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Extracting Highlights from the Worldwide Information Industry: A Management Perspective for Software Engineering

by

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Introduction

The purpose for this paper is two-fold. First, we would like to examine the Worldwide Information Industry (WII) with the view of looking into the underlying factors for software engineering purposes. Second, we would like to look at these major components in the underlying structure and extract WII highlights from a management perspective. Of course, the underlying rationale is to allow the reader the basis to be able to proceed (beyond this paper) to examine developments in software technology. This paper is designed to serve that purpose.

Of course, we are faced with restrictions of space in this paper when we set for ourselves the task of examining the $100 billion (USD) worldwide business which the Information Industry has now become. Fortunately, we can avail ourselves in this paper of a three-year study of the Information Silicon Rockies near Boulder, Colorado.

What do all these silicon patches and nests mean? Developments from these places continue to come out into the marketplace and help set the pace for *unrelenting changes* in hardware/software proportions in a computer mix. Software now accounts for the substantial proportion in computer budgets. If not software, something called peopleware – or both.

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This study gave special attention to the eighties and the previous decade. The joint authors each got into the computer field in the early sixties. We each average nearly twenty years in the computer areas. The commercial computer industry is barely thirty years old. Between the two of us joint authors, you got more than the usual experience by computer professionals. Yet the computer field has gone so far so fast especially in the past ten years, we both feel it is a continuing struggle just to keep up with what's going on.

Highlights from a Management Perspective

What can we say about the Information Industry especially in reference to the Eighties? Allow us to make twelve observations:

1. Breakthroughs in microprocessors during the last ten years have turned the computer world literally upside down. We are now in the era where software costs increasingly dominate our attention in the budgets for a computer mix.

2. Microprocessors, or the computer-on-a-chip devices, mean that computers are now not terribly expensive equipment anymore. We at Concord have examined the major breakthroughs in microelectronic technology during the past ten years. There were 22 major breakthroughs in the field of which sixteen were developed by one firm. No, not IBM. It is Intel which, as you know, is in California's Silicon Valley.

3. In the world today, there are silicon patches beyond that in California. There is Silicon Glen in Scotland, Silicon Island which is in Kyushu in Japan, and there is Silicon Beltway which is I-495 in Massachusetts. There is also a patch called Silicon Alps in Zurich, and the Silicon Prairie in Austin, Texas.

4. Key concepts in computer work have changed dramatically due to the availability of these not terribly expensive computers. About fifteen years ago, the era of big expensive computers was with us. There were hardly any minicomputers; there certainly were no microcomputers as yet. We can remember when centralized data processing was in vogue. The term, distributed data processing (or DDP), existed primarily in the research labs. So were terms like intelligent terminals, word processing, commercial satellite links, commercial computer networks.

What all of this means is simple. We believe we should be careful that the concepts we use today are attuned to *the technology setting* in the Information Industry. With all the changes we have seen the past twenty years, we need to be cautious about *even* the underlying theory. The computer field is one of the most dynamic and fast-changing industries. The Information Industry is the veritable Knowledge Industry. What is being mechanized are functions of the human mind itself. So we would say for purposes of designing an education

program in the computer field: beware the overemphasis on practice *and* beware the overemphasis on underlying theory – unless, of course, the curriculum is reviewed and updated every 3 to 5 years. Continually try to strike a balance between practice and theory. And above all, nurture a hunger for continuing the education which ought to be the responsibility of all those who graduate from computer education programs. We just cannot depend on habits from academia training alone to keep us on track in this knowledge-intensive field which is the Information Industry.

5. The advent of inexpensive computer equipment has led to explosive world-wide growth in computers. In the U.S., for example, the installed base for all sorts of computers from the very beginning of the computer age to December 1981 was 5 million units. This includes superduper units, mainframes, minis, superminis, microminis and microcomputers. Just one year later, by December 1982, it should be nearly double that number, or 9 million units. That means it took 29 of the first 30 years in the computer industry to a level of X, on the 30th year, it is to be at 2X.

That's for the U.S. A similar thing is happening throughout the world. Even in the Third World. In the Philippines for example, in the past three years especially, there has been an explosive growth in micros. Not only in Manila. But also in places like Baguio, Cebu, Bacolod, Iloilo and other parts of the country.

One of the co-authors remembers seeing a distinguished looking gentleman in a hotel lobby middle of last year in Cagayan de Oro carrying under his arm the *current* issue of one of the most popular microcomputer magazines. I asked him about it. He said that he was part of the local amateur radio group and they have been using micros partly as communications switches for their radio network.

So much for micros, for a while. What about the big computers? What about the so-called IBM compatible or *plug compatible manufacturers* or PCM's for short? As some of you know, the PCM segment of the computer industry was pioneered by Gene Amdahl who today has left Amdahl (the firm) and joined up with his son who, out of UC Berkeley just a few years ago, helped start up a rival PCM company called Magnuson. Both Amdahls (father and son) have just started yet another computer company.

6. The PCM segment of the Information Industry prospers, although recently with increasing difficulty, as IBM has pursued its aggressive hardware pricing strategy. Intel, for example has gone belly up and portions of it were absorbed by NAS. As we look at the rest of the Eighties, the PCM segment should continue to prosper, continuing to squeeze out the BUNCH (that spells B-U-N-C-H which stands for Burroughs, Univac, NCR, Control Data, Honeywell). There still is a very large investment by many very large users in their applications programs. This investment in applications software puts a strong floor for them to stay with IBM compatible equipment. Incidentally, the Japanese computer manufacturers (led by Fujitsu) are almost all using a

strategy of developing and supporting IBM compatible equipment. It is likely that IBM will continue to pursue an aggressive hardware pricing strategy; IBM is also likely to continue to attack software problems with hardware solutions with something called microcode. Attacking software problems with hardware solutions have been going on for several years now, and are likely to continue into the future.

7. Japan, as many of you know, is becoming a worldwide factor in the Information Industry. But there is not necessarily going to be a replay of Japan's relatively easy successes in automobiles, sound (stereo) equipment, cameras, motorcycles and copying machines. IBM simply is not the sort of company that plays dead. Incidentally, the Japanese have started to adopt a sort of slogan: Americans use cars instead of their feet, Japanese use computers instead of their heads.

8. Something is becoming widely understood in many parts of the world. And that is the high-tech, capital-intensive process of assembling and testing computer hardware except for gigantic ones like Cray Supercomputers from Chippewa Falls, Minnesota. Many entry firms have come on the scene both in the United States and overseas adding to competitive price pressures.

The French, for example, have pushed for what they call *informatique* and *telematique.* No less than the French government has led the drive for full participation by France in the Information Industry. For several years now, telephone customers in Brittany have not had to use telephone books; they use VDU's, that is, visual display units or computer terminals. One of the co-authors was in that part of France a little less than a year ago and he saw what the technology in those terminals were like. Using that same technology, today in the U.S. East Coast, a French firm has started marketing these intelligent terminals for about $100 each.

Another example. We don't need to remind the reader about the veritable flood of facsimile Apples all over Asia. The Apple facsimile from Taiwan made by Sunshine Computer is not the Apple but the Apolo; the Japanese Apple is nicknamed not so humorously, the Apor-ro. Still another example. It is not widely known that IBM Brazil assembles and ships mainframe computers to, of all places, IBM Japan. That's Brazil to, not from, Japan. There's also a Brazilian Apple; it is nicknamed the Ipanema Carioca.

9. There is yet another shift brought about by the changes wrought by microprocessors. It has shifted the *value added* in information processing. From hardware as you already know to marketing and the *packaged systems applications* side of the Information Industry business.

These packaged systems are probably going to have five characteristics *(powerful; low cost; programmerless or user friendly; highly reliable, easily maintainable; network-based).*

– *Powerful:* delivering up to 1 MIPS (or million instructions per second) for a professional work station, thus providing the increasingly highly

paid professional with all the computer horsepower necessary to get the job done in this increasingly competitive world.

– *Low Cost:* priced at between $100 to $150 per KIPS (kilo or thousand instructions per second) and thus providing the necessary cost justification, at least in the U.S., for furnishing most white collar and supervisory blue collar employees with a dedicated work station hooked up to a network within reach of massive computer facilities and databases. For the Third World, this lower cost might mean the dispersal of work stations on a less-than-widespread basis until such time as local manufacturing and assembly of computer equipment becomes reasonably widespread.

– *Programmerless or user friendly:* providing ease of use and access to computers in an era where, at least in the U.S., programmers are in short supply and are costly; user friendly means that the end user is not asked to program the system nor is the end user confronted with complex operating procedures when working on a computer system.

A co-author recently examined working models of programmerless systems which are clearly beyond the prototype stage. This particular example is called expert systems. Experts who need not know anything about a bit from a byte or other computerese terms but who know their field of expertise rather well, have been entering their experience, their know-how and judgment factors into computers at the Stanford University School of Medicine. Experts for instance, in tropical diseases, enter into the machine with the use of these programmerless packaged systems what they know about diagnosis and treatment of specific tropical diseases. The Stanford computers with these expert information become expert systems. These expert systems can then be used by non-experts for purposes of, well as you guessed it, diagnosis and test of tropical diseases. These expert systems work. They reflect a field in computers called artificial intelligence. Tests were conducted to rate these expert systems; they scored better in analysis and diagnosis of, say, tropical diseases than individual experts as well as non-experts. These programmerless packaged systems were so organized they pulled in the collective experiences of the leading experts in the field. These experts collectively beat out any one expert. What this means is that medical peer review is a good procedure like that of getting a second (expert's) opinion. And combined with computers, the practice becomes unbeatable if used properly. Computers are used as information engines which is what they ultimately are – not the high speed calculators some non-computer people think they *only* are. Yes, *information engines* are what computers really are. So software engineering really is part of *information engineering.*

– *Highly reliable, easily maintenable:* having an MTBF (mean time between failures) of one a year, and an MTTR (mean time to repair) of less than an hour if on-site maintenance is provided; of course, users will keep a spare on the premises, where possible, to avoid high cost, on-site repair service.

– *Network-based:* designing communications links into the local PABX

(private automatic branch exchange) network, or to a coaxial cable network like Ethernet or Wangnet, or to value-added public carriers like Tymnet or Telenet.

10. Microprocessors have shifted the *value added* in computers to the *packaged systems applications* side of the business; this has led to an explosion of what used to be called just the computer services business. The shift in *value added* in computers has led to an explosion in the growth of computer firms especially those with a sharp product-service focus and those with leadership founded in *firm purpose, clear concept* and *steadfast strategy*.

Concord, for about two years, conducted a far-ranging field survey of this services business. There are really very large companies in market segments of this computer services business. Independent package software houses like Cullinane – processing services such as Automatic Data Processing, Electronic Data Systems, Computer Sciences Corporation (or CSC). CSC alone has revenues of nearly $1 billion. The office automation field is led by Wang and Xerox. Intelligent networks are expanding with Satellite Business Systems (SBS, a joint venture by IBM, Aetna Insurance Group in Hartford, and Comsat). During the recent operational flight of the Columbia, the orbiting space shuttle, one of the two commercial satellites parked in space was a big one for SBS. CAD/CAM meaning computer-aided design/computer-aided manufacturing with a firm like Computervision. Factory automation using robotics is becoming popular with a firm like Unimation in Danbury, Connecticut.

Distributed data processing with companies like Paradyne and Datapoint. Point of sale (or POS) automation for supermarkets, the soft goods retail trade, discount chains as well as travel agencies, airline passenger counters, and the financial services sectors in insurance, banking and brokerage business. POS, by the way, also includes point-of-receipt automation. In banking, of couse, there is the much talked-about electronic funds transfer systems (or for short, EFTS).

11. EFTS is already known to individual customers in many parts of the world. ATM's (or automatic teller machines) provide 24-hour banking services and the field was led earlier by firms like Recognition Equipment and Diebold. Cash management accounts or CMA's was pioneered by Merrill Lynch which, as some of you know, was one of the early supporters of a debit card. You heard correctly, a debit not a credit card. Payrolls have in several parts of the world been conducted on an EFTS basis. In many parts of Europe, for example, the postal systems handle some EFTS functions within something called GIRO, spelled G-I-R-O.

EFTS means transactions handled by computers – payments or other money transmittals among financial institutions, individuals and business firms. Institutions supporting EFTS include banks of all types, savings and loan associations, credit unions, credit card services, travel and entertainment card companies, retailers. Also life insurance companies and brokerage houses. *Automated* clearing houses (or ACH's) and in the U.S., Federal Reserve bank districts in

10-12 regions in the U.S. alone. EFTS of course means hard-wired devices. ATM's with leading companies like NCR, Burroughs, IBM, Bunker-Ramo (which is now part of Allied Corporation). Electronic POS terminals with leading firms like Singer, NCR, General Instruments, IBM. Credit authorization inquiry and response terminals which really are POS terminals on line to computer systems by the banks and credit card companies – in this field, the leaders are TRW, Datatrol, IBM.

EFTS is not a magic wand. It grows because of the increasingly prohibitive costs in many parts of the world of handling transactions on a paper basis. EFTS grows because financial transactions have just grown astronomically in the past twenty years. Financial institutions were being buried in *paperwork,* what they call *back office problems.* Fortunately, microprocessors have come just in time. Hence the growth in EFTS computerization.

As you can imagine, EFTS transactions require very reliable computers. Pioneering in duplexed CPU's is Tandem which has just been represented in Manila, EFTS has grown quite fast in the U.S. No wonder Tandem is one of the faster-growing computer companies today.

There are constraints in the unrestricted growth of EFTS. Let's just mention a few, at least in the U.S. What is called *Regulation E* brought about by recent legislation provides customer protection against undue financial disclosure, unauthorized liability, pre-authorized transfers, resolution of errors, statutory damages and criminal liability. In the U.S., some states restrict off-premise terminals. The U.S. Supreme Court has ruled for example that retail point-of-sale machines are branches if they are used for deposits and withdrawals. Thus they must comply with banking restrictions within the state in which they are located.

The EFTS area has grown so fast, standards still lag in several categories. Let's just mention five areas. Consumer interface such as reports, transactions advice slips, others. Plastic cards themselves beyond size and physical composition. EFTS message formats. Even numbering systems. Communications protocols. In the U.S., the development and use of national standards is voluntary. Standards are worked by the American National Standards Institute (ANSI for short).

So much for eleven of the twelve observations in this paper. What's the last one? It's probably the most important one.

12. There is more than meets the eye when we point out something you already know. IBM dominates the Information Industry. Perhaps a lot of you already know major facets about IBM. It is worldwide. IBM, by the way, does not stand for the *Itsy Bitsy Machine* Corporation. Or, *I've Been Moved* Company, or It's *Better Manually* Company. Almost $40 billion in revenues, IBM has a workforce of nearly 400,000 people – it's a world by itself. It has dominant market share in almost any segment of the computer industry it decides to enter.

Actually, IBM is almost never the first to enter an industry segment. It was not first to get into computers. Univac did. Not first in minis; that was DEC (or Digital Equipment Corporation in Maynard, Massachusetts). Not first in office automation; that was Wang Laboratories. Not first in microcomputers commercially; that was Apple and Tandy Corporation with Radio Shack's TRS-80 micro. But IBM dominates. It is beyond the purview of this paper to look into what makes IBM tick and how it gets to dominate an industry market segment. What is germane to this paper is to look at the various parts of the Information Industry and lay down the groundwork to allow us in this paper to go beyond the usual.

This paper probes into what drives developments in the computer field especially in the software area. Microprocessors started it all, after mainframe computers and minis established the computer field to be fast growing. The EDP (Electronic Data Processing) terms during tab equipment (IBM 407) days gave way to MIS (Management Information Systems) concepts as computers moved from generation to generation into the *bewildering* proliferation that it is today.

IBM's System/360 computers in 1963-1964 started the so-called third generation in equipment. Then IBM's System/370 in 1970. Afterwards, IBM 303X processors with the original crispy and then midlife spicy flavors. Along the way, IBM's 4331 and 4341 processors. Also, the IBM 3081, the superduper version.

Just a little reading of *Relative Performance Ratings (RPR's)* for IBM processors during the past twenty years provides perspective. If the S/360 Model 50 was a *1.0*, then:

Relative Performance Ratings (RPR's) with IBM 360/50 = 1.0

	IBM 3031(3032)
IBM 4331	IBM 3033
IBM 4341	IBM 3081

If today you hear about an IBM 3081 installation, just one – that's equivalent to 50 during IBM S/360 days. In 1965, one of us was on the computer faculty of the oldest engineering school in the English-speaking world. We had a 50. And it filled a good part of the floor which used to be the church in a monastery. One of us can remember doing a lot of praying there during those years. Now we'd need 50 of those monastic churches for a 3081 if technology did not change.

But the dramatic story is in the downward prices for these mainframes over the past twenty years.

System/360 purchase prices in the mid-Sixties ranged from about $1 to $10 million. That old engineering school, by the way, got its 50 with two 50

per cent discounts. And the machine was sold by T. J. Watson, Jr. himself!

Just about five years after, the System/360, System/370, for comparable computing power was at half the System/360 prices – starting at $0.5 million and up.

For IBM 4331 and IBM 4341: the range – again for comparable computing power – is almost 1/10 of System/360 purchase prices beginning at a little over $100,000 to $500,000.

Purchase prices for IBM 3031 is between $500,000 to $800,000; IBM 3032, $1.0 to $1.5 million; IBM 3033, $1.0 to $2.8 million; IBM 3081, $3.8 to $5.0 million – about 1/5 or 1/10 of System/360 prices.

If you plot the RPR's and purchase prices on log-log paper with scale of $10 million at the upright scale *equal* to the bottom scale with RPR value of 1,000, you can see a family of parallel lines at about 40^{o} from the horizontal. There would be four top slices, a gap, then a bottom fifth slice. The top four slices would be, respectively, original S/360, original S/370, original 303X, midlife 303X. The gap would be the pricing skip when IBM lowered the boom in hardware pricing. The bottom fifth slice is the current technology (the 4300 series).

If what's happened in computer equipment prices happened to cars, a Mercedes Benz which in 1965 cost $5,000 (that's for a 200) – would today cost $1,000.

By the way, as you can gather from these remarks, IBM is the price leader in the industry. For several years through the Sixties and Seventies, they held a price umbrella under which competitors could take shelter and prosper. Some of them even became fat cats. You know: fat, dumb and happy . . . until one day a few years ago, IBM lowered prices substantially like by 30 to 40% in some instances, say, for their 303X line. Competitors especially the PCM's struggled for survival. That's when some fat cats went belly up. We should not mention them by name lest our remarks disturb the peaceful dead. Let's just pray that their computer souls rest in peace.