The Vectors of Change

FACTORS	YEAR 1976	YEAR 1986	YEAR 1996	YEAR 2006
1. General Business Climate				
Freedom to innovate	Unlimited. Market opportunities in virtually all disciplines and topics.	Scientific and technical opportunities fade. Emphasis upon business information.	Business information becomes secondary to software to push or pull information to customer	Consumerized information. Follows laundry detergent model.
Marketing	Customer-initiated sales. Early adopters and pacesetters only.	Missionary marketing. Direct calls, direct mail, and trade shows. Fear-uncertainty-doubt so ld systems.	Direct calls for the largest customers. Use of consumer marketing techniques for other customers.	Brand and embedded in the delivery medium or device, global
Financing source	Government	Individuals	Venture firms	Largest organizations and individuals
Data base producers	Scientists or subject specialists with computer expertise	Subject specialists and entrepreneurs become a force in database publishing	Anyone with an idea and software knowledge can become a database publisher or information entrepreneur	Substantial barriers to entry exist.
Competitive arena	Collegial	Room-for-all approach	Competition emerges among large organizations	Competition routinized. Similar to major automobile companies' approach in 1996
Number of competitors in segment	Comparatively large number of competitors. Mostly large companies.	In each topic area, one dominate company with two smaller firms followed by a dozen rivals	A few firms are emerging as dominant. A proliferation of options from many different types of organizations.	Up to seven dominant brands at the top with thousands of competitors who struggle to survive
2. The Electronic information Environment				
Worldwide usage	Usage limited to a limited number of organizations and researchers	About 500,000 users worldwide	More than 30 million users worldwide	Within the educated segments of a population, almost total penetration

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Commercial online access to numeric data	Some large banks and brokerages experiment with online transactions	Almost 100% penetration of transaction-oriented financial institutions use proprietary services	Online access stimulates realignment of the global financial services segment; online an environmental factor	Financial services embedded in product and service delivery; financial services reshaped around microcase technology
Internet	Technology in experimental and developmental stage	Usage concentrated in universities. Hundreds of thousands of users worldwide.	Usage penetrates small business and professionals working at home. More than 30 million users in North America.	A medium, ubiquitous at a consumer level with more costly options for niche applications
Niche information	Produced by manual processes	Expensiveand limited to largest, most affluent organizations	Widely available for organizations of all sizes with specialized services like Pointcast & Backweb delivering individualized data to local desktops. Fees range from costly (Bloomberg) to free (Microsoft/NBC news).	Individual units of information are automatically aggregated by agents; niches and markets exist. Some for long periods of time; other for brief intervals. Highly fluid markets worldwide.
Commercial online access to text	Available on a limited basis to certain government contractors, academic institutions, and research laboratories	Limited to about 135 commercial online service providers in North America serving 500,000 customers	Commercial online is readily available. Wide array of Internet and other online services. More than 6 million users of for-fee online service	A few large distributors and aggregators; a multitude of small online services
Software innovations	Limited to specially trained engineers and scientists working in large organizations or formal research programs. Highly concentrated.	Specially trained engineers working in a large number of organizations. Entrepreneurial software companies become a major part of the development environment.	Software development driven by teams and individuals. Organizations of all types are significant factors.	Certain applications become programmable by most users. Advanced systems require specialized training and development environments. Widely dispersed.
Database development budget	Research and development funding	Individuals or far-sighted companies fund	Venture capital available	Funds not widely available unless for a breakthrough value-added product

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Pace of innovation	Slow. Driven by Department of Defense programs	Gaining speed. PC hardware and software arena active. Stagnant in mainframe and client server	Very rapid across all segments and product lines. Emergence of Internet time; that is, seven times faster than normal.	Flattening, slow down becomes a major economic threat; innovation focuses on consumer applications
Aggregators	Information gathered by associations, specialized reference publishers, and some small firms specializing in specific disciplines	Online publishing handled through established aggregators like UMI. Primary publishers lack market demand, so electronic distribution is a secondary concern.	Aggregators threatened by publishers who withhold electronic rights or take a more proactive role in aggregation.	Five or six major brands
3. Markets				
Markets	Limited to engineers and scientists able to program first commercial computing systems	Limited to individuals who receive specialized training. Penetration of most service businesses.	Any user with hardware and resources to pay various fees. Little or no training required.	Highly fragmented, transitory, and fluid. Not necessarily anchored to a place or product.
Library market	Established and easily reachable. Stable budgets. Growing interest in electronic information access.	Main source of revenue for full text providers. Starting to seek relief from cost of storage and shelving of books and serials. Budget pressure rises.	Slow growth or no growth market for many full text providers. Site license or tape lease sales can yield large orders but attract fierce competition from established aggregators. Cost justification necessary.	Exists but transformed into different types of services; the largest become for fee clearinghouses. Budgets unstable. Self-funded.
Fortune 1000 market	No online. Information obtained from personal contacts, printed material, and consultants.	Near 100 percent use of commercial online services. A handful of the largest online vendors' customers obtain direct licenses from aggregators to fix otherwise variable online costs.	Baseline use of commercial online services, usually with a flat fee for core suppliers. Intense comparison shopping for best deals.	Mix of information sources. Real time decisions about what to buy, where to buy, and how much to pay. New online services develop around situational purchases of data.

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Middle market ($100 million and above in revenue)	No use of electronic information.	Low levels of for-fee online usage but more use of intermediated services like Find/SVP (New York)	Direct use of Internet and low-cost online services or local service providers for electronic mail and online access.	Routine use of electronic information. Market is large because of the number of companies in it although individual company expenditures are lower than Fortune 1000 expenditures.
Small office, home office market	Non existent for all practical purposes.	Some technical and journalism professionals work from home offices. CompuServe Work at Home debuts.	Most rapidly growing business information market. Intuit has more than 3 million customers in the U.S. Internet usage is in the 10 million range.	Dominant business model for most knowledge workers: education, employment, contract work, education, employment, contract work, etc.
Professional (personal use)	None outside of academia and certain research environments	Limited to CompuServe and Bulletin Board Systems (BBS)	Usage in the 12 to 15 million range and rising. More than 20 percent penetration in affluent households with median incomes above $35,000 where a PC and modem are present.	Ubiquitous for those with resources.
Association market	Large associations used mainframes to manage dues and fund raising	Online limited to top 100 associations. PCs used to manage office tasks.	Almost 90 percent penetration of the top 5,000 associations. Savvy associations offer Internet presence to public and members.	Consolidation complete. Surviving trade and professional associations operate as for-profit entities or by government grant
4. Marketing Factors				
Customer's financing	Financed as capital investment. 5-year amortization.	Provided as part of the service	Scheduled payments	Microcash plus today's options

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Product types	Compilations. Electronic replicas of text reference books.	Full text and electronic reference books predominate	Multimedia and multiobject products readily available.	Software constructs for most applications.
Price sensitivity	None. Only the subsidized or cash rich organizations can afford.	Relatively insensitive but only those with sufficient resources can afford.	Very sensitive t price, although the combination of social pressure and price pressure broadens user base.	Highly sensitive, pay a premium for service and support
Ease of use	None. Command driven interface. Programming required for most interactions.	More important to newcomers to online	Products that do not conform to Windows are viewed as hard to use.	An appliance for mass markets. For specialized applications, still hard for non-specialists to use without training
Content and collection scope	None. Anything electronic was useful.	Important. Users could differentiate among products.	Perceived as important but price and timeliness more important	Defined by user. Answers more important than content. Cross language standard
Ability to customize for the customer's system environment	Highly customized because each system was built to deliver specific functions for a specific client.	Not available	Limited to the technically skilled or the organization able to afford Notes or a similar integration software	Built into the system; responds invisibly and automatically to user actions
Sales tactics	Direct sales emphasizing support and service, not price or quality.	Low key, relationship based	Aggressive selling using multiple avenues	Hyper aggressive marketing with advantages exploited by those with assets
Copyright	Applied to print. No strong movement to protect electronic information.	Important but not a critical issue	Very important. A critical issue. Digital equivalent of a chemical trace	Embedded via digital watermarks
Packaging	None, reels of tape	Plastic bags and boxes	Shrinkwrapped CD-ROMs	Consumer packaging None software downloaded

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Computer case	Separate steel cabinets. Design emulates refrigerators.	Desktop case in beige. Steel skin with lightweight interior components and shielding.	Plastic or composite for laptops. Desktop devices blend steel, plastic, and other materials for style.	Variety of case materials, including engineered materials for wearable computers. Styling, not functionality, becomes high value feature.
5. Computing Infrastructure				
Computing architecture	Mainframe, glass house	Mixed environment. Client server becomes available.	Client-server architecture introduces distributed mainframe concept	Environmental computing. Fully distributed. Wide range of system types available from most locations.
Hardware	Required special room, environmental controls, and staff.	An option (could be bundled with product)	User provides	Function embedded in a wide range of consumer devices from PDAs to wireless telephones to refrigerators
Software	Every program is unique. Very complex. Tailored to meet specific tasks. Integration and reuse almost impossible	Consumer and shrink-wrapped solutions emerge	More important than hardware. Visual programming tools. Modular programming predominates. Java becomes tool for supporting multiple platforms.	Software either highly customized for largest customers or embedded as standard feature of the product. Can be tailored by individuals with skills.
Operating system	Mainframe or minicomputer time sharing environment	Some PCs, many dumb terminals	Client-server with Windows interface	Windows and local compiling for user's computing environment
Network architecture	Proprietary	Proprietary with Novell as standard for business	TCP/IP emerges as standard	Open environment for low end applications; proprietary for high-end applications

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Network speed	56 kilobits for advanced applications. Higher speeds in research networks or on I inks between nodes.	Standard Ethernet (10 Mb/sec) and other proprietary architectures	Fast Ethernet or higher (100 Mb/ sec)	Gigabit speeds
Desktop performance	X terminals, character based	Less than one million instructions per second	More than 8 million instructions per second	Wide range of speeds available at competitive prices
Interface	Command driven, green letters on a black screen.	Proprietary in most instances. No standardization.	Common user interface. Becoming increasingly standardized to the Common User Interface or Internet browser model	User defined interface for interaction; for example, airplane cockpit. Default is an icon based interface.
Modem technology	Slow and expensive. Leased lines required for commercial applications. Teletype common.	Dial up 2400 and some 9600 available. Higher speed options include T 1 availability.	SONET and ATM available for high end applications. Dial up 56 kilobits announced.	Synchronous optical and gigabit wireless are within reach of small and mid-sized businesses
CPU	Proprietary, speed ratings not relevant in mainframe environment	Brands of CPUs emerge with speeds doubling and price halving every 12 months	Standard chips sets emerge for each major platform. Speed becomes a marketing device. Average Pentium more capable than 1976's most potent mainframe.	CPU dominated by a small number of companies. Optical computing devices available
Objects	Text only	Text and some image files	Multiobject files possible.	Multiple objects in multiple versions commonplace database application.

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6. Production or Information Manufacturing				
Production systems	Expensive and highly individualized.	Some off-the-shelf tools combined to meet a specific publishing requirement.	Windows based clients with more powerful servers.	Integrated environment based on Windows or user-defined interfaces.
Database production software	Built from scratch or heavily modified mainframe programs	Some commercial software with customized add-ons	Windows compatible software from Microsoft, Quark, Adobe and a handful of other companies	Standard function of any computer with an output port. Part of the operating system.
Database technology	Mainframe and proprietary. Flat file. Numbers and limited text.	Online is limited to text. Multiple flat files can be queried by commercial systems.	Multiobject architectures debut. Proprietary architectures and scripting languages necessary.	Multiobject DBMS standard; no practical limits on object size or location
Record volume	Limited by data entry systerns	Abstract and index volume per full time equivalent per day about 20-40	Automated full text systems generate as many as one thousand records per production employee per day.	Produces volume of tens of thousands of records per full time equivalent using various software tools.
7. Staffing				
Information managers	No formal position exists.	Librarians thrust into role of online arbitrator.	Information expertise, not formal training, becomes checkpoint for information management. People from different disciplines and job functions hold position.	Most staff are information centric. information positions proliferate. Many new job functions.
Staff	Engineers or professionals with specialized training.	Some on-the-job but most professionals have a degree in library, information, or computer science.	Experience and knowledge of new information technologies become more important.	Most staff are familiar with basic information technologies, regardless of training or academic discipline.

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Type of worker for database production jobs	Technical background, probably able to handle other computer related tasks	College education with computer experience	Ability to use system and create usable records Academic training not relevant.	Software assumes most functions. Value added products require a person with domain expertise.
8. Networks and Delivery Methods				
Internet	Limited to certain academic and research center staff	Most U.S. universities, research institutes, and government officials and contractors have access	Affluent, educated computer users and about 40 percent of U.S. businesses have access in some fashion	One of many network options. Access to high value networks requires permission or appropriate resource
Intranet	Proprietary internal networks only	Did not exist	More than 90 percent of Fortune 1000 companies operate Intranets for employee and contractor communication	Standard part of the organizational environment
Information delivery	Users interact with information through a multi-layered intermediated process	Pull model. A search must be conducted to retrieve information.	Pull model. Information flows to the person who a need or interest in a specific topic area.	Deals with companies integrating push technology into products may be necessary to get and keep market share
Distribution media	Magnetic tape and some punched cards	Online, some CD-ROM	Online, CD-ROM, facsimile	Wireless, other options available.
Printing technology	Impact line printing; output to commercial typesetting equipment in large organizations	Impact printing, some laser output. One color printing.	High speed laser output for office environments. Ink jet for small office and personal use. Four color printing devices available.	Four color, high speed lasers are standard

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Display of typeset full image page or page replica	Not possible	Microfilm and rasterizing Tagged Image File Format or Group IV facsimile images	Portable Document Format, Postscript, and Tagged Image File Format images. PDF option embedded in Ventura, FrameMaker, Pagemaker, and other commercial publishing tools	Page display standard emerges, probably Microsoft or Adobe as standard
Reports (output)	Green bar paper, row and column. Programming required.	Impact printing on office sized paper. Some formatting possible. Pre-defined report options available.	Pre-defined reports, pull down report tools widely available.	Reports are in the form of memoranda, dot point summaries, and graphs. Automatic generation.
CD-ROM	Laboratory experiment	Commercial products appear. Drives cost about $700.	Standard software distribution media. Personal ROM makers cost about $500.	Optical storage standard.
9. Human Factors				
Search-and-retrieval syntax	Laboratory demonstrations only	Command driven	No formal syntax required. Some natural language.	Spoken input for a handful of languages. Vocabulary constrained. Systems do not require training.
Voice input	Not available	Some commercial products and expanding research in the field	Available for popular personal computers.	Widespread commercial deployment.

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Portable computing	Laboratory demonstrations only	Portable computers debut. No practical battery option.	Business fashion accessory for most professionals. Battery life about 2.5 to 4 hours.	Wearable and embedded devices. Eight or more hours from batteries or equivalent.
Video	Graphics available on research workstations only. Graphics created with standard ASCII character set.	Charts and graphs and some images can be displayed on office computers with special video cards.	High resolution, accurate color monitors available. 21 inch monitors widely available for about $1,000	300 dot per inch resolution standard on engineered material flat panel displays.