
- Images and motion
- Spatial sensitivity and symmetric organization
- The shape of emotion, the gesture of feeling

1  
1  
4

December 1992

**Forms of Human Intellectual Technology**

- The rhythm of humor and laughter
- Physics in human-(machine)-human communication
- Metaphors of time and space

1  
1  
5

December 1992

**Evolution of intellectual technology**

- Orality -> Writing -> Executable Writing -> Multiiform

December 1992

**Evolution of intellectual technology: Speech, orality:**

---

- 60,000 years of human life
- Mnemonics; alliteration, rhythmic patterning
- Spatial memory aids, Stoics and Sophists memory technique
- Technology of visualization of rhetorical sections of speech

1  
1  
8

December 1992

**Evolution of intellectual technology: Writing and notation:**

---

- 6,000 years of human life
- Writing is a memory aid, collapsing time and space
- First application: to list and count objects, manipulate world
- Developed into system of mass communication
- Necessary for experimental science

1  
1  
9

December 1992

**Notational systems are continually evolving**

---

- Mathematics as hierarchical condensation of ideas
- Music capturing dynamics, pitch, intensity
  - FFT
  - MIDI
- Dance and gesture Laban, motion notation
- Drawings, plans, symbol standards
- Recipes, algorithms

1  
2  
0

December 1992

**Writing objects and technology took centuries to develop**

---

- Books
  - Standard interface of titles, authors, page numbers, chapters, table of contents, index, cross references
- Libraries, dependent upon these standard interfaces for non-linear access
- Catalogs and cataloging conventions ( AACR II) allow the world's libraries to appear as one book

1  
2  
1

December 1992

**Writing objects and technology took centuries to develop**

---

- Perfect reproduction printing, which led to cheap copies
  - Decrease in cost, size and weight led to the nomadic book and newspaper
  - Newspapers and magazines use low cost to establish quick browsing access to constantly changing information

1  
2  
2

December 1992

**Evolution of intellectual technology: Executable notation:**

---

- 40 years of human life
- Writing as a machine: the act of reading causes action
- Programming languages
  - Simple syntactic and semantic characteristics
  - Recursive semantics
  - Visual poetry structure adds semantics
  - Underlying graph structure

1  
2  
3

December 1992

**Evolution of intellectual technology: Executable notation:**

---

- CAD languages that compile into a machine: VHSIC Hardware Description Language
- Executable drawings
- DNA descriptions compiling into proteins
- Nanotechnology languages compiling into machines Universal Constructors
- Cellular Automata

1  
2  
4

December 1992

**New objects [NewBooks] [NewBots]: Multiform**

---

- New Objects that terms like Multimedia cannot capture
- Universal, networked, user-designed or altered, creating new mixtures of metaphors
- Dynamic, multifaceted
- Just being created, available to few
- Creating new industries

1  
2  
5

December 1992

**New objects [NewBooks] [NewBots]: Multiform**

---

- Replaying, in a few decades, the stages writing went through in centuries
  - More general than manuscripts or printing, since they include dynamic images and sound
  - No longer possible to combine world libraries in one book each person or group has their own view
- Explosion, fracturing of ways of seeing, hearing, feeling, understanding

1  
2  
6

December 1992

**What world view are these new object/machines creating?**

---

- Learning to see
  - Same images are seen very differently by each person
  - Creation of new aesthetic vocabularies
  - Creation of language of visual context

1  
2  
7

December 1992

**What world view are these new object/machines creating?**

---

- Learning to interact
- New technologies of creating simulated objects obeying physical law
  - Use of acquired knowledge about the physics of ordinary things becomes part of the interface
    - Interactive physics simulated objects obey the laws we learn as children

1  
2  
8

December 1992

**What world view are these new object/machines creating?**

---

- Learning to find
  - Spatial memory
    - Yates *Art of Memory*
    - Umberto Eco *The Name of the Rose*
  - From Terabyte to Petabyte data creation or acquisition
  - Permanent Store in 256-bit addressable universe

1  
2  
9

December 1992



**What world view are these new object/machines creating?**

---

- Learning to control
  - Virtual realities were created in the 1970's to control objects
    - Simulation
    - Visualization
    - Operations research insights made graphic
    - Multisensory input and output
  - Annotated realities are continuously evolving
- New technologies of controlling objects

1  
3  
0

December 1992

**What world view are these new object/machines creating?**

---

- Learning to share
  - New technologies of sharing objects
    - Digital objects books as hypertexts
    - Hypertext linking creates new, self-defined communities of interest
  - The act of seeing implies copying; print-based copyright law is immediately poorly defined
- Learning to protect: encryption, digital signature, privacy

1  
3  
1

December 1992

**What world view are these new object/machines creating?**

---

- Learning to link
  - Linkage to existing information environments implies location matters less
  - Changes all organizations based on information, and the lives of those involved in them
  - New problems of sharing human knowledge and empathy
  - Empathy is foundation for solidarity and world peace

December 1992

**What world view are these new object/machines creating?**

---

- Learning to learn

December 1992

**Scientific Computing : Creating new windows into the universe**

---

- Worlds never seen
- Worlds we create by seeing in new ways
- Worlds we create by computing what we think we ought to see

December 1992

**How do systems change?**

---

- Evolve, in the same way as language
  - Metaphors dying off into accepted vocabulary
- Interaction between evolution, planning, and design
- After the system evolves, write standards based on what works, which become the design documents for the future

December 1992

**How do we change the world system?**

- **Russia**
  - Moscow Center for Sparc Technology: Academician Babaian and the Elbrus III gang
  - Zelenograd Academician Guskov and the Courier system
    - WARC allocation
  - Zelenograd tuneable antennas for nomadic machines
  - Novosibirsk Nuclear expertise in optimizing Fortran compilers
- **Ukraine**
  - Hydrology Institute

December 1992

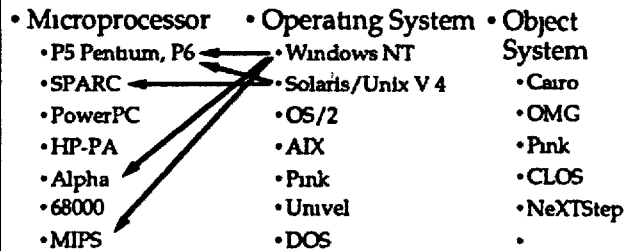
**How do we change the world system?**

- **China**
- **Pacific Basin**
- **India**
- **Middle East**

December 1992

*Do we resolve the tension between proliferation and open systems?*

**Future of Systems**



December 1992

**Who has been creating these new worlds?**

- **Science fiction writers**
  - Jules Verne, 1864
  - Arthur C. Clarke, 1945 geostationary satellite
  - Aldous Huxley
  - William Gibson
- **Historians, Philosophers, Mathematicians, Physicists**
  - Complexity and simplicity, condensed notation
  - Simulation, prediction, recreation

December 1992

**Who has been creating these new worlds?**

- Alexander Bell, 1876 World-wide point-to-point connection
- Pierre Otlet, 1934 Libraries over telephone, Schuermeyer, 1935. books in homes over tv
- Vannevar Bush, 1945. Memex (drawing on Otlet, Schuermeyer)

December 1992

**Who has been creating these new worlds?**

- Ivan Sutherland, 1963 MIT graphics, visualization, virtual reality
- Doug Engelbart, Bill English, Jeff Rulifson, Alan Kay, 1968. SRI, Xerox PARC: desktop metaphor, mouse, windows: the Alto
- Tom Furness, 1970 Wright-Patterson Air Force Base. Virtual reality

December 1991

**Who has been creating these new worlds?**

- Ken Sakamura, 1970 University of Tokyo TRON intelligent houses
- Bob Kahn, Vint Cerf, 1973: DARPA. ARPAnet, knowbots
- John Tukey, Fred Mosteller, Jerry Friedman, 1973 Bell Labs, Harvard, SLAC: understanding through visualization

December 1991

**Who has been creating these new worlds?**

- Duane Adams, Bill Joy, 1975
  - DARPA, UC Berkeley open software systems Unix
- Carver Mead, Lynn Conway, John Ousterhout
  - Caltech, PARC, UC Berkeley software to make hardware 1978
- Joe Becker, Kazuko Nakajima, Xiao-jie Yang, Martin Kay
  - Xerox PARC, U Toronto Unicode standard for all written languages 1992

December 1991

**Who has been creating these new worlds?**

- John Warnock, Charles Geschke, James Gosling
  - PostScript, object document description 1978
- Whitfield Diffey, Martin Hellman
  - Public Key Encryption 1976

December 1991

**Basic technology changes that shape computing**

- Networking speeds jump by an order of magnitude each *three* years, so LAN, MAN, and WAN become the same thing
- Storage costs drop from megabytes to gigabytes per dollar
- Processing power continues exponential growth: MIPS = 2 (Year - 1984)
  - Shift to desktop multiprocessors

December 1991

**Major change in interconnection of computers**

- Not coming from the computer companies
- Agreed to by CCITT, CCIR
- Agreed to by all PTT, Ministries of Telecommunications
- Agreed to by all switch manufacturers
- Agreed to by all carriers

December 1991

### Asynchronous Transfer Mode switches

---

- Fixed length cells, switched in real time
- From 155 Megabit to 2.4 Gigabit, in integer multiples
- Dynamic allocation of bandwidth
- Carry all data, voice, image, video on
  - SONET
  - Twisted pair, coaxial, multi-mode fiber, single-mode fiber
- CCITT has demonstrated responsiveness to technical merit

December 1992

### ISDN

---

- Slow, late, but inevitable and ubiquitous
  - Japan is 90% wired, Europe is moving, US lags
  - Trip '92 Demonstration in November, 1992 in Washington, DC. Southwest Bell, US West fail
- Major shift to Customer Equipment for switching
  - Use existing wire, existing switches
  - Small board in switch, new Customer Terminals in home
- All Suns have ISDN connections: 400K machines/year to kick-start market, force carriers to create low tariff

December 1992

### Wireless Connections

---

- Satellite Low Orbit, Low Power
- Spread Spectrum
- Infrared
- Light modulation
- WINForum
  - Sun, Apple, HP, IBM, NCR, DEC
- WARC 1992 Torremolinos

December 1992

### Usage Model Inverts: Data Consumers become Data Generators

---

- Consumers Today
  - Software designed to analyze and evaluate data
  - Each machine generates little data
- Generators Tomorrow
  - Video, audio, special signalling
  - Each machine generates HUGE amounts of data
  - Today built-in audio
  - Tomorrow built-in audio, video
  - Compression saves us 18 months

December 1992

### Networking Technology needs

---

- Local Area Needs
  - High bandwidth guaranteed on demand
  - Synchrony needed for video and multimedia
  - Multicasting needed for distribution
- Wide Area Needs
  - Merge LAN and WAN
  - Bandwidth on demand only
  - Data routing and delivery by the WAN infrastructure
- Nomadic needs
  - Allow useful work when disconnected

December 1992

### Basic technology changes that shape computing

---

- Operating systems blend, merge, provide equivalent services, and become invisible
- Old ideas are finally implemented
  - Secure microkernel
  - Multi-threading
  - Federated Naming
  - Irrelevance of location
  - Testable interfaces

December 1992

**Basic technology changes that shape computing**

- Software becomes object oriented
  - Interface Definition Language makes system and application software modular, creating the first competitive market in systems components
- Object hierarchies allow world-wide development, but threaten dangerous complexity
- New languages bring new development power
  - Notation is everything, data structure shape thought

December 1992

**Object-Oriented Programming**

- Critical for distributed, parallel programming
- Critical for security
  - Encryption
  - Proveability based on strict interface definition
- Critical for management of millions of distributed objects
  - Distributed Object Management Facility: Object Request Broker
  - Federated Naming
  - Object definition

December 1992

**Object Management Group: 250 companies**

- IBM, Borland, Sun, HP, DEC, NCR, Fujitsu, Microsoft . .
- Sun/Hewlett-Packard joint project in 1989 Interface Definition Language [IDL]
- Technology base for compound documents, multimedia, and fault tolerant software
- Foundation for application development for next five years

December 1992

**Future of Operating Systems: Who will survive?**

- Windows NT Cutler brings VMS to Microsoft
- Solaris/Unix V 4
- OS/2 IBM will do anything to beat Microsoft
  - Wang
- Pink Only multithreaded environments will support objects effectively, and aid migration to multiprocessors
- AIX
- Univel
- DOS
- VMS
- MacOS
- OS/400
- VM/MVS
- NewtOS, EO
- Chorus

December 1992

**Future of computer systems: Who will survive?**

- |   |                  |
|---|------------------|
| • Intel P5 Pentium, P6 Hexium 80x86           | • Motorola 68000 |
| • SPARC IEEE 1754 V9-64bit                    | • Motorola 88000 |
| • IBM/Apple/Motorola Power PC 601 [- RS/6000] | • CRISP-Hobbit   |
| • Hewlett-Packard Precision Architecture      | • ARM 610        |
| • DEC Alpha                                   | • Transputer     |
| • AMD 29000                                   | • VAX            |
| • Intel i860/i960                             | • Clipper        |
| • Mips R4000                                  | • IBM 360        |
|   | • AS/400         |
|   | • Wang           |
- Ranked in decreasing probability of survival in volume production

**Can the machines keep up?**

- Clock speeds 200 to 400 Mhz CMOS
  - 1 Gighertz clocks speeds arriving soon
- Superpipelining, multiprocessing will yield multi-hundred MIP desktop machines soon, 1 GIP by 1997
- Software that builds hardware will allow us to move from 32 bits/ 1,000,000 transistors, or 0% utilization to 25% efficiency with an order of magnitude more transistors
- A computer to match your algorithm

December 1992

**Processor implications for networks**

- Any two machines will be able to saturate current networks (any networks)
- Massive computational power can attack previously uncrackable encryption schemes
- High bandwidth I/O channels will follow these processors

December 1992

**Basic technology changes that shape computing**

- Packaging moves to multichip modules
- Localized cooling speeds existing processes by factors of two to four

December 1992

**Basic technology changes that shape computing**

- Reallocation of broadcast and satellite spectrum from broadcast to personal communication services
  - Spectrum for movement, fiber for fixed location
- Breakup of the local telephone switch monopoly
  - Kazakhstan
  - ATT and McCaw Cellular: \$3.8 billion
  - MCI consortium national licenses
  - France Telecom

December 1992

**Basic technology changes that shape computing**

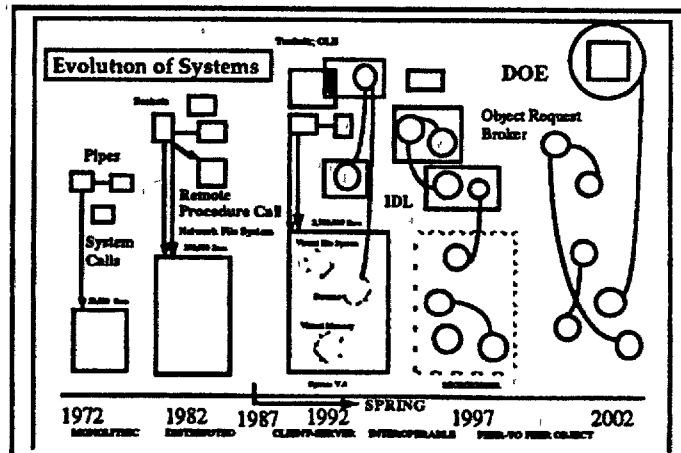
- Cheap energy storage devices (batteries, rotary), due to electric car investment to meet zero-emission regulations
- Portable displays with arbitrary resolution, approaching ease of use of paper
  - Cheap high-resolution image projection
- Universal character codes (Unicode, ISO 10646) allow multilingual reading, writing, publishing

December 1992

**Basic technology changes that shape computing**

- Nomadic machines emerge as the next major computer market
  - Merger of consumer electronics, networks, telephones, televisions, books, newspapers, magazines and data base
  - Digital Newspapers, Filofaxes, Stethoscopes, EKG, maps
- Nomadic connections to world-wide information and entertainment network use spread-spectrum, LOPS, IR, microcell, ATM
  - Networked retail transactions drive prices to the margin

December 1992



**Basic technology changes that shape computing**

- Major security problems, coupled with severe system breakdowns, will reveal vulnerability of today's computer systems
  - Washington DC telephone system, KDD, Pacific Fleet Command, TRW, DEC security codes
- Major threat serious virus among 80 million PC clones
- When software designs hardware, CAD files control the world

December 1992

**Basic technology changes that shape computing**

- Reversal of the 120-year process of elimination of privacy
- End-to-end encryption, using public key technology, alters publishing as we know it
  - Exact control of readership, based on secure key distribution
  - Authentication of text
  - Mechanism for coarse grained and fine grained copyright control

December 1992

**Basic technology changes that shape computing**

- Digital money becomes widespread, allowing anonymity and security for all transactions
- Digital signature becomes a tool to enable copyright

December 1992

**Basic technology changes that shape computing**

- Worldwide network of sensors will increase today's data volume by orders of magnitude
  - Surveillance of personal state heart, blood, brain
  - Surveillance of environmental state chlorine, carbon, heat
  - Community interactions made visible changes meaning of citizen and consumer
  - Making the invisible visible changes behavior

December 1992

**Making the personal computer more personal**

- Embedded sensors allow monitoring of bodily state
  - Cholesterol levels
  - Fibrillation onset
- Embedded neuronal monitors
  - Stanford Medical School
- Embedded neuronal stimulators
  - Minitel services roses made immanent

December 1992

**Making the personal computer more personal**

- Merger of organic chemistry, with self-organizing molecular structures, with semiconductor physics and technology, in nanostructure devices
  - DARPA
  - UC Berkeley
  - Harvard, Yale, Stanford, Los Alamos

December 1992

**Making the personal computer more personal**

- Environmental sensors allow monitoring of what affects us
  - Water, air, heat, radiation
  - Seismic: Pulsonic
  - Streets, electromagnetic spectrum, solids transport
  - Plutonium shipments
- Gore proposal to open intelligence agencies satellite data files
  - Crime of Reagan administration destroying a generation of remote sensing analysts by Landsat data prices

December 1992

**Basic technology changes that shape computing**

- New, sophisticated accounting systems will allow full costing of information systems
  - Cycle of materials
  - Cycle of energy use
  - Income accounts will include natural assets
- Networks and accounting systems will merge
  - Visualization of actual state of systems, not guesses

December 1992

**Making the personal computer more personal**

- All citizens will have access to information about changes affecting them, leading to a new politics of information technology
- Encryption-enabled privacy brings problems as well as solutions
  - Freedom of Information laws will change
  - Surveillance agencies will change their mission as well as their technology
- Universal digital access brings power
  - With ubiquity comes fragility

December 1992

**People's ideas of a computer have changed dramatically since 1980**

- We are all multilingual, with different vocabularies and grammars
- World yesterday separate PC, mini, mainframe, supercomputers
- World today networked services: client requests, server response
- World tomorrow peer-to-peer object interactions in world-wide persistent shared memory

December 1992

**Today's turmoil**

- Radical change in price/performance transforming industry
- Too many computer companies adding no value
- Mainframe computers in decline, proprietary minicomputers vanishing
- PC companies volume, but no margins, no market share, no profit -> Intel, Microsoft
- RISC workstations. the only high growth area, but for how long?
- What's next?

December 1992

**Beyond Industries to Economic Development**

- Creation of world-wide markets brings equality and diversity
- New technologies are democratic. everyone must learn
- New technologies flatten hierarchies, create independence, allow innovation at the margin
- Only investment in change will cause it to occur

1  
0  
7

December 1992



### Distributed Knowledge and new objects of knowledge

---

- Knowledge enables change, but does not cause it, it is up to us to create the proper social context
- Major economic shifts are here, our systems must not reject innovation
- Investment in infrastructure must look to future development, not to old technology
- A world-wide change in values is here, we can use it to draw generations and cultures together

December 1991

### In the last ten years...a vision of a powerful desktop environment emerged

---

- Dedicated to one person
- Power of a Cray
- Linked by networks to the world
- Graphic access to information, libraries

December 1991

### Technology Direction in the Early 1980's

---

- Set goal of MIPS = 2 (Year 1984) [15]
- Bet on the microprocessor
  - use 680X0 linear address space, move to RISC in 1983
- Use Portable Software Unix
- Assume Global Networking
- Assume cheaper memory would make graphics possible
- By the end of the decade, UNIX workstations were approaching the power of a "worldwide network of Cray-class machines with large-screen graphics"

December 1991

### Where did the energy go in the 1980's ?

---

- Volume development of one metaphor  
*The Computer is a Desktop*
  - Doug Engelbart 1968 IEEE/ACM Conference
  - Xerox PARC Alto 1974 Mouse, Keyboard, Bitmap, Icons, Drag and Drop, Select-Operate syntax
- Advanced development of a more specialized metaphor:  
*The Computer is pen and paper*
  - Ivan Sutherland 1963 Sketchpad
- Main changes: Performance, Weight, Cost

December 1991

### Embarrassments of the 1980's

---

- Security
  - No protection for memory in DOS PC's, Macintosh
  - Everyone in 1980 knew better
  - Not possible to stop a virus
- No memory greater than 640K bytes IBM
- No Networking
  - No network security
- One simple metaphor

December 1991

### Sea Change in the 1990's

---

- Emerging new metaphors. The computer is ....
  - Pen and Paper Portable pen-tops 100 million by 1996
    - Quaderno, Sharp/Apple, Sony, IBM, Matsushita, Thompson
  - A Telephone: Voice activated, voice recognizing devices
  - A Book, a Radio, a Television
  - A Meeting Room
  - An invisible apprentice Devices in desks, walls, appliances, books, calendars, vehicles

December 1991

**Sea Change in the 1990's**

---

- **New Metaphors** The computer is ..
  - **A Map** Spatial browsing
    - Flying over three dimensional representations of information
  - **A Friend, Guide** Annotating Reality
  - **A Playground.** Intuitive Physics forms the foundation for the interface
  - **A House, Café, Theater** explore shared space
  - **A different interface** for each person and each application

December 1992

**Where will the energy go in the 1990's?**

---

- **Explosion of new metaphors**
- **Security** end to end encryption
- **Development environments** for objects
- **New computing paradigms, new algorithm analysis**
- **Parallel computations, multiprocessors**
- **Convergence of Unix/Solaris, Pink, WindowsNT, OS/2, [DOS, MacOS, NewtOS] as conceptual platform**

December 1992

**Innovations in the 1990's**

---

- **Synchronous memory**
- **Multichip modules**
- **Object Technology**
- **Encryption**
- **Nomadic computing**
- **Map-based user interface**
- **New display techniques**
- **Dynamic documents**

December 1992

**Embarrassments of the 1990's**

---

- **Unix, Microsoft Windows NT, OS/2, Apple/IBM Pink; AIX, Univel**
  - Not secure, not real-time, not proveably correct, not easy to use or understand
  - All are large systems, written in C++
  - All are major projects, with great inertia
    - Impossible to make small improvements with small efforts
- **No openness to new ideas. lack of source code access**
- **Security: technical errors compounded by denial**

December 1992

**Basic technology changes that shape computing**

---

- **Emergence of universal 256-bit address space data storage**

December 1992

**Twenty years to make technology available from first working model**

---

- **Car is only one fourth of the invention**
  - Roads are one fourth
  - Gas stations, garages and hospitals are one fourth
  - Education, training, and the laws are one fourth

9  
6

December 1992

**Twenty years to make technology available from first working model**

---

- Writing technology requires.
  - Pens, brush, stylus
  - Wax, wood, clay, leaf, paper, codex, books, presses
  - Bookstores, kiosks, distribution
  - Cultural change schools, libraries, teachers

9  
7

December 1992

**Twenty years to make technology available from first working model**

---

- Electric motor for mass use washing machine
- Car
  - Airplane
- Radio
  - Television
- Telephone
  - Laser
- Microprocessor
  - Alto
- Digital switch
  - Fax

9  
8

December 1992

**Acceleration of change: five to ten years from model to deployment**

---

- Home video recorders
- CD-ROM
- ISDN, SONET, ATM
- Encryption and digital signatures
- Fiber-based sensors
- Object technology

9  
9

December 1992

**Each technology created massive industry, changed world economic order**

---

- Cause for the movement of the core of world economy from Europe to England to US to Japan
- Successive technologies turn services (expensive, no economy of scale) into mass-manufactured objects
- Computing differs it enters all technologies

1  
0  
0

December 1992

**Services become mass-manufactured objects**

---

- Home labor becomes appliances
- Horses become cars
- Town criers become newspapers
- Orchestras become CD's
- Meetings, markets, travel become telephones
- Paintings become books, films, which become MTV/CNN
- Manipulation of information becomes computing

1  
0  
1

December 1992

**Services become objects**

---

- The two largest governmental expenditures are just beginning to incorporate computing
  - Health services become portable monitoring systems
  - Education and training become interactive computing systems

1  
0  
2

December 1992

**Beyond Products to Industries**

---

- Now takes less than 20 years
- Requires investment in the infrastructure
- Must reach volume market to develop

1  
0  
5

December 1992

**Beyond Industries to World Economic  
Development**

---

- We need the participation of all creative people

December 1992

340

**Open Sources Seminar  
3 December 1992**

# FIRST INTERNATIONAL SYMPOSIUM: NATIONAL SECURITY & NATIONAL COMPETITIVENESS: OPEN SOURCE SOLUTIONS Proceedings, Volume II - Link Page

[Previous](#)      [Outline of a Global Knowledge Architecture: Visions and Possibilities for the Future](#)

[Next](#)      [Information Validation & Auditing](#)

[Return to Electronic Index Page](#)