INCIDENTAL PAPER

Growing Up With the Information Age

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John LeGates began his career as an entrepreneur in the earliest days of computer communications and networking. He was the first to put computers in schools and later in hospitals. He built the first academic computer-resource-sharing network and was a member of the Arpanet NWG, the original Internet design team. Since 1973 he has been a member of the Harvard faculty, where he co-founded the Program on Information Resources Policy.

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NOTES ON GROWING UP WITH THE INFORMATION AGE

John C. B. LeGates

WHAT IS THIS DOCUMENT?

In 1997 I was approached by a writer for The New Yorker magazine, who asked if they could do a "life and times" article about me. It would be the feature article in one of their issues - a minimum of twenty pages. Alternatively it might be longer, and be serialized over several issues. The interest in me came from my (perceived) role at Harvard as the ultimate insider in the evolution of the information age - someone who worked with and understood most of the major players. Before Harvard, I had been an entrepreneur in computer networking, and was a pioneer in some of its most visible applications.

He and I agreed that the main weakness of this idea was the high level of confidentiality of my relationships. I had kept secrets at the time, and I intended to keep them now - I would not write a "tell all" story. Going by those rules, I prepared this piece. The intended audience is the writer who would prepare the article(s). My notes are therefore hopelessly egocentric, completely unpolished and entirely unedited. They are a kind of “career and times” biography of me, a review of the evolution of the information world as I participated in it, and a partial history of the Program on Information Resources Policy at Harvard.

As a history of the Harvard Program, it is only a sample. It covers the revolution in telephony and computer communications from 1973-1997, principally in the United States. Comparable stories could be told of the Program’s involvement with media, postal services, intelligence, the military, information services and related phenomena from 1973 until 2011.

In 1998 Tina Brown resigned as editor of The New Yorker, and the interest in me disappeared as well. These notes end with that date.

Computers in Education 1965 – 1967
I am 24

The great changes in “The Information Age” began before I went to work, and they didn’t end when I retired. But my career saw transformational growth both in the way the information world worked, and the way it affected the entire world. I saw the transformation from “The Industrial Age” to “The Information Age”. I played a role myself in making all this happen, and was in a good position to witness what was going on.

In the early sixties, the “Information Age” meant the “computer age”. “Computer” meant what we now call “mainframe”. The vacuum tubes were gone and machines were transistor-based. But they were big, expensive, hard-to-use, esoteric machines. If you wanted to use one, you learned a

programming language and spent endless hours punching your instructions on Hollerith cards. Then you applied humbly to the priesthood who ran the machine, took your place in line, and waited while your job went through. The machine would do only one job at a time and gave you no feedback along the way. If you did everything right, you got your results. If not - better luck next time.

Then came one of the milestone innovations - time sharing. “Time sharing” was not a real-estate concept, but a new layer on the operating system combined with a new generation of input/output devices. It began the democratization of computing. Several people could simultaneously use a machine, each appearing to have it to himself. At the same time a number of “high-level application languages” sprung up which were far easier to learn and use than the incumbent “machine languages”. For the first time a user with limited computer skills could control an operation and even interact with the computer in real time and get error messages and intermediate results. Simple modems appeared, and the user could stay at home or the office. Remote personal computing was now possible using a terminal that looked like an ordinary typewriter. Time sharing was the first form of computer communications and networking - nothing more refined than having a terminal that could access a computer that wasn’t in the same room you were. At the time that I started, the number of simultaneous terminals - the new world standard - had just increased from four to eight.

Time sharing was developed together by MIT and a small Cambridge consulting company named Bolt, Beranek and Newman, Inc. (BBN). MIT, a non-profit educational institution, promptly decided to make money off the invention. BBN, a for-profit corporation decided to explore how it could be used to help the education process. Someone on the search committee knew me and I got the job.

BBN had been founded in 1953 by three MIT professors as a consulting company in acoustics. In the early days an employee named J.C.R Licklider had a request for management. It went something like this:

“Buy me a computer”.

“What will you do with it”?

“I don’t know”.

“Do you know how to work one”?

“No”.

“Do you know what it has to do with your work here”?

“No”.

"Why do you want one"?

"Because it's the tool of the future"

They bought it.

Licklider went on to found computer science at MIT and become the central figure there for a whole generation. BBN went on to become a hotbed of computer innovation. It probably shares with Xerox PARC and Bell Labs the record for the most significant innovations in computer history - and a comparable reputation for failing to capitalize on them. While I was there it came to be called "Cambridge's third university". Bright people from all fields gravitated to it when their ideas didn't fit anywhere else. I remember being impressed with the originality and productivity of these individuals. It was entrepreneur-nerd culture long before the words became popular. It was a "we are the smartest people and we are transforming the world with our ideas. There are no rules but those we make" culture. It was perhaps arrogant. It was in any case a very enjoyable environment for me.

Computer science didn't exist yet as a field. Many people came from electrical engineering or applied math, but some of the best came from English literature, art history, philosophy and anywhere else. Richard Bolt, the Chairman always regarded himself as an artist (painting and music composition) first and a physicist almost by accident. The first person to be granted a computer science degree by Stanford, Alexander McKenzie III, showed up at BBN, but that was a little later. He was, it happens, an old friend of mine from New Hampshire. His father had personally measured the highest wind ever known on earth on top of Mount Washington.

If there was a category of person within this melange, it was the MIT dropout. MIT was a high-pressure grind with a very heavy reliance on numerical techniques, and (at least compared to Harvard) a very rigid curriculum. Undergraduates were selected pretty much by quantitative aptitude and achievement test scores. People who developed other interests often left. They were bright, full of ideas and inexpensive to hire.

I was vastly less impressed with the bureaucracies that grew when research ideas succeeded and got government grants. These bureaucracies would then turn into grant-searching engines, painting themselves whatever color the money seemed to be looking for.

Despite my youth and inexperience, I had a free hand. I wasn't so much exploring new territory as creating it. I was handed some computer time and connection ports, a language (Telcomp, a member of the JOSS family and I believe written by BBN), some terminals - the legendary and legendarily unreliable Teletype ASR 33 - and a vague mandate to the effect of "go see what this can do for education; and try to make some money if you can". No one had ever tried this before and there were no guidelines.

There were related notions cooking within the company that I could take or leave, depending on

how it was all going. Wallace Feurzeig was running a project on basic learning, which included Seymour Papert and the development of the "Logo" language. Paul Castleman headed a group researching the use of computers in medicine.

I didn't like the word "terminal", which I thought could make computing sound like a serious disease. Since we seemed to be making everything up, including the terminology, I lobbied instead for "station". But I was overruled by the hardware people. It was my first experience of the product reflecting the mind set of the supplier rather than the intended user.

I had to make some decisions pretty fast. Within the first week I shaped the assignment to mean:

> Computers in educational institutions.
>
> At the high school and college levels.
>
> Dealing principally with science and math.
>
> Both to use in teaching science and math, and as a tool for scientists and mathematicians.
>
> Beginning in New England, and especially in the Greater Boston area.
>
> And scrounging resources (telephone lines, applications programs, documentation help etc) for free whenever possible.

I published a price list and started selling.

Two years later I was still a one-man department, but I had grown a gratifying little empire. It was decentralized like the Holy Roman Empire; perhaps I could better compare it to a big jazz band. Everyone improvised, but I got to call the tunes.

We had about 75% of all the schools in the world that were using computers connected to us - and even paying for the privilege. We had produced a substantial body of teaching and applications software, which was being widely published and shared. We produced courses not only in the use of computers, but also in the use of computers in math and science, and in the use of computers in the teaching of math and science. Students and teachers - at least some of them - seemed to love it and benefit by it. We had evaluation projects underway to see if any of this made a difference. There were beginning to be serious grants at the federal level to develop and evaluate the field. Massachusetts had assigned an Assistant Commissioner of Education to spend two years at BBN and decide whether we should be the model for a statewide initiative. There was a parallel effort in BBN to sell Telcomp connection to the business world and develop a major profit center. We were starting to be visible, not only regionally, but nationally. I had personally done the first stages of all of these activitires, but others quickly took up my initiatives and ran with them. I became a kind of initiator, encourager and organizer for the

whole field.

There were two aspects of our innovation that seemed especially promising.

One was the motivational force of the computer. Students got very excited about it. Anecdotes poured in about kids giving up playtime to get their chance at the terminal. Kids who had never shown an interest in science suddenly came to life and did well. Kids would come into the school at midnight to use the terminal if someone would let them in. Was it the novelty "gadget" syndrome? Was it the non-personal, non-judgmental nature of the machine? Were kids somehow wired to love information technology? It was too early to tell.

The other was that it introduced a kind of thinking that was otherwise absent from the traditional curriculum. We called it "iterative logic". Wally Feurzeig told a cute story on himself. He asked a class of fourth graders what held the world up. "It rests on the back of a giant turtle". "Very good, and can anyone tell me what holds the turtle up?" Same kid: "another turtle". Wally was getting excited - it looked like a breakthrough in iterative logic. "Can anyone tell me what holds up that second turtle?" The same boy stood up: "Listen, mister, I'll tell you the whole story. It's turtles all the way down."

During the Watergate crisis, Dr. Bolt, the Chairman, was chosen to head the panel on the Nixon White House tapes - the famous 18 ½ minute gap. He reported that the tape had unquestionably been altered. The White House representative rose and demanded "we insist on an evaluation by OUR people." Bolt calmly responded, "we thought we were your people." There were no further objections. His ability and integrity were beyond question. I have always believed that his humanity, endless good will, and enthusiasm were the real cause of BBN's particular kind of flowering. Over time, we became close friends.

I became very visible, not just to my cohorts but with the public. I bought some blue shirts because white shirts were too bright for television. The notion that computers were coming was permeating America at the time. But the notion that it was coming to your school stirred up a new level of attention. How can I get in on it? What will it do for (or to) my child? This is important, but is it real? Will it break the unions? Will it slice the budget? Can we dispense with buildings and learn at home without teachers? Will a computer-delivered curriculum mean that we're only taught by the best teachers? Will we all have the same curriculum nationwide? Will all students in ten years achieve at the level of the best students now? This was kid-philosopher heaven.

Oddly enough I was a booster of what I was doing as a trial, but not as an outcome. I doubted that this would bust the unions, eliminate the bricks and mortar and make teaching something we only did at home. What's more, I was leery of prophecy in general. The debate was fun and important, but I didn't see it as a tool for discovering where we would all go. That I argued, we would know if we ever got there.

I remember one conference at which I was only an attendee, but not a speaker. A young Harvard Professor named Anthony G. Oettinger began his remarks “The reason society has tenured positions at major universities is so that the holders of those positions can stand opposed to the trend and tell it like it really is”. He proceeded to demolish everything every other panelist was saying. He was almost completely ignored.

Two encounters with other worlds impressed me with a “we/they” difference:

One was the aforementioned Massachusetts Undersecretary of Education. He and I wound up spending many hours together, usually giving presentations to large groups in public colleges. He was a man with an undeniable affability and good nature. His role evolved into making a few introductory remarks about how Massachusetts was in the lead in this exciting endeavor. Then I would give the substantive presentation and answer all the questions. It slowly dawned on me that he couldn’t have done it. He didn’t understand a thing - about computers, research, education - not a clue.

But he took me under his wing and gave counsel and advice, for example on reimbursement for travel expenses. “You can charge the maximum for meals, even if you don’t spend it. Put the difference in your pocket. After all, you’re entitled to it.” I never knew if he was at BBN because he was the outstanding thinker in the Mass. Department of Education, if he was there on exile because he was hopeless, or if it was just random.

When I first met the Commissioner of Education for New Hampshire I set out to break the ice by mentioning my relationship with his Massachusetts counterpart. After my first sentence, an instinctive repugnance took over his countenance. “We don’t do things here the way they do them in Massachusetts.” I had insulted him.

Another encounter was the experience of offering identical courses to two different groups. One was students at Lexington High School, the other was math faculty at Massachusetts State Colleges (most of whom held Ph.D.’s from similar institutions). The Lexington students learned the subject, and then took it over and innovated. The college faculty could never grasp the rudiments, even by the end of the course. Was it the difference in age - or worlds with different standards?

This promising beginning looked like the explosive start of a new way of doing things, which would of course mean profits for the business and a career for me. But there was something else going on as well. Telcomp was losing a standards war.

We got started first, but a similar effort soon started up at Dartmouth. John Kemeny, head of the math department had a vision similar to ours. But he had what turned out in hindsight to be some key advantages. One was his prompt promotion to President of the University. Another was the competence of Tom Kurtz, the man who became head of the computer center - forming a team. This meant a top politician, a seasoned executive, a substantial budget, and a “captive”

university. But more important, they were using a computer language (BASIC) with the backing of a major computer manufacturer, General Electric. No comparison showed that BASIC was better than Telcomp - quite the reverse. But GE had worldwide sales capability, and slaughtered BBN in the commercial markets. That gave BASIC the critical mass in written applications, and the handwriting was on the wall. We education people were essentially a bump on the elephant of the commercial world. If Digital Equipment Corporation (DEC), who supplied our hardware, had adopted Telcomp; if our Mass Department of Education man had been a Kemeny; if I had been sensitive to the larger political and business dimensions of growth, perhaps it would have come out differently. But we were beginning to lose clients because we didn't run in BASIC.

Regardless of who succeeded and who failed, computers-in-education was off and running, and would move without me. I was approached by a former BBNer who dangled a good salary and an exciting new challenge. I took it.

Thirty years have passed (to 1998), and where are we?

In the secondary schools computers are in a quarter of the classrooms, mostly to teach about computers. The unions haven't been busted, the bricks and mortar are still there and curricula are swinging back to the traditional subjects and methods after a movement driven by "liberal thinking" and not by technological innovation. Scholastic achievement is no higher than it was in the sixties; in fact it appears to be lower. We have at this very moment another unfunded national initiative to "revolutionize education" through the wonders of the information revolution. Professor Oettinger was closer to right than the others on his panel.

Higher education is centered on the disciplines. Computing has profoundly penetrated most disciplines, largely as a tool. As such the tool is taught along with the other tools of the discipline. The changes in the disciplines have driven the changes in teaching, and not the other way around, and in that sense computers have gotten into education backwards.

Hospital Information Systems 1967-1969

"MBH (Man's Best Hospital)" or "The competing WASP establishment across town" is what Samuel Shem called it in his cult classic House of God (meaning Beth Israel Hospital). Regardless of moniker, Massachusetts General Hospital in the late sixties was the flagship of the Harvard Medical School hospital system, a major medical research center, the site of the invention of anesthesia, and one of only a handful of 1000+ bed hospitals in the country. It was and is a "tertiary care" hospital, meaning that you go to your doctor, who sends you to his local hospital, and if they can't handle you, they send you to MGH or its counterparts. MGH patients have included a contingent of kings, sheiks and tycoons who could afford and only wanted "the best". It also routinely has the most difficult cases referred from around the world. Nonetheless 97 percent of patients admitted are discharged alive. The rest left via a quiet back door labeled "deliveries" (not unlike the department in which some of them were born).

By the late sixties there were already a number of experiments, startups and research projects poking around in “computers in medicine”. Indeed, one of the best known was at MGH under the management of Doctor Octo Barnett. However when MGH decided to implement the world’s first hospital integrated information system, it opted for a fresh start built on a non-medical background. It selected Washington Engineering Services Co. (WESCO), whose reputation was built on a massive piece of software called NPQ. NPQ maintained a relational database of naval ships. If you wanted to change something on a US Navy ship, NPQ told you what other parts would be affected, and how. From a logical point of view, it seemed as good a choice as any. Once again I was doing something never done before and there were no guidelines.

WESCO set up an office ten minutes walk from the hospital and hired a small but strong team, which included the chief designer of the SAGE system. MGH itself assigned about 30 of its own people to work with us. The grand plan was to start with tracking patients, rooms and beds; and then expand incrementally into medical record tracking, medical record content, pharmacy, laboratory, blood bank, billing and accounting. It was an administrative system in a medical environment. There was no plan to be involved in medicine itself, except as support.

I was initially in charge of man/machine interface, but quickly evolved to be overall technical director, and then in charge of the whole project, reporting to the head of the Cambridge operation. Then as the company grew I also headed the marketing effort and was #2 in the company.

Why did I rise so quickly and find myself in charge of people who had so recently been my peers? It was certainly not because I could do overall systems design, or write software, or other technical tasks better than they, or even as well. In retrospect I think it was my ability to communicate with all parties. I could understand and speak the language both of the users and of the technical people who were trying to design something for them.

We chose the then-brand-new IBM 360-40 as the mainframe computer. In those days computer systems were notoriously unreliable, and it was customary to minimize risk by building a whole system from components of the same maker. Ours, however, was too diverse, and we opted for terminals from Sanders, software by ourselves and so on.

IBM was already by far the biggest player in the computer business, and in the eyes of the public almost synonymous with it. When doing my public appearances for BBN, I was often introduced as “The IBM man”. The company was enjoying some unusual advantages.

Because of the risky nature of any computer installation, the manager in charge could expect trouble. There was a built-in need for ass-covering. One way to do it was to buy IBM. “It wasn’t my fault, I bought the best-known product, and even it failed”. IBM could also use technical standards as an anti-competitive tool, and became almost synonymous with this technique.

There was considerable debate as to how IBM had gotten to this formidable position. It hadn’t

been first in the market. Univac and Sperry, now long gone, were ahead of it. Nor did it bring the biggest company to the computer business. G.E., for example was bigger. Nor did it have the best technology. Experts almost uniformly agreed that others were better. BBN, for example preferred DEC hardware. The usual explanation was that the pioneers were thinking like technology companies, whereas IBM was basically a marketing company. And as a marketing company it had done a lot of things the customer needed in the shaky early computer days. It offered software bundled into the hardware, good customer support, and end-to-end service. It was also widely agreed that the big diversified companies who had moved into computers - GE, Honeywell, Exxon - never understood how computers differed from other products.

The 360 series, however, was to elevate IBM to even grander heights and give it yet another advantage. The 360 was the first modular mainframe. As your needs grew, it would grow too, without obsoleting your investment. It was also technologically in the league with the best. By the time the 360 was retired, IBM was four times as big as the rest of the industry put together. IBM's R&D budget was greater than the combined gross revenues of all the computer manufacturers in Europe. IBM could now keep ahead of the industry by staying ahead technologically.

"Computer networking" had now progressed. Conceptually it still meant "access by remote terminal to a mainframe computer". But the whole thing worked pretty well, and the number of connections was up in the thirties (off-the-shelf), and approaching one hundred (the cutting edge).

Our grand plan for each application had four stages. First, understand the current information flow. Second, rationalize it. Third, automate it. Fourth, hand it over to the hospital as a turnkey system. We had built fudge factors into the budget for fixing computers that didn't work, for training computer-illiterate hospital people, for doing things twice and various other presumptions of uncertainty.

MGH admitted about 100 new patients a day, and had half that many internal transfers. Matching a patient with a room included matching him or her to the right level of luxury payment (a single, a quad etc), the right disease type (infectious respiratory, psychiatric etc.), the right level of care (intensive, pre-operative, long-term etc.), and other requirements. For each admission, there was a form with information about the patient. It had an astonishing 92 information fields, including food allergies, religion and mother's maiden name. It went to dozens of places, including the medical records room and the laundry.

Even simple identification of a patient could be a problem. Boston has had strong immigration from Ireland. "Sullivan" was the most common name in MGH's medical records. There were 30,000 "John Sullivans" down there.

The information flow was not only complex, it was also full of bugs and glitches, some of them potentially life-threatening. A recent internal sample had suggested that almost half of all

laboratory reports were erroneous (wrong patient, wrong thing measured, wrong number copied down, sent to the wrong place etc.).

Our project fell behind schedule almost from the beginning. We would interview people about what they did, write it up and hand it to them for review. Their response: “Oh, it’s not at all like that.” Then we would find the sender of information disagreeing with the receiver about what was transferred. Then we found that what we had measured was the formal flow of information. But there was a whole separate informal flow that people couldn’t articulate. Then we discovered people lying about what they did in order to protect their turf.

All these problems were as nothing compared with the resistance to “rationalizing” the information flow. We were destabilizing the ways things were done, many of which had evolved rather than being assigned, were dependent on personalities or crossed department lines. People had to ask their boss what to do about our innovations. Bosses had to ask bosses. A few years later, when hospital management information system development was widespread, a study showed that 60 per cent of information entered into some systems were deliberate lies.

And of course the equipment didn’t work as advertised. Because we were using equipment from different manufacturers, we had to connect them using interface specs. These in turn proved to be inaccurately documented, or got changed without notice when products were updated.

A year into the project, the first functions were somehow starting to work. But we were way off schedule because we were way off course. The hospital meetings had escalated into a weekly hour with the head of the hospital and his direct reports. They were rethinking the whole management structure of the place. Our project had caused them to go back to basics - or more precisely - examine the basics for the first time.

Meanwhile we were also having fix-it meetings with our vendors, mostly IBM. We would produce long lists of things that didn’t work as documented. They would look sheepish and set off to fix them, in many case product-line wide. During the course of our work there was a landmark case (not with us) in which IBM was held not liable for damages caused by its systems not doing what they were claimed to do. The reason: computer systems and manufacturers were presumed not to perform as claimed, and it was a “caveat emptor” market. A joke of the period asked what the IBM salesman did on his wedding night. Answer: spent it talking about how great it was going to be.

There were, of course, recriminations and finger-pointings, including at us. We, after all, were also not delivering as promised. But most of the grousing was at lower levels and didn’t hurt the big picture. Overall the quality of our high-level interactions was superb. The hospital recognized that they were into something bigger than expected and of real value. IBM saw us as the prestige contract that could open a huge market, and made commitments to us at very high levels. They always tried hard to make sure that nobody felt embarrassed, and delivered the fixes and patches we needed. They often became the fall guy, since theirs was the simplest thing that

wasn’t working, and they always took it like gentlemen (I remember no women on the IBM teams). The stresses of other early major development efforts were usually far worse than ours.

We had no way to know it, but we were at the leading edge of many intersecting confusions. Collectively they added up to the turmoil of computers hitting management reality.

Part of the problem was, had been and has continued to be C.P. Snow's "two worlds". Computer people come with a deeply-ingrained scientific mind set. They expect things to function in a structured, articulable, way with an optimal solution (or solutions). Managers, by contrast, need flexibility, secrets, personalities, invisible substructures.

Computer people differ from other scientists in that they expect their product to be full of bugs, and constantly under revision. Managers need stability, and helpers (including machines) that do what they say they will.

There has remained a mutual distrust. Computer people often look down on managers as unable or unwilling to learn computer language and logical thinking; also as inflexible for failing to adopt innovations as quickly as they appear. They feel that they have to do the managers' work for them. A more subtle form of this attitude is the periodic berating of customers by computer people for failing to take advantage of the latest technology. Rob Wilmot, Chairman of ICL (The leading British computer manufacturer) spent a year touring Europe with charts showing how little of the available computing power users actually used, and urging them to shape up. The managers' counterpart feeling is that the techies don't understand the basics of the business and refuse to translate their offerings into English. Their gadgets need to be fixed before they work right even the first time. They want to redesign them before they've built them.

Another fundamental hardship is that the introduction of computers requires a top-to-bottom rethink of procedures that are being computerized. The procedures usually weren't thought through in the first place - they more likely evolved. The automation demands a what-is-this-really-about, back-to-basics examination.

And that examination usually winds up challenging the corporate knowledge that has become embedded in the organizational structure. Departmental functions change and lines get redrawn.

And that in turn means that people lose and gain influence, stability, corporate hiding places and career paths.

Which in turn invokes sabotage, hidden agendas, and all the other species of political infighting.

A joke of the era laid out the schedule for a computer development thus: 1: order the computer, 2: redesign your processes for it, 3: cancel the order.

Schools of thought and commercial empires have risen and fallen as the world learned all this,

and eventually learned to articulate and cope with it. For us, it was all pioneering. On balance, our experience was much better than most of the large development projects in the next decade. Both we and MGH looked for the value and not the blame.

Eighteen months was a major benchmark for the project. We had delivered perhaps 10% of the original schedule, but had explored lots of territory neither side had even imagined. MGH renewed, increased, and greatly expanded the scope of our contract. WESCO spotted a trend and made a critical business decision.

Founding Companies 1969-1972

A new formula for success was starting to make waves in the business world. “Found a new company and grow it with a new technology or market niche. Own equity. Sell it. Be rich”. The era of the startup and venture capital had been around for a while, but it was starting to roll.

Meanwhile my own curiosity was pushing me towards a new realm. I had started as a child scientist and turned into a young philosopher. I had selected a career. I had a pretty good grasp of how “thinking technology” functioned, and was getting a handle on the behavior of management structures. Each step seemed to me just a more mature level of the same inquiring instinct - I wanted to understand how things work. Now I was ready to explore the whole life cycle of organizations. It was time to found a company.

We spun off the Cambridge office of WESCO as Cambridge Information Systems (CIS). WESCO kept much of the stock, and we raised a chunk of new money from venture sources. The Cambridge head became CEO, his first such position. I was #2 (EVP) in charge of the MGH project, and the company’s technical and marketing efforts. I had stock options that would mature with continued employment.

Our work with MGH was being billed as “time and materials” consulting, and was profitable for us. However we aimed to develop hospital management modules, which we could resell as proprietary products, with additional tailoring and training as a time-and-materials service. We would have better margins than consulting provides.

I launched a local marketing effort, which brought in another contract, Boston City Hospital. Meanwhile, as part of the MGH medical records project, we had attacked the automation of cataloging, taking out, and refiling some three million documents. We developed one of the first bar-code readers. We launched a separate effort to develop and market it as an independent product line.

Boston City Hospital was another very large hospital. The City ran it, but in conjunction with all three Massachusetts medical schools. Harvard, Tufts and Boston University, used it as a teaching facility. It was said that the emergency ward provided the best crisis-care experience this side of

Vietnam. They needed to upgrade the medical records system, and then move on to rebuild other systems.

"Upgrade the medical records system" sounded fancy enough to get funded, but when we got there, we found that it had a simpler meaning. The national accreditation committee was coming around in three months, and the medical records department was going to flunk. The accreditation code required records to be back on the shelf shortly (a month, I believe) after the patient was discharged. There was a big backlog. We were to clear it up.

The system was in severe disarray, with dysfunctional people (probably patronage jobs), and no orderly procedures. They had no idea how big the backlog was or how to fix it. Meanwhile the Medical Records Director occupied a spacious, well-furnished office and paid no attention to the problems. The same day he signed the $40,000 contract for us, he signed a $285,000 one to redecorate and refurnish his office. His secretary worshiped him.

In a few days, we redesigned the whole system so that it worked. Then we spent the bulk of the money to use Boston's pool of cheap, talented students as shelvers. The average unshelved record was two years old. The most recent was four months and the oldest twenty one years. One patient had sixteen different records. How did they get past the last accreditation?

We did the job and the customer was overjoyed. We started developing proposals for more important things with BCH. I launched a nationwide sales campaign by mail. I approached all the non-V.A. 1000 bed hospitals (about twenty). There was favorable response - all we could handle.

Meanwhile our team was developing a wholly unexpected problem. Our CEO seemed to get a personality transplant along with his new title. He became isolated, autocratic and inconsistent. He started having an affair with one of the MGH group leaders. Instead of the team talking problems through, we were handed solutions, orders and deadlines - many of which didn't make sense. I started getting feedback from our potential partner on the bar-code reader, and from MGH that he was impossible to work with. One of our long-term senior people told me "after I leave here, he'll be the only CEO I'll look back on with no respect or affection whatsoever". I, as #2 man, should do something. But what?

I was relieved of the problem on a Thursday afternoon about two o'clock. He stormed into a group meeting virtually apoplectic and purple with rage. He announced that I had been working on the new BCH and the non-Boston hospital contracts for a month and nothing was signed. I was incompetent. I was fired.

Within two more months, the core team was all gone. Within a year, so was the company, and it brought WESCO down with it. MGH moved forward with the project on its own, sometimes using other consultants. The MGH-IIS (Integrated Information System) has been a success.

What a difference a single personality can make! Three years later I met him on the street. He was all smiles. He now understood that nobody else was making sales that quickly either. He'd been wrong to fire me. Perhaps we could start another company. Would I come to dinner? I found excuses.

Although I had moved on from BBN, I kept my friendships with colleagues and customers there. Three of us thought we saw a business opportunity. Computers had become smaller and cheaper, and could handle more terminals. Terminals were more reliable, cheaper and easier to use. The BBN/Dartmouth model had been to connect remote users to a centrally managed mainframe via telephone lines, and charge them for the service. We envisioned a smaller model in which a school would own a "minicomputer" and set up terminals in the classrooms or laboratories. We knew how to build the teaching modules and we had the contacts to sell them. We would place them as turnkey devices in schools, along with tailoring and training. We could use materials and knowledge that we had developed ourselves, and that were also emerging from Dartmouth and elsewhere. We would build it in BASIC. We would have a mix of consulting and product margins.

Shortly after I left CIS, we founded a company - Computer Advisory Services to Education, or CASE. The filing fee was $25, and the legal work $75. There was no outside money, and we were the only employees and shareholders.

From the beginning we were in demand as consultants. But like most entrepreneurs, we worked at night and on weekends to develop the business plan for the minicomputers. We learned how to formulate a proposal with cash-flow, profit-and-loss, and assets-and-liabilities budgets. We negotiated a tentative Original-Equipment-Manufacturer agreement with DEC, giving us a 40% discount.

DEC was thriving by building "minicomputers". These were smaller than IBM-type mainframes, and offered far more power per dollar. IBM seemed to have missed that niche. DEC was a lively, loosely-structured exciting place, which attracted the same kind of people I had seen at BBN. Riding that niche, DEC would become the world's second-largest computer maker. But as it got big, it would lose its edge. There would be endless debates about whether it could be more structured and still keep the spirit and the people. DEC would in turn miss the microcomputer market and go into a decline.

Ken Olsen, the founder and CEO of DEC provided an introduction to American Research and Development (ARD), who had backed them at their start - and thereby become legends. We presented our plan to General Doriot, the CEO.

ARD turned us down, converting CASE into a successful small consulting company.

A small consulting company is a good way to make a living, but not a great one. In most of them, you spend two-thirds of your time selling yourself, and the other third doing billable work

at triple your pay.(We were spared that problem, customers lined up outside our door) On the positive side, you are your own master and you have the prospect of building a larger consulting company and making more money. On the negative side, the work is uncertain, the hours long, and the impression that you are your own master partially illusory - you are also your customers' slave. It is hard to get rich selling the company, because you are its principal asset.

We considered the conundrum: we're doing well and making money. But we're using up time in which we could be doing better and making more money. After another year or so, we decided to simply close it down.

EDUCOM, ARPANET and Internet 1969-1972

EDUCOM

I was being courted by an organization called EDUCOM, or the Interuniversity Communications Council. It was an association of about 100 universities, established to explore the development and sharing of modern technology for teaching, administration and research. Jordan Baruch, one of the original BBN'ers was the CEO. Of his upbringing on the border between Italian and Jewish neighborhoods in Brooklyn, he claimed: "my favorite meal was spaghetti mit gefilte fish". The EDUCOM Bulletin is still among the magazines in the "take one" rack for the airline shuttles between New York and Boston. Until I joined, EDUCOM had mostly sponsored conferences and publications. It was basically sharing information about what the individual members were doing. Now it wanted to become an operating entity. I was asked to be in charge.

I had some qualms about running an operation the non-profit sector – it can be inefficient and pay poorly. By way of mollification, they included two conditions in my contract. I could continue to found and operate for-profit companies on the side, as long as there was no conflict-of-interest. And it was very likely that EDUCOM would produce for-profit network spinoffs. I would be in charge of that as well, and could be a shareholder, board member or CEO.

My part of EDUCOM was called "The Educational Information Network" or EIN. Its mission was to gather and document computer programs from the member universities, and make them available to the whole group. The plan was to start with a paper-and-mail-based exchange of software, move forward as the technology became ripe into dial-up computer access, and eventually graduate to high-speed data networking - the EDUNET. Once again I was doing something that had never been done before – there was no template.

My new EDUCOM circle was academic computer science departments and computer centers. They were all very security conscious - almost all had had bomb threats from leftists who suspected them of military connections. One member of the EIN steering committee was known to the public from the national news. He was seen quelling a student riot wearing a helmet and shouting through a bullhorn. If these people were doing anything with the military, they were cagy about admitting it. If there were admissions, they were inevitably accompanied by

circumlocutions like “Yes, the money comes from the Office of Naval Research, but it’s only used to pay for high-minded things like my academic studies.”

Computing everywhere was centrally controlled. In most universities a mainframe was operated by the computer science department. It not only served for computer science research, but also for teaching about computers, and was available as a kind of service bureau for the administration and for other departments. This looked like a structure that could not sustain growth.

Computers behaved like a scarce resource. They required so much esoteric knowledge that they were run by a priesthood of anointed computerniks. The machine ran twenty-four hours a day. It was expensive and permanently being upgraded. The priesthood were technical types with little appreciation of other people’s needs and inadequacies. They were viewed with ambivalence by the users, who loved them for the help they might provide and loathed them for their total control and insistence that you “do it our way”. In some cases a department (often administrative) would acquire its own computer, usually a mini, and escape the central priesthood. Then it would develop its own priesthood, complete with the same ambivalence in miniature. This ambivalence has become a permanent feature of organizational computer usage. (note from 2011: Now of course, the personal computer has eliminated the middleman for most small applications)

While I was at EDUCOM, Harvard abolished its computer service center altogether, remitted the fees to the departments, and told them to go buy services on the open market. Oettinger chaired that decision. Very few years later, Harvard re-established the “Office of Information Technology” to supply those services more efficiently provided by the university to itself. Relations between OIT and its users had a heavy dose of the usual loving, tolerating, and loathing. It was abolished again in 1996.

Centralization may have been a yoke from which the users struggled to be free, but it was an environmental blessing for EIN. It provided an easy mechanism for programs to be transferred among universities. Working originally through the computer guys, we created a way for disciplinary departments to talk about computing to similar departments in other universities, rather than to their own computer geeks. Control began to shift from computing supplier to user. Almost every major program developed somewhere in the EDUCOM membership turned out to be useful to the other members. Science areas provided most of the major applications: Statistical packages were our “best seller”.

EIN did very well. It grew to be most of EDUCOM. After a year it was triple its expected size. Our documentation won awards as the best around. Our funding was renewed and increased.

By then something was becoming apparent. Like most successful computing developments, we had become a success by solving a problem. But we had created new needs, and were now a problem looking for a new solution. Our most conspicuous problem was speed. Our programs traveled (electronically) on tape, which in turn traveled (mechanically) by mail. Once they

arrived, there would be a flurry of correspondence between the sender and the user over how to run and debug them. Feedback started coming in from our members that program sharing was great, but could we do it on-line? Could the programs be catalogued on-line? Could they be moved over wires? Could they even be operated by a remote user on the site that had developed them? Could the inevitable interaction between the originator and the new user be done on-line?

With the technology of the times, “no”. Remote computing was possible, but only for tiny applications. Electronic transmission was far too slow - slower than a tape going through the mail. 2400 bits-per-second was the best modem speed over a non-dedicated wire, and it was very unreliable as well. We started looking around for better all-electrical transmission. We found it hiding in one of the early-adopter communities of the day - the military/industrial/academic complex. We had discovered the Jurassic Internet.

ARPANET and Internet

Was I there at the creation of the Internet? Was anyone? That depends on what you mean by the Internet, and by its creation.

I was almost immediately part of (and helping to create) the small community that was everybody in the world involved with computer networking. BBN was there (Frank Heart, Alex McKenzie, Robert Kahn) as well as MIT (J.C.R. Licklider), ARPA (Larry Roberts, Steve Crocker), Carnegie-Mellon (Harry Rowell), Dartmouth (Tom Kurtz), Network Analysis Corporation (Howard Frank), UCLA (Leonard Kleinrock) SRI (Doug Engelbart, Vinton Cerf), and others. Now that the Internet is in the limelight, these names have become legendary as the pioneers. I worked with them all, and became personal friends with many.

The Internet, like most major technological developments, happened in small stages, each taking the mix of technologies, administrative structure and problems of its time, and making an incremental change. The change, in turn, creates a new mix of technologies, administrative structures and problems. The question of when the mix of things that fed into it turned into what we mean by “the Internet” is a little like that old question “Is it soup yet?”

There are several histories of the Internet around, most carefully claiming not to be “definitive”. One is available from The Internet Society, and written by some of the principals who made most of the major advances. You’ll find it on the web at http://www.isoc.org/internet-history/. Even it claims to be “cursory and incomplete”. Its style as a history gives a pretty clear picture of how complex it is to reconstruct what happened. The document describes itself thus: “In this paper, several of us involved in the development and evolution of the Internet share our views of its origins and history”. The fact that the net didn’t all crystallize at once is reflected in the statement, “The Internet represents one of the most successful examples of the benefits of sustained investment and commitment to research and development of information infrastructure.”

Perhaps a useful analogy to the Internet development can be had by looking at the genealogy of your grandparents. Each of them had two parents, four grandparents, eight great-grandparents and so on back. Each of those ancestors could be considered "the origin" of your grandparents. Perhaps the first to settle in your town is even referred to as the "origin" or "beginning" of the family. Your grandparents also had descendants. Each of those descendants had additional ancestors. The Internet came from many generations or lines of development. Each of those fathered ("parented", to be fair) many developments in addition to the Internet. Many of those developments could be referred to as "cousins". Alternatively you could think of Internet development as a tapestry, with many independent strands interwoven to create a coherent whole. But while "Unified" in this analogy is OK for the tapestry, it goes too far for the Internet.

I won't go over the history again. However let me highlight a number of moments that can be thought of as "the beginning of the Internet", with notes about what you therefore think the Internet to be.

Circa 3500 B.C.: Babylonian clay tablets and papyrus scrolls appear that refer to earlier ones - the logical basis of hypertext (later called "linking").

Circa 300 B.C. The Library at Alexandria introduces cross-references and annotations. If the Internet is freedom to move around linked ideas for you, these could be the beginning.

1945: Vannevar Bush proposes MEMEX, a thinking machine that lets users create trails among related pictures and stored information. His article in Atlantic Monthly of July 1945 is considered the beginning of modern hypertext theory.

April 1962: Leonard Kleinrock at UCLA published the first paper describing some aspects of packet-switching theory. If you believe that the Internet is packet switching, a departure from circuit switching as in telephone networks, this is it. His first book on the subject appeared in 1964.

August 1962: In a series of memos, J.C.R. Licklider (then at BBN, I believe) laid out the concept of a "Galactic Network". He envisioned a globally interconnected set of computers through which everyone could access information from any site. It provided a vision. Very few predictions come anywhere near close to what actually happened, but this one did. It was also the first serious appearance of the term "information superhighway". If by the Internet you mean a model or vision, toaqrds which it could grow, this is it. There was little idea, however, of how it could be done or at what cost. In October 1962 Licklider became the first head of ARPA's computing organization.

1963: Douglas Engelbart published "A Conceptual Framework" for the machine implementation of hypertext. It is built as the "Augment/HLS hypertext system" in 1968.

1964: Paul Baran at RAND published a paper on packet switching networks for secure voice for the military. In England, NPL (National Physics Laboratory) independently began work on packet switching. It's the underlying transport technology of the Internet. Disputes continue to this day on the relative significance of Baran's and Kleinrock's primacy.

1965: Larry Roberts, then at MIT Lincoln Laboratories, and Thomas Merrill linked two computers in Massachusetts and California. It was the first distant computer linkup, or wide-area computer network. That is unless you believe that a network of telephone switches is a computer network, even if the computer is unionized telephone operators plugging cables into switchboards - in which case step back about a century.

1967: Roberts, now in Licklider's old job at ARPA published a plan for the ARPANET. It is presented at a conference in which the ARPA, RAND, and NPL people find out about each other.

1968: ARPA issued an RFQ based on the plan, which was won in December by a group at BBN, headed by Frank Heart. The central job was to devise computers that will attach ("snuggle up" in Heart's words) to computers and then communicate among each other using packet-switching technology.

September 1969: BBN installed the first Interface Message Processor (IMP) at UCLA. Three other sites are added in October. In that month, the first ARPANET message is sent from UCLA to Stanford Research Institute. If the Internet isn't the Internet without content, this was the beginning - the analogue of the Wright brothers' first flight.

According to Kleinrock, it went something like this: "We set up a telephone call to SRI. We wanted to send the word "login" We typed the 'L' and asked on the phone, 'did you see an L?' 'yes, we see an L.' Then the 'O'. Did you see an 'O?' 'We've got an 'O.' When we typed 'G', the system crashed". It was the dawn of an era.

Connected to the SRI node was Douglas Engelbart's project on "Augmentation of the Human Intellect", including his NLS hypertext system.

March 1972: Ray Tomlinson (BBN) wrote the basic email send-and-read software. Roberts wrote the first email utility programs. Email is by far the most widespread application on the Internet, and for a respectable percentage of Internet users, the only one they ever see. If you're one of those, perhaps March 1972 is the beginning of the Internet.

October 1972: Robert Kahn presented the ARPANET to the (narrower) public at the third International Computer Communication Conference. (I had been the U.S. delegate to the first conference, held in Amsterdam in 1970). This event is usually considered to be the first appearance of the net outside of its priesthood, and the point at which the net started to grow. I disagree – keep posted.

June 1973: TCP/IP protocols are developed by the Internetwork Working Group (INWG) and formally presented by Vinton Cerf (Stanford) and Robert Kahn (BBN) in September. These protocols allowed the ARPANET to link to other networks with different architectures. They turned a packet-switched network into a network of networks - or internet (with a small "i"). This net could accommodate the diversity of user types we see today. If the germ of a working network of networks is your idea of the Internet, this is your date.

January 1, 1983: After years of planning, all computers connected to the ARPANET switched over to TCP/IP simultaneously. Lapel buttons and bumper stickers proclaimed "I survived the TCP/IP transition". If an operational network of networks is the Internet for you, 1/1/83 is your milestone.

1989/90: Tim Berners-Lee at CERN devises the World Wide Web. It's a format that can be used for diverse applications. A user knowing only one "language" (HTTP) could use any program built in it. If you think the Internet is a bunch of stuff all in one accessible language, this is the beginning.

1993: Marc Andreessen at the University of Illinois creates Mosaic, the first successful web browser, which he gives away for free. It can let a non-technical person use the web. He then takes it commercial as the Netscape navigator. The Internet takes off as a consumer phenomenon. Before this, if you weren't a researcher, you probably hadn't heard of it.

Even in this cursory history, you will note that there is no clear beginning, or even definition, of the Internet. Many different threads (genealogies, technological lines of development) are interwoven, such as computer-to-computer communication, packet-switching. internetworking, universal user language, and applications such as email, and hypertext.

So where do I fit into this picture?

There are two ways my role could be characterized. One is as the principal denizen of one of the Internet's major blind alleys. Even I would agree. The other is as the key person causing one of the key evolutionary moments; the real introduction of the Internet to the world outside itself. Here is the story - the reader can decide.

I entered the picture in early 1969. "Computer networking" still meant linking terminals to mainframes. However on the frontier, it was about to mean what the words sound like - the linking of one computer or network to another. One place more than any other was the center of computer linking: The Advanced Research Projects Agency of the Department of Defense (ARPA).

ARPA had sponsored a number of frontier-pushing advanced computer applications at several sites around the country. Now some of those places wanted to use the resources of some of the

other places. The cost of duplication was prohibitive. But could they be accessed remotely?

As I have said, electronic data communication was slow, unreliable and costly; worse than sending tapes through the mail. ARPA launched a new research initiative to solve just that problem: high speed, reliable, affordable electronic communication.

Once I started looking for electronic solutions to EIN's needs, I found myself immediately in the ARPA inner circle. The connection was originally made through J. C. R. Licklider, then at MIT.

Of all the ARPANET principles, he was physically the closest. His office was ten minutes walk from mine. MIT was both a member of EIN and one of the early ARPANET sites. We liked each other on sight, spent a lot of time together and became close friends.

Licklider (always known as "Lick") would have been a hard person to dislike. He combined a bright and active mind, a complete lack of egoism, a permanently sunny disposition (though not aggressively so), and an irrepressible non-threatening sense of humor. His puns would disarm the most self-serious conversation. If no pun was handy, he would invent slogans that made fun of his own liberal politics ("Clean for Gene - clean again for Phnom Penh"). As a manager, he was non-directive. Instead he created an atmosphere in which good people could do their thing. The room with the copier had the name plate "Z. Rocks". A sign sticking out of the back of one mainframe proclaimed, "Absolutely no hardware changes without notifying the management."

One winter night he and I were trying to get to Newark airport in a dreadful snowstorm. The Eastern shuttle put us on a 727 in the front row. "Good," says Lick, "in these seats we'll get there first." After an hour on the ground they switch us to an Electra (better anti-icing), this time in the back row. "Good," says Lick, "if the plane crashes, we'll be the last to go."

The match between EIN and ARPANET seemed made in heaven. For starters most of the ARPANET advanced computing sites were at EIN member universities. Those that weren't (RAND, BBN) were at non-profit think tanks or places that were highly acceptable centers-of-thought by academic standards.

From EIN's point of view, ARPA had the only solution going for our resource-sharing problem. Furthermore the ARPA sites were in the part of the universities that we related to - the computer scientists: they were already engaged with and often committed to us. Once Lick and I started talking, the idea of EIN using the ARPANET to communicate among its members rapidly escalated to (at least the possibility of) EDUCOM taking over the ARPANET. This idea was not necessarily as far-fetched as it sounded.

EDUCOM also looked good to ARPA. To see why, we need to reconstruct where they were at the time. What were they trying to do and where was the frontier?

As I traveled around to the various sites, I found isolated pieces of advanced computing research.

They all seemed to combine three elements in various mixes:

> First to develop some branch of science that required an advance in computing in order for the branch to advance.
>
> Second to push forward some aspect of high-performance computing.
>
> Third to make these new advances available to researchers not located on site.

These goals are both separate and interrelated. In that sense they were proving mutually stimulating. Just as it took World War Two to provide the incentive and environment for major advances in aerodynamics, so were these developments providing the stimulation and environment for each other to grow.

You will note something that I did not report, and that is because I didn't see it. What about the famous origin of the Internet: "The military wanted to develop a network that could survive nuclear attack?" The closest I ever heard to such a thing was one of the IMP performance requirements - and a necessary one at that. The net needed to be able to identify either a line or an IMP that was out of service, reprogram the net so that it worked anyway, and restart the dead element when and if possible.

Was there a conspiracy of silence about military purposes for the academic work? I don't believe so.

The nuclear-survivable network idea was indeed present among the threads in the Internet historical tapestry. The 1964 study by Paul Baran at RAND had been funded to address that feature (among many) for a secure *voice* military network. In doing so, it had become one of the three unrelated streams that began to develop packet-switching as a networking technology. But that study had not been funded by ARPA. By 1968/69 the mantle of packet-switched networking had passed to ARPA, which took the lead with its BBN/IMP contract. The original Baran mission was no longer among the goals.

In the Internet-history-by-the-participants this question merits only a footnote. Here it is: "It was from the RAND study that the false rumor started claiming that the ARPANET was somehow related to building a network resistant to nuclear war. This was never true of the ARPANET, only the unrelated RAND study on secure voice considered nuclear war. However the later work on Internetting did emphasize robustness and survivability, including the capability to withstand losses of large portions of the underlying networks."

No doubt the "false rumor" was reinforced by another later development. After the 1972 presentation, many specialized, and sometimes separately owned networks began to sprout using the ARPANET technology. Most of the early military uses, however developed on the ARPANET itself. In 1983, the military uses split off. Thus MILNET became an operational

network for the Department of Defense, leaving ARPANET to continue serving research needs.

It seems that in every era there is some segment of society that Americans want to despise. Over the years, I remember big business, Madison Avenue, the CIA, big oil, big government, unions, suburbia, welfare recipients, etc. In the late sixties it was "defense". Vietnam war veterans would hide that piece of their biographies. Campus newspapers were doing exposees on intelligence activities. Academe, with its traditionally liberal attitudes, and defense were particularly uneasy with each other.

The question: "what are we wonderful academic scientists doing taking money from the nasty military?" did come up from time to time. The response, as might be expected, depended on who was talking. I would say that the spectrum ran like this:

> (Right end) This is work that I want to do anyway. It benefits knowledge and the human race. If they're willing to fund it, I'm willing to accept the money.
>
> (Left end) I'm taking money that might otherwise be spent killing people and putting it to humanitarian purposes - a double benefit for humanity.

Oddly enough I didn't meet anyone who thought of him-or-her-self as a bad guy.

ARPA had some other pressures as well. The bad military image was no help at budget time. Turning part of the operation over to academia would have provided direct relief by getting some of the operation off ARPA's budget. It would have also provided an applicant for further research money (academia, EDUCOM), which would have a better image, and perhaps therefore a better chance of getting funded - the perfect image laundry, as it were.

There were also rumblings here and there about incest. You have no doubt noticed the small number of institutions - MIT, BBN, Stanford etc; and the movement of the small number of key persons among them. I picked up just-below-the-surface concerns, especially in Congress, about self-dealing. ARPA would give a grant to some institution, then hire the key player, then the key player would go administer the grant. Licklider went from BBN to found the computer interest at ARPA, which then gave a grant to MIT. He then went to MIT to administer the grant and found project MAC (Multiple Access Computer). Lick wasn't a crook; he was at worst an innocent. Roberts, Crocker and Cerf all went from ARPA contractors to ARPA itself. Eyebrows went even higher when Ivan Sutherland went from ARPA (as Roberts' immediate predecessor), after a stint at Harvard, to found Evans and Sutherland. The for-profit company's principal income was from an ARPA grant. Robert Metcalfe took the Ethernet concept private as 3COM, and made a great personal fortune. This kind of closed community may be OK if everyone is competent and honest. Otherwise, and maybe anyway, it begins to look like your basic political-machine abuse. Again, turning it over to a consortium of universities could be an excellent cure for the image.

The initiative came from our side, specifically from Lick and me. If we were going to get

anywhere, we had a lot of selling to do - to both EDUCOM and ARPA.

EDUCOM seemed like the harder sell. How unified can a consortium of 100 universities ever get? We would have to convince each one, and probably dozens of people in each school. However we had a stroke of good luck.

Jordan Baruch left. I mean him no disrespect. He was a good man, but he was an outsider to the world of education, and therefore limited in his clout within the group. We were very fortunate in his replacement.

Henry Chauncey, the President of Educational Testing Service (ETS), was a man whose name commanded instant recognition and respect. He was almost so perfect an example of the old-money/upper class/high-culture Yankee as to be a caricature - all the way to the accent. His ancestors had come over on the Mayflower, and his remoter ancestor, Chauncey de Chauncey, had been with William the Conqueror's army in 1066 (as had my own forbears). He was a graduate and Fellow (trustee) of Harvard. His career had included educational and public-service positions of the highest rank. His integrity was beyond question, his intelligence and grasp splendid, and his judgement sound. He could understand and wrestle with subtleties, and his mind was open to change. He was not quite so disarmingly open as Lick; Henry always kept a professional distance. But he was always accessible and never threatening. People not only respected him, they liked him.

Fortunately he and I were also a good match, and quickly became friends. We stayed at each others' homes and visited each other on summer vacations. Unfortunately he moved EDUCOM headquarters to Princeton (he was still head of ETS), and I entered the weekly-commute-through-Newark-Airport phase of my career, spending a day or two each week in New Jersey.

The only virtue to this routine was my weekly dinner at the Newark Airport restaurant. The Newarker provided the best food in Newark and interesting service. It was reputedly run by the Cosa Nostra. There were about two waiters per customer, and they were all (waiters and customers, except me) well-dressed beefy Sicilian-looking characters with bulges under their left armpits. Someone must have pointed out to the local mafia that they were creating an image problem. One week they made a permanent switch. The waiters were now all well-dressed trim Englishmen with bulges under their left armpits. I always wondered if the Sicilians were now waiting table in London.

I presented Henry with our EDUCOM/ARPA notions, and he quickly decided that checking it out should be a top priority. It was becoming clear to everyone that EIN, the success story of EDUCOM, needed direct high-speed electronic access to continue growing - perhaps even to survive.

It is not quite fair to say that we became a "three musketeers" trio. I was personally closer to each of Henry and Lick than they were to each other. But we were of one mind, and worked very

effectively together. And when Henry spoke, the EDUCOM member schools listened.

How about ARPA? At ARPA there was no question who was in charge. It was Lawrence G. (Larry) Roberts.

Roberts was intense and decisive. His subordinates found him distant and even a bit frightening. He led by example and not by intimidation, but his example was forceful.

On at least three different occasions I witnessed this leadership in the same unusual shape: A team of senior researchers would have been working on some tough technical problem for weeks or months, and had gotten stuck. The people were not dummies - they would be, for example, MIT faculty or postdocs. They would come to Larry, outline the problem and ask for more time or resources. In two or three sentences he would hand them the solution and walk away. They would stand there amazed.

Although I spent considerable time with Larry, we never met outside of work, and I can't claim to be among his friends. The task of getting him interested fell to Lick. Apparently it wasn't easy. The ARPANET people had plenty to do without being bothered by academic administrators. Getting Roberts' attention would require a major event. We created one.

As I said, every Internet history I have read counts the October 1972 appearance of the ARPANET at the International Conference on Computer Communications as a major milestone. It is credited as the ARPANET's coming-out party, its introduction to society, its first encounter with potential users outside the ARPA community, the point at which it opened up to the world and vice versa, the moment when it stopped being force-fed and started to grow on its own.

In fact the 1972 presentation was not the turning point. It was an aggressive promotion that grew out of the real turning point.

Namely the EDUCOM Fall Council of October 14-16, 1970 in Atlanta. I organized and chaired it. Henry mobilized the academic community, and Lick produced Larry Roberts. I offered it to the EDUCOM membership as a look at a technology that could mature along with EIN, and provide EIN with the capability it obviously needed. Larry described the status and plans of the net, and expressed strong interest in EIN as the vehicle that could both use and manage it. Lick closed the session with his vision of the universally-wired future.

Lick began his remarks "Ever since John introduced Larry as 'the horse's mouth on networking', I've been worrying how he would introduce me."

For EDUCOM it was a sensation. Member after member told me it was the best thing EDUCOM had ever done, and that it brought EDUCOM to a new level. As reported in the next EDUCOM Bulletin: "During the Friday forum on the future for EDUCOM, it was noted that once the ARPA network was fully developed, 'if EIN didn't exist, it would have to be invented.'... The

membership voted to have a task force investigate EDUCOM support for the evolution of the ARPA network into a common carrier data communications facility and the possibilities of a comparable educational network ..." I was fingered as the key person in this pursuit.

I am reluctant to speak for ARPA, but it was obviously significant for them as well. I was promptly invited to join the ARPA NWG - the core network design team. I was not one of the tech wizards, whose names I have mentioned already and who are now legends. I was not expected to make technical contributions, except perhaps in the man-machine interface area (which was hopeless anyway in that era). I was instead to feed in information about what academic users might need and keep EDUCOM in the loop.

What I found there was intriguing not only technologically, but also sociologically. The people were top notch. But their universe was limited to the upper echelons of the inner circle of the computing world. Their idea of a “user” would be a research project in advanced computing.

Furthermore they were developing not only a new technology, but also a language that was different from and, at first exposure, incomprehensible to people from both computing and telephony. Their vocabulary had “Interface Message Processors”, “switched packets” with “headers” and “cyclic bit error checking”. “Connection” meant a random dynamic assortment of “routings”. This language sailed past both the computer and telephone people without making contact.

Larry, who had not previously attended to - or appeared to care about - events outside the ARPA community, began to appear “in public” so to speak. EDUCOM and ARPA, together and separately, started exploring management alternatives that could make the net operational to wider communities.

Our panel was reprinted in the EDUCOM Bulletin, and reprinted again in Behavioral Science magazine. A subsequent article (by me) appeared in the Association for Computing Machinery Bulletin in June 1972. Larry and Lick and I became a kind of intermittent road show, appearing together in various public forums.

For example we were the centerpiece of another EDUCOM event on April 29, 1972 also organized by myself. The conference was called “The Financing and Organization of Computing in Higher Education”. Along with the three of us, there was Richard Nichols, Vice President for Marketing of AT&T Long Lines. The conference proceedings summarized the progress since Atlanta:

“ARPA started the network but has no interest in managing it. Its interest will continue to be in funding new research facilities and promoting new ideas; it is anxious to get out of the position of administering either the communications or the use by universities. AT&T may provide communications, but it will not take on the responsibility of building a management superstructure. Some organization will have to take on this function. EDUCOM has been

mentioned as a possibility. ... Henry Chauncey, President of EDUCOM, wrote to the presidents of all EDUCOM members and some other large institutions, informing them about the network and asking for an expression of interest. All of the institutions responded, about 90% favorably. If the network is to be successful, there must be good standardized documentation. Thus some organization must develop standards and examine and test the documents before they are distributed to users. EDUCOM has offered to assume this responsibility.... The problem of getting people onto the network is more one of organization than of money."

The person to do all this was, of course, me.

I became active and visible in wider circles. I was constantly addressing conferences and workshops, including meetings of college presidents. At the same time I was immersed in the ARPA community and other networking frontier groups. EIN continued and even accelerated its explosive growth. I recollect feeling that I was spared having to write about what I was doing, simply because I was being so often quoted and cited.

I also began to get unsolicited job offers in the academic reapm. These included, for example, Vice Chancellor of SUNY - the largest university in the world, Dean of the Medical School at Stony Brook, and tenure at Illinois Institute of Technology with my choice of departments. I was asked if I "would be considered for President of New York University."

EDUCOM, and I in particular, became promoters of the ARPANET as an operating entity beyond the community of ARPA research sites. Our goals were mixed. One was to explore whether we wanted to run it. The other was to make sure it became available, in order that EIN could use it. One of our methods was simply to make the wider world aware that there was something here that could and should become available.

One of my talks, at Princeton in June 1971, was taped and transcribed. I updated it in January 1972, and it was published by EDUCOM as "The ARPA Network - Technical Aspects in Nontechnical Language." EDUCOM aggressively distributed this paper, and it became the standard document in all forums for demonstrating the technology and its benefits to the layman.

Meanwhile Henry was using his connections in Washington. One of the places where my paper became influential was the United States Congress, especially the senate. We were told - via the informal feedback that emanates from such places - that it had transformed several key committees from unawareness to pushers of the technology.

It is most likely the item that prompted the involvement of Senator Albert Gore, Jr. Though the unfortunate remark (if he ever really made it) that he invented the Internet is an overstatement, he deserves credit for adopting it early and vigorously promoting its development and its Federal budgets. It's probably fair to say that he invented it as a Federal priority.

We were hearing things like:

"With all the flak we take around here for military spending, we wanted to show some civilian payoff."

"We made it clear to them that this thing should be visible by the election."

"It helped them a lot with their budget."

I cannot document these claims, save the usual "they came from reliable inside sources".

Most of the INTERNET histories simply list the October 1972 presentation to the world as a fact. One, however, adds a few more lines. In The Roads and Crossroads of Internet's History, by Gregory Gromov we read:

1972: Public demonstration of the ARPANET.

In late 1971, Larry Roberts at DARPA decided that people needed *serious motivation* to get things going. In October 1972 there was to be an *International Conference on Computer Communications*, so Larry asked **Bob Kahn** at BBN to organize a public demonstration of the ARPANET.

> It took Bob about a year to get everybody far enough along to demonstrate a bunch of *applications* on the **ARPANET**. The idea was that we would install a **packet switch** and a *Terminal interface Processor* on **TIP** in the basement of the *Washington Hilton Hotel*, and actually let the public come in and use the **ARPANET**, running applications **all over the U.S.**...

The demo was a roaring success, much to the **surprise** of the people at **AT&T** who were *skeptical* about whether it would work.

> Source: Vinton Cerf

The words "Larry Roberts decided" and "serious motivation to get things going" are the keys to evaluating my role. They did not come out of the blue. They were the product of Roberts' exposure to an aggressive eager user (EIN), beginning at my Atlanta conference; and very possibly also the product of pressure from Congress triggered by my paper.

And it seems that AT&T hadn't read my paper, which would have showed them that the technology did indeed work. Remember my remark that the new language was incomprehensible to the old technologists.

Philosophers will argue forever about the role of personalities versus forces as the cause of human history. There is little doubt that without me, the Internet would have happened anyway.

But the 1972 debut may not have happened, and the shape of the development curve may have been different - even significantly different. When I started, the ARPANET community talked to and was known only to itself, and showed no interest in other communities. When I was finished, it was well known, especially in key circles in business, academia and Congress. It was actively courting visibility and interest, and trying to promote development by outside users. There was no turning back to insularity. By this reckoning, I did play a central role at one of the pivotal points of Internet development.

In the end EDUCOM did not become an on-line network operator. In that sense, our efforts were a dead end. We were not the foundation for the cathedral, we were the scaffolding. Perhaps a better image is that we were not the chemicals but the catalyst. In any case, we began a success story that was eventually someone else's success, and our role is largely overlooked.

Most of the major players, Kahn, Cerf, Heart, Engelbart, Kleinrock, have ridden the Internet to visible and illustrious careers. Licklider remained at MIT as the beloved founding father of the now-famous Laboratory for Computer Science. He retired and is now deceased. Roberts moved to GTE, where one publication said "Their next success will be whatever Larry Roberts thinks up next". He progressed from there to be founder/CEO of several related companies. Metcalfe is a major player in the Boston hi-tech venture scene. McKenzie became head of network activities for BBN. Henry Chauncey remained head of EDUCOM and ETS until his own retirement. I am told that around age ninety he still visits ETS, and offers cogent and heeded advice (year-old information in 1998).

In March, 1972, pressed by both EIN's exploding significance and his wife's diagnosis of cancer, Henry decided to relocate EIN to the Princeton headquarters. Exactly zero of us chose to go. I closed down the office and disbanded the Boston group at the end of June.

Harvard 1973 -

I was not motivated to leave EDUCOM by a need to grow into something new, but here was an opportunity to work with an empty easel. I took some time to look around and think through what to do next. In the end I came up with two choices: both of my own creating.

One grew out of my lifelong interest in the natural environment. Because it's never quite been my profession, it's always been active as a hobby.

I do not usually have pivotal flashes of insight, but one played a role in this option. I was turning over the idea that conservation, to work in the long run, had to be profitable. I suddenly saw garbage from a new angle: instead of stuff to throw away, perhaps it could be considered stuff to mine for valuables. I started checking out the technology, which was under development as bits and pieces; and the economics, which was obviously hypothetical. I visited and interviewed several places where parts of the problem were being addressed.

I particularly enjoyed a couple of days with Sunset Scavengers in San Francisco. They were a

beautifully-run municipal waste outfit that separated glass and metals for sale before reducing the rest to a usable slurry. It was an 100% Italian-American company based with pride on "garbage was so low that nobody would touch it but the lowest immigrant group - we Italians." I walked in the door with no introduction or credentials, and they treated me with the warmest of hospitality. Maybe it was because I would only compete 3000 miles away and maybe they were just pleased to see someone show an interest in garbage - anyway their generosity was marvelous.

I put together a draft prospectus and built up the political connections to set up a next-generation counterpart in eastern Massachusetts. I got the promise of for-profit investment money. But when the time came, I chose the other option.

My urge to "understand how things work (and make something happen)" was developing yet another dimension. I was becoming convinced that the benefits of technology were not merely determined by better technology, as I had previously assumed. Instead the heavy factors had to do with how society itself worked. What made companies choose and promote a technology? How were government regulations and initiatives formed, and did they help or hurt? How much was being shaped by current or traditional habits and ways of getting things done? Why was there "risk money" for some ventures and not others? Why did AT&T twice turn down the Internet?

I was talking these ideas over with James McKenney, a friend who was also a professor at Harvard Business School. He said "There is someone you should meet. You two came to the same crossroads, even though you got there on different roads. His name is Anthony Oettinger."

Oettinger had come to the crossroads this way: He had been the founding Chairman of the National Academy of Sciences Computer Science and Engineering Board. After a year, he concluded that the funders of the Board could dictate the outcome of its work, destroying its impartiality. In response he closed the Board, returned the money, and resigned from the Academy. He returned to his office at Harvard pondering: "if the Academy can't provide impartial, competent advice, how can it be done?

Official notice, warning, disclaimer and claimer From this point on, Tony and I have enjoyed a fusion of our careers. We bill ourselves as interchangeable. I cannot disentangle "my" accomplishments from "our" accomplishments. He routinely says the same. I will continue to use the word "I", but I sometimes mean "we", and almost always "I in a context created by us". If there is such a thing as dedicating a story like this to someone, then I wish to offer this one as a contribution to Tony's upcoming career-and-70th-birthday celebration.

I don't mean that we do everything together. We each take extensive business trips alone, for example, and we have never co-authored anything.

We get frequent remarks on our obvious personal differences. My style could be called

British/Yankee reserve; his Mediterranean verve. I am cool-tempered, he is emotional. I am understated, he is dramatic. I am best at finding the central point, he at elaborating the implications and details. I speak as simply and with as few words as I can. Tony's speech blossoms with images, similes and metaphors, and can be wordy. My desk is neat, his covered with piles. People respond to us differently and hear what we say differently.

How do we cope with our differences? It's simple - we exploit them. If we're both present with someone, and they don't like or can't understand one of us, the chances are pretty good that they can work with the other. Our minds work so differently that we each come up with ideas the other wouldn't conceive. This happens every day, even after twenty-five years. We act as checks on each others'excesses.

So what are our "accomplishments", and why are they worth reading about? First we invented a whole new method for bringing intellectual integrity to bear on strategic decisions. This was why I chose Harvard over the for-profit option. We work specifically with the communications/information world, but our techniques may also apply to other environments full of conflict, confusion and change. Second we have worked personally and corporately with almost every major player shaping the information age. We have heard everyone's story and helped them form their strategies. We have been uniquely positioned to understand the inner workings that got us to where we are.

A few success samples: We have helped every White House since we formed our Program. We have spent time with both houses of Congress, all fifty state utility commissions and perhaps thirty foreign countries. We were recently told by a telephone company that "use of your map (one of our Program's planning tools) has created twenty billion dollars in value for us." Of the same map, we have been told that at least half of the Fortune 100 information/communications companies have used it as the centerpiece of their thinking process. We wrote the keynote article for the centennial issue of Science. We played a central role in the military reorganization of 1986 (The Goldwater-Nichols Act). We have appeared on all three of the national network morning television shows and All Things Considered. Articles about us or featuring our thought, have appeared in Fortune, Newsweek, The Wall Street Journal, The New York Times, and elsewhere. We got a nice recent compliment from a senior Senate staffer. He called to get another copy of one of our papers - he couldn't get the first copy away from his Senator. The "compliments" pages of our website detail a heartwarming litany of praise for value obtained.

In 1997 we are the oldest, largest and best-known independent think tank in our field in the world.

The deal that we articulated at the beginning was only this: Each of us is secure in a career. Let's gamble two years on a venture that - if it works - will be personally fulfilling and will aid thought and action in the information world. We are both surprised at what that seed grew up to be.

Our method is not easily explained - but here's the essence of it. Our role is to work with the people with the power. We want to make sure they understand what's happening and how to think about it from all the angles. To do this we need to understand the key players and see how each of their pieces fits into the overall jigsaw puzzle. Then we need to inject this knowledge directly into the decision-making process.

That means that we need to have the confidence of organizations whose very existence may depend on annihilating each other. In order to pull off that trick, we impose some unusual limits on what we try to do.

First we don't make decisions. That means no drafting legislation; no recommending lines of business, acquisitions or product lines; no endorsing options and no predicting the future. The people with the power want to make decisions themselves - and should. Only they know the inner workings of their power base - the resources, the interests, the politics. Only they will have to live with the tactics and the consequences.

Second we take every known measure to be impartial. That means no proprietary work; no consulting (in the usual sense); no "expert-witness" testimony; no serving on boards of directors or otherwise assuming responsibility; no non-disclosure agreements and no appearing on anyone's platform in front of anyone else. Above all it means that we are funded only by hands-off gifts from parties so diverse that their interests cancel each other out. There have been over 500 organizations that contributed money and resources to us. And by the way no unlisted funding sources.

Third we must be not just impartial, but also well-informed. Many of our affiliates say that being both at the same time makes us unique and is our greatest achievement. Our internal production line produces books. Each selects some hard contentious problem, and tries to lay bare the real issues (as opposed to the superficial issues, smokescreens and red herrings), the players, their stakes, the forces the trends, the numbers, the arenas in which the battles will be fought, the rules, and how the rules can be changed. Once we've done the best draft we can from the ivory tower, out it goes for review by all the players. If we're going to know what's really happening, only they can tell us. Then we put it all together in a document that lays out all the varying facts, perspectives and angles. We make a map of the territory; our readers maneuver their armies.

We've found that if you're inside a stakeholder, you simply can't see the world from opposing perspectives. The reviews that come back, for example from AT&T, Apple, The Federal Communications Commission, and Japan look like each must be talking about a different world - including the basic facts and what the underlying contention is all about. Our job is to lay them all out for the reader, then stand back and analyze what it means when you can see all the angles.

But just as a reminder, for us, "analysis" is a word with theological limits: no solving the problem (unless there's only one choice), no predicting the future (unless it's undisputable), and no disclosure of inside information or confidences (ever, period). We're in the description and

thinking business, not the solutions business, futures business or secrets business..

Each study produces knowledge, but so what? Our natural audience - senior decision makers - are too busy to read. Furthermore, they're probably not worrying this week about the subject of our latest book.

In return for their contribution to our Program (we call it "affiliation") they get an open door and a red carpet invitation to bring their problem around and talk it over. In practice, this is how we help bring solid thinking to bear on real decisions. People can drive our inventory of knowledge with their own agenda.

And they do. Perhaps thirty times a month Tony and/or I sit down in a confidential meeting with someone in government or business who lays out what he or she is worrying about. We usually hear about their biggest uncertainties, what they think is happening that calls for a decision, what they are considering doing, why they are considering doing it, etc. etc. This stuff is usually very different from what they say to an audience. What they tell us is kept in perfect confidence. Whatever we tell them we can trace back to publicly-available information or sound thought or common sense.

If it goes well, we hear that we have been an idea bounce and a sanity check, that we have prevented them reinventing some wheel, that we opened their eyes to new perspectives, or that we caused a paradigm-shift in their thinking. They continue to review our drafts and renew their contribution at the end of the year. And thus our unique engine moves forward.

If it goes badly, we survive because of our statistical stability. We have the freedom to tell people what they don't want to hear, and we don't always benefit financially by that habit.

We create about twenty-five books a year. All are available to the public, and many are republished by commercial presses and academic journals. We also offer seminars and courses within the University (and pay them overhead).

This whole thing is murder at cocktail parties when someone asks me what I do. From that angle I look forward to retirement.

I take about one airplane flight for every two working days. It's a slight improvement over EDUCOM, but it's the other angle from which I look forward to retirement.

THE INFORMATION AGE

one

I will quibble later with the phrase, “the information age”. But for starters it identifies the ballpark.

There’s clearly too much story to tell in a few pages. I’ll try to provide a sample by following the telephone industry and some of its encounters with other players: especially newspapers, computers, and governments.

Telephone histories are no rarer than Internet histories, and I won’t rehash them here (“come here Mr. Watson...” and all that). Instead let’s look at it, starting in the 1970's, from our angles.

Remember for starters that the telephone business was (and is) big. It was roughly ten times the size of the entire newspaper business or broadcasting business. That made AT&T, with 85% of the market, roughly four times bigger than the newspaper and broadcasting businesses combined. It was the largest company that had ever existed. Its gross revenues were bigger than the GDP of all but thirteen countries. It was classified by investors and regulated by governments as a “utility”. That meant a “widows, cripples and orphans” security, and a monopoly with controlled investments and earnings.

Our relationship with AT&T began with Robert Lilley, then President. After hearing our peculiar sales pitch, he replied: “As you know, we’ve had every important economist in the country on our payroll. That means that if they say something favorable to our company, nobody will believe them. What you’re doing is unique and different. If you say something positive about us, they might believe you because we didn’t pay for it. If you say something negative about us, we can deny it because we didn’t pay for it. We’ll sign up.”

Let’s think of telephony as a business whose 20th century basics were determined by two growth engines: universal service and business applications (business); and two formulae: RB/ROR and rate-setting (financial underpinnings).

Growth engine #1: universal domestic voice service, commonly called “plain old telephone service”, or “POTS”. Universal (as opposed to partial) service was articulated early in the century by AT&T Chairman and Patron Saint Theodore Vail, and was put into law in the communications act of 1934. Vail is to telephones as Rockefeller is to oil - a hero inside the business, a ruthless aggressor to many others. “Universal service” in 1910, when almost nobody had a phone, may have been a glorious vision, or merely a political ploy. But it was nothing Vail could have expected to see in his lifetime. The communications act was little more than a rephrasing of the radio act of 1927 (itself a rephrasing of earlier railroad legislation) and the Interstate Commerce Act. It passed without debate. If Congress had anything in mind, it was a vague idea to be acted on long after the next election. At the close of World War II, the telephone was 79 years old and penetration was about 45% of households. Evolving that into “universal” became one of the great industrial growth stories of the century.

Growth engine #2: Telephone service to business: In the beginning, POTS was POTS for

business too. But by our era the business market was sprouting additional services, such as CENTREX (central exchange service), leased lines, computer communications lines (usually measured in kilobits/second), large bulk accounts, and special pricing (more in a minute). The evolution from POTS to more complex and powerful services has been a vast success story as well.

Income distribution over customers was very lopsided, as is characteristic of utilities, greatly exceeding the 80/20 rule. The prime customer sector was financial services, followed by airlines.

Business usage - by the way - provided a view into the way telephony was vertically integrated, and not just a geographical monopoly. I was explaining the basics to a very senior insurance executive, who was accompanied by the firm's chief technical officer. I pointed out that if they wanted to connect their computers to their own computers across the street (and even in some cases inside a single building), New England Tel would have to do it - it was illegal to do it themselves. The executive turned to his expert in complete disbelief: "could this possibly be true?" "Yes, we don't like it, but it is."

In the early seventies the local telco owned not only the switches and lines, but also the wiring within your house and the telephone set. All you got for your fee was the service.

The companies could also be said to own the vocabulary and the philosophy. Wiring was "outside wiring" or "inside wiring", depending on location - there was no "our wiring" and "your wiring" question of ownership. Anything they did not own (virtually nothing in those days) was a "foreign attachment". Service was "end-to-end", including maintenance (which was free). The companies' employees were deeply imbued with a sense of "total obligation" and "responsibility to the customer", made even more profound by the utility nature of the service and the obvious fact that nobody else could provide it.

Formula #1: The rate-base/rate-of-return formula: RR = OE+d+T+r(V-D), or Revenue Requirement = operating expenses + taxes + depreciation + the allowed rate of return times the total cost of the plant minus total depreciation. Keep your eye on the ball, namely the last term "r(V-D)". This absurdly simple formula dictated the profitability of an industry that brought in over $100 billion in 1970's dollars. It has only two determinants: "r" the allowed rate of return is the percentage that governments will let you keep. Percentage of what? "V-D" is the book value of the plant. Or put another way: You can only earn a percentage of the value of your assets. Operating expenses can be fun, they can be powerful; but they can't be profitable. The incentives built into this scheme have played a key role in how the industry met the winds of change.

Formula #2: The costing and pricing formulas. Ever wonder how the price of your telephone service was set, and why it was different from your cousin's bill in the next state? Don't commit yourself to mastering this one, or the rest of your productive life is gonzo. Rube Goldberg on steroids and LSD couldn't have dreamt up anything so complicated.

The underlying mechanism looks something like this: Your price is supposed to reflect what it costs the utility to provide what you used, plus a reasonable profit (see formula #1). When you ring me up, let's say from New York to Boston, you use your phone and my phone, plus the short wires dedicated to each. So far pretty straightforward - perhaps. But you also use some switches and lines in between that are used by other people, some of whom are calling from Bangor to Dallas and some of whom are businesses. You use some of the Chairman's time to organize all this. The opportunities for complexity already present themselves.

For starters, I didn't pay for my phone and wires when I answered your call. That would be politically unpalatable and a business disincentive. So those costs have been allocated to you. (The same reality hasn't quite hit the cellular business, but it's getting closer.)

Furthermore, your house is farther from the street than your next-door neighbor's and therefore has a greater installation cost. Do you pay different rates? No, that too would be politically unpalatable. There's cost averaging.

How about that stuff whose use we share with strangers, like the switches and the Chairman?

How do you compensate for varying minutes of use (mou's) on the same gear? How do you distinguish between traffic sensitive (ts) and non-traffic-sensitive (nts) costs?

If I've set up the questions clearly enough, then two things should now be clear: pricing is all about cost allocation, and cost allocation has some big components that are not economic. Exactly!

two

Cost allocation was done by a clubby collection of telco and government players who all got together in one place and set the underlying structure and rules. (The places they met - Atlanta, Denver, Ozarks - gave their names to the costing plans) They had, among other things, social goals: principally the promotion of universal service (growth engine #1). Costs were disproportionately laid onto long distance, business, and to a lesser extent urban services in order to reduce residential and rural prices.

Because telco bashing has been a sport rivaling baseball, please let me praise a piece of work for which I have never seen telcos given credit. Both telephone penetration and long-distance usage are price elastic; in the sense that lower prices produce greater usage (though not necessarily greater profits). It would have been very easy for something to get off balance, such as unmeetable demand for telephones, hopeless clogging of long distance plant, or investments that couldn't be recovered. During all those years of juggling costs, it never happened - a brilliant accomplishment. Part of the reason it didn't happen was that prices were often set at market rates (neither strictly cost-based nor socially oriented). Depending on your school of thought, this was

called Ramsey pricing, Pareto optimal pricing, value-of-service pricing, inverse-elasticity pricing, or hit-'em-for-what-they-can-pay.

Somewhere in our earliest musings, Tony or I must have used the word "subsidize". We were promptly invited to AT&T headquarters for a conversation. The two of us found ourselves in a room with about fifteen very senior executives. "There is something you gentlemen need to understand: there are no subsidies within the telephone network". They carefully explained that most of the cost pool was "joint and common costs" (such as the switches and the chairman), and therefore not strictly allocable to a particular service. Therefore each service (including your call to me) paid 100% of its strictly allocable (you could call them "incremental") costs. It also picked up a piece of the joint cost pool. Therefore nothing was failing to pay 100 percent of its strictly attributable costs, and hence no subsidy. In 1974, the word "subsidy" held a danger for AT&T, namely that the business customer would see itself as the subsidizer, and find another solution.

Whether there really was or was not subsidy now boils down to the meanings of words and senses of fairness about that vast joint cost pool. But they had articulated a fact that plays an eternally critical role in the telco wars. The assignment of joint costs is technically arbitrary (read politically flexible), and therefore there is no such thing as the "true cost" of a particular service.

Let's note some things about costing and pricing, and then move on:

First the machinery that set pricing was done from 1945 by a non-adversarial negotiation. It included all the stakeholders who cared to participate; and they were capable of agreement. This machinery broke down in the seventies and hasn't worked since. Stakeholders became too numerous and their stakes too diverse. This transformation may hold a lesson for countries experimenting with "industry self-regulation", as has been tried in the UK and Peru, and is now being tried in Australia and New Zealand. New Zealand is a unique example, having taken an extreme position of "government hands off". Telephone policy is now the product of the courts.

Second the whole vast scheme, under the banner of "cost-based pricing", was actually the reverse: price-based costing. In case you were looking at your prices and wondering how costs dropped in half after 6 pm or the drugstore's costs were twice your costs, your suspicions were justified.

Third, subsidy or no, the industry finished the sixties with prices for business, long-distance and urban services that might be beatable by a new-entrant competitor. Big customers - especially geographically dispersed companies who used a lot of long-distance service - could even provide service to themselves cheaper than buying it from telcos.

Fourth, the notion that costs could be precisely allocated, and therefore that pricing could be strictly cost based was deeply inculcated into telcos and regulators. This false assumption has confounded both company strategy and public policy ever since. Even the specific costing

produced by the second Ozark plan distorted decision making for years.

We were the first people ever to diagram the whole costing, pricing and money-flow system. It was quite a set of charts. As I said, even Rube Goldberg.... Only a handful of people in the world had a grasp of how it worked, and probably none of them understood the pieces beyond their own responsibility. AT&T lost most of these specialists to the Bells upon divestiture on 1/1/84, and the Bells laid most of them off during the downsizing binge that followed. We found ourselves in the unexpected position of explaining key aspects of their internal operation to telcos, and later of being their only surviving institutional memory.

three

When we first started working with GTE in the early seventies, Leslie Warner the Chairman called the business a “simple, comfortable industry”. Soon thereafter, he changed his tune to “It’s getting very messy, and I’m going to retire.” Sure enough, the next time we called, we were introduced to Theodore Brophy, the new Chairman.

The mess, of course, was competition. Competition is generally considered to have started with Carterfone or Hush-a-phone in the late sixties, entered the long distance business with Southern Pacific Communications (later SP, and yet later SPRINT) and DATRAN, and then galloped through the long-distance and “foreign attachments” businesses. In my view, histories of this sort dwell too much on formalities. There is more depth and breadth to the real story.

In fact they miss several real stories, each embedded within a larger one - a kind of reverse “layers-of-the-onion” metaphor.

The competition just named all advertised and offered something to a customer, and got formal blessing from the FCC - providing convenient dates that can be cited as “the beginning of competition in X.” These were, however, embedded in a larger collection of events. Each of the developments I worked on at BBN, MGH and EDUCOM are examples. Long before there was any fuss about offerings and permissions, organizations were doing things for themselves that they might earlier have simply purchased from a telco. In addition, some information services began to bundle in communications, trying to make their remoteness invisible or the access price fixed. General Electric Information Services (later GEISCO) offered an information processing utility, but also offered remote access as part of the plan. TYMSHARE offered access via TYMNET, a data networking technology developed independently of the ARPANET. (The Chairman of TYMSHARE complained bitterly to Congress that he was the victim of government-subsidized competition)

There was also a “who owns the technology” layer. Virtually all telephone technology had been developed at Bell Telephone Laboratories and Western Electric. By and large, that same technology was used by the 1600 independent telephone companies. It was used worldwide, and

where it wasn't, there were standardized interfaces to it. AT&T was very slow to recognize that anyone else was even capable of providing communications functionality, much less of doing it well or at a reasonable price. Competing technology sneaked up on it out of the computer industry, providing the first opportunity to misuse the term "convergence". It remains a charming irony that the transistor was invented at Bell Labs, but its successful commercialization elsewhere eventually undid the parent company's monopoly.

"Convergence" correctly recognized that the computer and telephone industries were now operating off a common technology base. It incorrectly concluded that these businesses were now competing to offer the same things to the same customers. Partial functional overlap, yes. Identity, no.

The escape of the technology (this is telco language, of course) was still only part of the history - in fact only part of the technology history. There are two other parts:

One is the obvious truth that the technology keeps getting dramatically cheaper and better. Moore's law (from Gordon Moore of Intel) is the most often cited measure. It says that the number of transistors on a chip doubles every eighteen months. But Moore's law refers to only computer chips. All the information technologies are improving like crazy. A common quip had it that if automobiles improved the same way, a Rolls Royce would cost fifty cents and get 15,000 miles to the gallon. Our own formulation is "SFCB", or "Smaller, Faster, Cheaper, Better". It applies to almost everything and every measure.

The less obvious truth is that the technology made a gradual change from being a scarce resource to being an abundant one. The two behave in fundamentally different ways. Scarce resources behave like the computers of my college days. The machine ran 24 hours a day, access was scheduled and a priesthood stood between me and it. Now there are computers in three of my thermostats and my microwave oven. They are used seconds a day, and when I want them, not when they will deign to serve me. When telephone technology was scarce, a monopoly utility was the only way to get it. Now hundreds of thousands of organizations provide service to themselves or others. A cross-country call in 1900 cost an average monthly wage and took a week to schedule. Now many families have a phone for the parents, another for the computer, and two for the kids. When I was young, the radio was the size of the desk and stood in the living room, where we haggled over its use. Now I can't tell you how many radios are sitting in drawers somewhere. If automobiles had progressed similarly, we would all keep a few Rolls Royces around, just in case we need to go out for coffee.

four

The technological events were embedded in larger social events. In the late seventies some sociologists and economists discovered that half the workforce and half the GNP was dedicated to information. To conclude this, they had to count all employees of information companies as

information workers, even if they drove trucks, and also all information employees of non-information companies, such as the mail room in a hammer factory. The details were challengeable, but information was suddenly recognized as big, big, big. Thus was born "The information age", "The Third Wave", the "information is strategic" management fad, etc.

It was at this time that governments – from local to national – started using the term "information age" as part of their vision for the economic future. We had a steady parade of parliamentarians, congressmen, secretaries of commerce, governors and mayors meeting with us. They feared being left behind if their information infrastructures weren't among the best. Or they wanted to get the jump on the competition by becoming the information hub for their region or the world. Most were from major developed countries, but a few were from other places looking to leapfrog the developed countries. These visits were earnest, but produced some curious moments:

- A representative from the Caribbean region wanted Harvard to fund its infrastructure development. I had to sadly tell him that Harvard extracted money from everyone else, it didn't dispense it.

- Meeting with a group from the Japanese Diet (parliament), Tony's fondness for images got us into trouble. "… you could become a prisoner of the past." The translator (a Japanese) simply stopped and sat there motionless and expressionless, like a clock whose spring had run down.

- The mayor of Hammerfest, Norway, which claims to be the northernmost city in the world, has a population of 9,000, and is nowhere near another settlement, spent a day with me. She was working on a strategy to make it a global communications hub. Perhaps most oddly, due to the plunging cost of communications, this idea was not unimaginable. "Perhaps with the right tax structure…."

Nobody is better positioned to be a true believer in the information age than ourselves, but again we don't see it quite that way. We think information won't feed us or keep the rain off. The agrarian and industrial ages haven't ended, but have been given a big efficiency boost by information.

Business economists see the universe as made up of two fundamental resources, capital and labor (matter and energy to the physicists). If the price of one drops relative to the other, it is displaced by the other - you fire workers and add machines for example. In our view there was always a third resource: information ("structure" to the physicists), which went unnoticed because its relative cost never changed. With SFCB running rampant, both capital and labor are being dramatically displaced or augmented by information.

To see why this displacement is largely invisible, look at the computer business. With the cost of a unit dropping in half every year, you might expect that the price of a computer would converge on zero. Instead the price remains roughly constant, but the power doubles every year. Users

prefer to pay the same price and keep getting more for it.

A handier image for the information age, therefore, is that the injection of information is making both capital and labor more productive. Neither is being displaced, but with a small injection of information, much more gets accomplished. Try to imagine running a modern bank or airline without a computer. The military language for the same phenomenon is “force multiplier”. It’s not so much the “information age” as the “age when adding information makes capital and labor deliver more”.

Once the technology was loose on the town, a thousand flowers bloomed (ouch, what a metaphor!). By the early 1970's, new information technology had not yet reached the home, but it was starting to look like a free-for-all inside organizations. New specialized services and prices became legion. There were a handful of telephone competitors offering communications services over their own plant, and hundreds of resellers. Most major corporations had built their own networks carrying voice and data. Computer-to-terminal and computer-to-computer communications were everywhere. An outfit wanting to upgrade its information handling had a huge array or make-or-buy options. One of the new carriers, DATRAN, planned the largest public offering in history; polishing the image of the “information age”.

All the while, however, the incumbent telephone industry provided rural residential connection at substantially lower prices than it provided comparable service in cities and to businesses. Did those socially-desirable cost distortions provide an economic advantage to the competition? The debate remains central to decisions being taken today (1998): Is competition providing more choices, lower prices and the organizational engine of the information age? Or is it merely a bunch of hucksters taking advantage of an artificial price umbrella? While neither extreme is the sole answer, the underlying principal is still uncertain.

five

The incumbents did not take competition lying down. They fought back with technology, new services, prices, regulatory manipulation and lawsuits. There were some amusing incidents along the way:

DATRAN opened the first part of its network - a data service between Chicago and Saint Louis. Within a few weeks, AT&T - then carrying 99.999% of the traffic, sued them for attempting to monopolize the business.

Some time later, MCI (sometimes called the law firm with the antenna on the roof) sued AT&T for providing discriminatorily poor access connections to its network. It won $600 million with treble damages. The rumor became prevalent, including within AT&T, that they preferred to pay $1.8 billion rather than admit nondiscrimination - namely that all their connections were that bad.

Regardless of who won each battle, the war clearly went to the new players - they got to play and the monopoly was broken - except in domestic local service, about which more later. (note from 2011 it's now gone as well)

There are many behavioral models of regulatory bodies, most of which describe some kind of "capture" by the regulated industry (the Averch-Johnson effect is an example). The behavior of the telco regulators, and especially the FCC, stand as a living demonstration that it doesn't always work that way. They were on the cutting edge of breaking, rather than preserving the monopoly.

Incidentally a new natural constant appeared around 1965: three years. That was the interval until data would be half of all network traffic. This prediction remained a constant throughout the sixties, seventies, eighties and nineties. One of the arguments that enabled the newcomers to get entry was that their growth would be restricted to data traffic. Therefore the incumbents would retain the voice and the growth in voice, and be unharmed. All the major telco competitors were originally designed to carry data. MCI and SPRINT quickly adapted to carry voice and survived. DATRAN and SBS didn't adapt, and failed. The proportion of all traffic that was data finally started to grow after the invention of the web browser in 1993.

six

In 1976 the telephone business struck back - a kind of Battle of the Bulge for the monopoly. The attack was not with a new technology, a new price, better marketing, regulatory manipulation, or even legal action. It was in Congress.

"The Consumer Communications reform act of 1976" was introduced by over two hundred congressmen and sixty senators. It basically elevated the telephone monopoly to the status of law - something it never had before in the U.S. It rolled back open entry to before it had happened and prohibited it.

The incumbents argued that competition bestowed no advantage. They themselves remained the most efficient suppliers. The cheaper prices that the competitors offered (including the prices that companies offered to themselves when they built internal networks) were an artifact of the cost allocation scheme. Its only strategic effect was to drain money away from socially desirable goals - most notably universal service.

They made this argument at about the same time that penetration achieved 95 percent, which can be considered "universal" in much the same way that 4 percent unemployment is "zero unemployment". However the "universal service" goal was so popular and the struggle for it had been so long that it remained - and remains - a powerful argument.

The heart of the incumbent's case was the word "subsidy" - now permeating the network and a

Good Thing. Were it not for subsidy, it was argued, the price of local telephone service would triple, and people would drop off the network. Then even those - such as businesses who thought they were disadvantaged by paying more - would be even worse off: They wouldn't be able to reach their customers.

To whom should Congress listen for clarity in the complexity and abstruseness of these arguments?

Answer number one for Congress is always the voting public. However the response of the public was anything but clear. It was worse than that: there was no response. The public didn't care about this one. The public has never cared about telecommunications policy matters. Telephony works fine and is cheap. The industry was able to muster over a million letters of support from among its employees. But as a congressman told me, discussing the public outrage that led to reregulation of the cable industry in 1992, "we can tell the difference between an orchestrated public indignation and a REAL one."

The companies' employees and their unions were all for it, of course.

The military was vaguely for it. The DOD had always had a cozy relationship with the industry. It had been nationalized on their behalf in 1917. As the commander of the Defense Communications Agency stated in one of our seminars, "When we wanted something, we walked across the street and had a chat with Bob Gradle (The AT&T-DOD contact man) and it got arranged." The same Commander was, at one time, unaware that most military traffic was sharing facilities with the public networks. However the military was also pleased at the prospect of a growing number of suppliers, always a virtue to them. They did not take a strong stance.

The big gorilla in this shoving match turned out to be the comrades of my friend in the insurance company. The corporate information officers of the Fortune 500 wanted their own control. They wanted the diversity of tailored and less-regulated offerings that was pouring out of the new competitors. Above all they wanted lower prices. These were people whose next raise was built on doing more next year for less.

An interesting aside: There has always been a big gulf between corporate information officers and the senior executives of their company. It is another manifestation of the techie/manager gap. Few CIO's understand the strategies of their company in its prime business, and few CEO's have much sense of what value information may hold for them. Information is usually 3-5 percent of the expense budget, and every year they get more for their money from it. Why worry?

This gulf has always been a headache for our Program. We believe that information can be a strategic resource. But we have only gotten the attention of a very few "user" CEO's. Admittedly some of them are potent, like Walter Wriston, Chairman of Citicorp, who claims to have brought the company from nowhere to #1 by strategic use of information.

At the time of the Consumer Communications Reform Act we were able to get two “user” companies to take a close look at their CIO’s built-in incentives. The CIO’s turned out to be in charge of the companies’ long-distance telephony; but not the local telephony, which was in local managers’ budgets. Both companies summed up these local costs, saw that they were much larger than the long-distance totals, and pulled their CIO out of the reform act hearings. Those testifying for the legislation may have been testifying against their own companies’ best interests. But they were the exceptions.

The weight of the “user” corporate testimony carried the day and the act was defeated. Representative Timothy Wirth, Chairman of the relevant House Committee, speaking at one of our workshops, called it “The sweetest piece of special-interest legislation that I have ever seen”. Competition was free to run, and the incumbents’ market share plummeted, probably much more than they knew. The total business grew so fast that the incumbents’ revenues and profits headed for new records every year.

seven

From 1976 to 1982 there were no overt structural changes in the telephone business, but plenty was happening. The major corporate users took advantage of their freedom-to-choose with a vengeance. “Enterprise networks” grew so much that even the FCC, which had no access to their statistics, suspected that the unreported infrastructure was as large as the public one. By 1982, when the next key fit of lobbying came around, the fortune 500 played no role. “We have no stake in what happens to them”, I was told. The competitive carriers grew enormously in size and their clout changed from symbolic to real. Even households started buying non-Bell handsets and hanging them on the line.

Plenty was happening in the computer communications business too. 1976 saw the development of Ethernet, which allowed much faster data transfer in local networks, and Queen Elizabeth II of England sent her first email. ARPANET technology became established outside ARPA and was adopted by large numbers of network users and some suppliers. Other networking technologies appeared commercially. The era of computer terminals connected to computers was evolving into the era of remote connections and networked computers.

And computers made the great leap to the desktop. The Apple I hit the market in 1977, the Wordstar word-processing program in 1979, and the mouse and Windows in 1981. From then on, a small user didn’t need to depend on anyone else for access. Indeed small computers themselves could be networked and take over the role previously reserved for the central processor. In the lingo of the business, the era of big iron was now threatened by the micro. The user now had another option, complete with another organizational structure. Inside organizations, the two would now struggle against each other.

Circa 1980, a consulting company that built systems for hospitals came to me for a sanity check.

They had done an analysis of off-the-shelf products and concluded that a certain big job could be done by either micros or mainframes. Choosing micros cut the price of a computation (million-instructions-per-second, or MIPS) by 99.5 percent. It seemed implausible; what had they done wrong? “Nothing, I said, but check it again next month.”

eight

In late 1979 I electrified an entire industry (so to speak). In closed session before about fifteen of the most influential men and women in the country, I opened my presentation with a tape lifted off my telephone:

> ...turning partly cloudy in the afternoon with a chance of showers in the early evening. Wednesday will be clear, but breezy and much cooler. This message is brought to you by New England Telephone.

By the time the reverberations of this talk had died out, its audience had launched a new industry, spent and lost hundreds of millions of dollars, and caused a law keeping telcos out of a major business sector.

The audience was the Board of Directors of the American Newspaper Publishers Association (ANPA). Katherine Graham (Washington Post) was there, as were Punch Sulzberger (New York Times), Robert Erburu (Los Angeles Times) and other mainstays of the industry. Here is the essence of what I told them:

At the beginning of our Program, Tony and I had a message for almost anyone. “Your business is about to find itself competing with other businesses whom you never thought were part of your world” It’s amazing how many free lunches in boardrooms we got with such a simple theme. But over the years we gave this idea considerable refinement and some practical teeth.

For example: Any information transfer takes place in three dimensions: substance (roughly “content”), process (roughly “conduit”), and format (as seen by the end user). Your particular business is defined by your specific location on all three. If you change even only one, you may have a different business.

The planes defined by any two of the axes are also useful. For example the substance/format plane can be thought of as the editorial plane; substance/process as managerial, and process/format as operating.

A newspaper is a bundle of different kinds of *content,* usually including local news, world news, editorials, sports, calendars, stock quotes, cartoons, horoscopes, weather forecasts, human interest stories etc. They mostly share a common *process.* They were originally collected by reporters, handed in print to editors, assembled in a layout room, set on linotype or similar

machines, printed on presses and distributed by truck and local carrier. Their *format* - the format seen by the end user - is print on large paper sheets. That particular slice of substance, process and format is the historic newspaper business.

The bundle of *content* items in that list is surprisingly diverse, both in what they are, and in the way the customer uses them. They came together in the newspaper largely by techno-historical chance. They all happened to be most conveniently used in a print-on-paper format.

“Technology”, I said, “is starting to break up the bundle.” First look at your own *processes*. The story of the newspaper business in the 1970's goes like this: By 1980 the same *content* is gathered in. The product still goes out in the same *format*, as print on paper. But the *processes* have been revolutionized. Most of the content now comes in over wires. It is organized on a computerized layout system. The printing plates are designed electronically. You did this to save money. The customer doesn’t see anything different, but there are some very important commercial differences.

One is that you can now produce different products. For example the archives are now electronic. One product could be remotely-searchable archives (for a price). Another could be an electronically-delivered newspaper. Yet another could be a tailored newspaper.

Actually the electronically-delivered newspaper was not a new idea. The first faxed newspaper product was offered by the Miami Herald in 1904. The difference might be that now the cost could be affordable and the customer might be acculturated.

In any case, pieces were already jumping out of the bundle. No professional stock trader got his quotes from the newspaper - much too tardy. No airplane pilot would get his weather forecast from a newspaper. It’s worth the extra money to get it updated electronically. The general public was beginning to follow the professionals.

And more importantly, it was now technologically and economically possible for other industries to supply the same content to the same customers using completely different formats and processes. Witness the telephone companies, more than ten times bigger than the newspaper business, suddenly offering weather forecasts.

And as if the appearance of electronic upstarts wasn’t bad enough, the long-term trends seemed to be in their favor. The cost of everything electronic was going down. The cost of newsprint, ink, and trucks was going up.

I pointed out that the newspaper was not in immediate danger of being supplanted. “Imagine a room full of technicians. I come in and announce that I have a new technology. It will carry 30 million bits of information, weigh less than 3 pounds, handle both text and graphics, be completely portable, be accessible in any order, operate 24 hours a day, cost less than 25 cents a connect hour, and be mostly paid for by someone else. I can assure you that the room full of

technicians would be amazed by this advanced capability. It is far ahead of anything currently available. The technology which I have described is the daily newspaper."

Where would this kind of thinking lead the newspaper magnates?

The question quickly focused in on classified advertisements. Newspapers have four sources of revenue: national display ads, local display ads, classified ads, and "circulation" - the money readers pay to buy the paper. Classified ads are about 30% of income nationwide - too big to lose, and possibly vulnerable to attack.

We have done more work than anyone else on the question of how a kind of information relates to different processes and formats. In this case, what predisposes something that has always been distributed in print to migrate to electronics, and when? The results, like the results of so many complicated investigations, look fairly obvious. For instance, if timeliness and searchability are important, and elegance of display isn't, then you have a candidate for electronics. If there's big money at stake, then the money is there to pay for it, which is why the stock quotes and airline weather went early. By 1970, classified ads looked like a good bet, as did local practical information like school lunch menus, school bus routes, and meeting schedules.

If the ANPA Board had any skepticism about my story, it evaporated four months later in Hawaii. As a result of my talk, Charles Brown, Chairman of AT&T, was invited to address the entire ANPA in open session. In what must have been one of history's most thoughtless disclosures, his message was "We're going into your business - we're going to eat your lunch". Good grief, Charlie Brown.

Newspapers jumped into the electronic age with a weapon in each hand. Offensively they launched the electronic newspaper. Defensively they leapt out of the woodwork onto the lobbying scene.

In the standard government arenas, including the FCC and the state PUCs, the telco regulators were the deans of the lobbying business. They had the best-paid people who took the commissioners and governors to the best dinners. Furthermore telco executives were expected to serve on local public interest boards - the local hospital and the Boy Scouts, for example - and to cash in on the good will if needed. Newspapers didn't even show up.

But when real money was at stake, the newspapers could play as hard a ball game as anybody. They now appeared, seemingly out of nowhere, both in public hearings and in "informal" meetings.

A congressional staffer described the encounter this way: "There are two things you can count on with the press. One is that the official witness will be the much-beloved publisher of some small-town paper, usually with gray hair. Citizen Kane will be nowhere in sight. The other is that you'll hear some eloquent version of the 'constitution argument'. The Constitution guarantees

freedom of the press. And if we lose xxxxx (in this case the de-facto monopoly on classified ads), there won't be any press any more. So the Constitution requires you to yyyyy (in this case forbid the telcos from owning content). When I hear this one coming I try real hard not to fall asleep, play my violin or throw up."

The soundness of the logic was not the point, however. What was widely believed to be the point was the symbiotic relationship between the front page and politician's faces.

This story was told to me by "a reputable source", who gave names and a date and claimed to have been there. The chairman of a key committee was buttonholed just as he was leaving his office for a plane to Europe. "If we don't get this one, your picture will never appear on the front page of the paper again." He turned to his staff, "give them what they want." Even if this tale is false, it clearly reflects how most Washington people felt about the press - they were being bludgeoned. Indeed the story may be a malicious rumor invented for revenge. "Never pick a fight with a man who buys his ink by the barrel" – attributed to Mark Twain and others.

AT&T could never have gotten the same results by threatening to disconnect his phone.

For the same reason, television broadcasters can exert disproportional clout. In 1996 they got an allocation of free spectrum for HDTV over the objections of Senate Majority Leader and presidential candidate Bob Dole.

nine

With the failure of the Consumer Communications Reform Act, the monopolies had lost their final offense, and were now on the defensive. The market was rushing out from under them. They fought it inch by inch, and lost each battle. When they could no longer own all the telephones in your house, for example, they came up with "the primary instrument". This doctrine asserted that the phone company needed to own at least one handset at each number, in order to properly test the line. Before they lost this one, the formal proceedings bought them about a year.

Telco-bashing was still an easy game, and very profitable for the competition. Aside from opening markets it also created an anti-monopoly climate that pervaded government action. Bills were proposed in Congress that broke up, rather than preserving, the incumbents' monopolies. They too failed, but set the scene for more action. The initiative passed to the Department of Justice and its antitrust case against AT&T.

The antitrust proceedings ground slowly through their normal channels. Behavior, structure and size were all scrutinized. Logic aside, it seemed almost certain that something major would happen, because of the antimonopoly climate.

In the proceedings:

- AT&T argued that it could not be punished for its behavior, as it had never done anything without full due process and approval by the government. This argument was perfectly true, but seemingly not persuasive.

- As to structure the company missed its best bet. It could have argued that its big customers had fled the monopoly and built their own telephone companies: hence that AT&T was no longer dominating the market. Instead they argued that the customer had choice, but they didn't produce statistics about how much had been chosen. Such numbers were not part of the public record. However we believed that a little sleuthing would produce robust estimates for what we called "off the screen" infrastructure development

- On size, they just didn't have a case. How could the largest company in history claim that it wasn't big?

A faction within the company argued that by demanding to "keep it all", AT&T was making "the mistake of the century". AT&T was a vertical monopoly. It owned local telephony, long distance, basic research, equipment design, manufacturing, and ownership of the wires and gear on the customer's site. The argument centered on that last one - gear on the customer's site.

The "keep it all" argument centered on the unitary nature of the network. If anything wasn't done "right" then the whole system was in jeopardy. It looked like an OK place to draw the line.

However the "foreign attachments" debate had already been lost. It is our Program's practice not to take sides, but if there is only one side we come down forcefully on it. There was no other side. With some attention to quality and interfaces, you can interconnect pretty much anything. Furthermore, people had been doing it for some time, and it worked. We articulated this case, as did of course the competitors. The "mistake of the century", according to its detractors, was to insist on keeping foreign attachments. Had the company given them away, the "keep it all" argument might have held for the rest.

Recriminations about the decision to go for it all surfaced again in The Wall Street Journal of September 5, 1997 as part of an article about John Zieglis' fitness to be Chairman.

In 1982 the antitrust suit took a sudden and unexpected procedural turn. There were several possible outcomes on the table. In a classic regulatory or *courtroom* format, the procedures would have called for laboriously picking each one, laying out all the logic and subjecting its acceptance to an open vote. Instead the key players went into smoke-filled-back-room-horse-trading mode - the classic *political* format. After a quick bargaining session, the company and the government emerged holding hands, and announced the basic structure that has shaped the business ever since. The agreement would take effect on 1/1/84, and was formally called the

"modification of final judgment (MFJ)". It was commonly called "the divestiture".

Incidentally the MFJ was also commonly called "telephone deregulation". The vocabulary in Washington at the time used polar opposites: Would we have monopoly and regulation, or would it be competition and deregulation? The divestiture was a philosophical endorsement of competition. But deregulation it wasn't. Since 1/1/84, the budgets, the head count, and the lines of code at almost all state and government agencies concerned with telephones, have gone up. Even more dramatic has been the increased involvement of the courts. It turns out that the conflicting stakeholders didn't evaporate on the passage of the MFJ; they just had to learn a new collection of governmental levers to manipulate.

The decision broke AT&T into one long distance company and eight local ones. It invented "Local Access and Transport Areas" (LATAs) roughly paralleling one or more pre-existing area codes. AT&T kept the traffic among the LATAs, as well as equipment manufacturing and much of Bell Telephone Laboratories. Local transport was given to the new companies, combining the 22 local operating companies into seven "Regional Bell Operating Companies" or RBOCs. Informally these were called the "baby bells"

After a bitter post-agreement battle with the babies, AT&T was stripped of the rights to the word "Bell", although only three of the RBOCs chose to use it in their corporate name.

Part of the Venerable Bell Telephone Laboratories (whose annual budget was bigger than Harvard's endowment) became AT&T Laboratories. The other part (about 8000 people) was jointly owned by the RBOCs and was renamed Bell Communications Research Corporation (BellCore). Local carriers were called "local exchange carriers (LEC's). Non-Bell LECs were CLECs or Competetive Local Exchange Carriers.

After the divestiture, a list of the ten largest "utilities" in the United States read like this: 1 AT&T, 2-8 the RBOCs, 9 General Telephone and Electronics, 10 Pacific Gas and Electric. *Each* of the fragments, and also the largest of the independents was larger than the largest non-telephone utility. All of them were Fortune 500 size.

A rule of government, when possible, is "first, do no harm". Satisfying it required some financial contortions in the way divestiture was organized. You may remember that by virtue of earlier financial contortions, prices equaled costs. Divestiture broke that chain. AT&T got fifty percent of the billable revenue stream, but inherited only 20% of the costs. Simple arithmetic suggested that local prices would rise hugely to make up the difference. The burden would fall on end users, aka voters - a political no-no.

The solution was called "access charges". AT&T would pay originating access charges to pick up a call from a local exchange carrier, and also pay terminating access charges to hand the call over to the carrier at the receiving end.

Access charges immediately raised the price of an AT&T-carried call by 80% to (guess what!) exactly the price before divestiture. Access money was passed on directly to the LEC's rather than being available to AT&T. Access revenue provided about half of all RBOC revenue, allowing them to keep prices at (guess what!) exactly pre-divestiture levels. However if you were a competing long-distance carrier (at first) or an enterprise network or data network provider (to this day) you were exempt from paying access charges. Access charges instantly provided a big incentive to get off the AT&T network. But incentives play out after the next election.

The baby Bells were also born with three prohibitions: no equipment manufacturing, no provision of "information services" over their own lines, and no interLATA carriage. Equipment manufacturing and interLATA carriage might be considered a reasonable outcome of the horse trading - dividing up the goodies among the parties. But the old AT&T had never been in the business of selling information; where did that one come from?

You guessed it - a concession to the newspaper business.

ten

Between the cost/revenue split, and the restrictions on the Bells, it was widely claimed that AT&T would soar out of the utility world and become a high-tech high flyer, while the Bells would remain stodgy, regulated utilities with utility p/e ratios. Investors bet big money on it. They were wrong.

AT&T's story is the easier to tell. The 1984 star-struck business to be in was computers, and everyone presumed that was where AT&T would go. It was also presumed that the company would lay off excess staff and rid itself of the monopoly mentality. It would of course also grow with the data business, which would of course amount to half the traffic in three years.

The company's costly disasters with computers are now well known. Its first billion-dollar-plus writedown-and-layoff were greeted with rave reviews by Wall Street. So were its second. There was a litany of praise of the "this company has become lean and mean and gotten its act together" sort.

Shortly after the third writedown, a cover article appeared in Fortune that said "wait a minute". Any writedown after the first is an admission that the last one didn't work. It went on to detail negative earnings, destruction of value, managerial incompetence and inconsistent strategy. Overnight, it seemed, AT&T flipped from golden boy to whipping post, where it sits as of this writing.

AT&T's woes, however, were not entirely of its own doing:

First it had to fight for equal treatment with other carriers on the access charges. It had to pay them, they didn't. Even when it won something on this problem, it won in little steps, with

several years of improving-but-not-yet equal treatment. With some carriers, most notably enterprise networks, it has never reached parity.

Second, it became the first example of the now-world standard of “asymmetrical regulation”. Asymmetrical regulation is supposed to be a transition between regulation and free market competition. On day one of competition, the incumbent carrier obviously has all the market and the power to crush the new entrants. Hence a regulatory counterweight has to balance the scales while the competition grows up. The competition was free to enter markets, negotiate deals and set prices at will, but AT&T had a long fight for those privileges. Furthermore it was exposed to open hearings, in which the competition could find out what AT&T was doing and even shape its actions.

eleven

Now for the Bells: The press was down on the Bells from day one. “Stuck with the dregs”, “No chance for growth”, “Utility margins and p/e ratios”, “Over regulated”, “Stodgy monopoly mentality”, “No control over half their income (access charges)”, “Too many employees, and unionized to boot”, “product turning into a commodity”, “saturated mature market”, “wide open to unregulated competition” were all among the common views. Not us, however. We saw them as having the biggest and best monopoly going; with monopoly being just as good in 1984 as it was a century before when the robber barons (if you’re a Democrat) / captains of industry (Republican) so overtly lusted after it.

To this mountain of complaints, the Bells added their own special grievance, as well as a shot or two in the foot.

The grievance (completely missed by the press) grew out of the RB/ROR formula, which specified that earnings were nothing but a government-set percentage of the book value of the plant. We quickly pointed out, and they agreed, that RB/ROR ganged up with “smaller, faster, cheaper, better” to create a very nasty bind.

“Smaller, faster, cheaper, better” has a simple corollary. If you provide the same amount of service, and the cost of the gear over which you do it is dropping through the floor, then the value of your plant will decrease. In an unregulated business - great! Ross Perot rode Electronic Data Systems to a vast fortune by exploiting that truism. He signed up ten-year contracts to provide computer services at a reasonable price, and then watched as his costs went through the floor over the ten years.

But if your costs drop under RB/ROR you’re dead in the long run. In fact you’re dead twice: once because you have to drop your prices, and once because your earnings fade away.

And if by some miracle you can avoid dropping your prices, then the Second Ozark Plan (remember those cost-allocation schemes) leaves you wide open to the competition. Costs had been disproportionately allocated to business customers, and also to urban ones."Value-of-service pricing" usually meant that if there were more people in your local exchange, then you charged them more.

In a 1990 paper, I compared the Bells' situation to a popular parody of the three laws of thermodynamics: You can't win, you can't break even, and you can't get out of the game.

- "Win" to a businessman, means earnings growth that beats inflation by more than three percentage points. Or at cocktail parties it means doing better than the average of the other businessmen at the party. But the Bells' future was threatened by nothing less than their past success: universal service, the only engine of growth the industry ever had, was finished.

- With no engine of growth, is there still chance of breaking even? Unfortunately that's where the RB/ROR formula and "smaller faster cheaper better" now gang up on you.

- But can you get out of the game? With problems so fundamental and dramatic, what's a poor RBOC to do?

twelve

The Bell's came up with responses fully as fundamental and dramatic as the challenges.

There were three big strategies, and a potent tactic. They were tried by not only the Bells, but by other telcos in the US, and around the world as well. Here they are in roughly chronological order.

The tactic, which would not seem dramatic in an unregulated industry, was called "rate rebalancing". This fancy phrase meant two things. One was "deaveraging", or the power to charge different prices in different places. The other was to adjust the income stream between residential and business customers.

The competition rushed to business customers like filings to a magnet. If it were only a matter of economics, the Bells could reallocate some common costs away from these customers and serve business with lower prices (and you thought prices were already reflecting true costs). But if they did so, the other end of the balance scale would go up. Those were residential customers. Oops I mean voters - sorry about that. After thirteen years of hard combat with the governments (lustily supported by the competition) we've seen only modest progress.

thirteen

Strategy one was “abolish regulation, or at least RB/ROR”. In the “deregulation” euphoria, the Bells all believed briefly that government had faded away, or at least that the regulators would topple with a small push. (It was during this euphoria that they laid off their cost-allocation wizards) But the competition, the governments, and the even the Bells themselves (eager to use regulation against the competition) wouldn’t let it happen. The state was stronger than the company. The RBOC's spread themselves out on a continuum from “work with them to keep them happy” (BellSouth, Bell Atlantic) to “fight ‘em to the death” (USWEST), with the others in between.

USWEST launched a nationally-famous publicity drive against the regulators, using cowboy images and slogans (“if you don’t make dust, you eat dust”). The Chairman of one of their Public Utility Commissions (PUCs) kept one in his office that showed two male buffalo bashing heads in a courtship battle. “It reminds me of the company”, he told me: “big, aggressive, stupid.” In the end this tactic cost them and their stockholders a great deal of money, probably billions.

The PUC’s came to recognize themselves in a changed role, at least in telecommunications. Most had been established in what might be called “the late robber baron” era. They have charters that mandate them to guarantee utility benefits to the public, and to protect the public from utility abuses. By 1980, that had come to be the minority portion of what they were doing. Instead they had become the arbitrators among business interests, mostly between telcos and competitors. They had become the tools whereby interest groups and telcos manipulated each other for their own purposes.

To put it another way, the good news is that government is a fair and open forum. That can also be the bad news. There would almost always be a session in which the government body would turn to the stakeholders and say “if you will work this out among yourselves, I’ll enact it.” If they didn’t, then government would work out a solution that gave a little something to everyone. By now, the stakeholders couldn’t agree on much.

Telcos were very slow to recognize that influencing government no longer meant taking a commissioner out to lunch. Now they had to reach compromises in advance with the other players before going to government. And compromises meant giving something away, a hard sell for the internal decision makers in a traditional monopoly.

The attack on RB/ROR seemed to have better odds. The state governments were the fields where many flowers bloomed, and several alternatives budded forth. They included “social contract” (I’ll guarantee not to raise residential rates, you let me alone otherwise), “banded pricing” (freedom to adjust prices within limits), “profit sharing” (divide the extra profits between shareholders and customers), and “price caps” (freedom to lower, but not raise rates). Some ideas dealt with prices, some with profits, and some with a diminution of public proceedings. Our own inquiry, which dissected these alternatives into their logically pure components, remains the most comprehensive to this day.

In the end, most states adopted an alternative to RB/ROR. “Price cap regulation” became the almost universal term. However different states came out with different meanings, and none of them was a “pure” concept, but a mix.

But a funny thing happened on the way to reregulation. No company had significantly better earnings than it would have had under RB/ROR. Indeed many states kept a shadow RB/ROR in place, along with the power to reinvoke it if the company did too well. Some states adopted schemes that one company characterized to me as “RB/ROR in drag.”

Yet another natural constant appeared circa 1985 - “two years.” This was the time that the Bells believed it would be until the big three federal restrictions were abolished. Like the “three years until data is half of all traffic” constant, it influenced strategic planning, and it rolled ever forward out of reach.

The RBOCs had one very bad break, illustrating beautifully the role of randomness in industry structure. Oversight of the decree was kept by the court - specifically Judge Harold Greene. The court had great latitude both as to the aggressiveness of its oversight and the range of its interpretation. Greene took an aggressive stance. His strong anti-Bell, and frequently sarcastic, opinions were a brick wall against latitude. When freedom from the court finally came, the act of Congress that brought it was nicknamed “The Harold Greene Retirement Bill of 1996."

fourteen

Strategy two: “get out of the telephone business”. Within three years, each RBOC had approximately 100 subsidiaries, spanning everything from computer stores to real estate to fleet management.

We worked closely with all of them as they made these decisions. Lots of different kinds of thinking were tried. Let me try to explain some of them using our “Information Business Map”.

The Map is one of those ideas which is hard to come to, but stunningly simple once you do. Tony and I had been trying for years to invent a visual representation for our field. It wasn’t until 1978 that one of our colleagues, John McLaughlin, finally cracked it. The essence was picking the right axes for a two-dimensional display. The vertical axis (going up) is simply “product” vs. “service”, which turns out not to be polar, but a continuum. The horizontal (as you move right) is “conduit” vs. “content”, or more flexibly, “form” vs. “substance”. Once you've chosen these basic things to measure, you can then find a unique spot for any item on the market. It’s all explained in our publication “Mapping the Information Business” by John McLaughlin and Ann Louise Antonoff.

An empty piece of stationery is all form and all product, with no aspects of content or service. It lives in the bottom left-hand corner. Make it into a blank business form, and it has a little more content. It lives to the right of the empty one. Filling in the form moves it further right (more content). Make it a form you fill out on a screen, and it moves upwards on the map - it's now a service. The upper right hand corner (all content - all service), is occupied by consultants and doctors. The middle is computers. You can fill in the map with the items you care about, and you now have a map of the whole industry. We called ours "The Map of the Information Industries".

Now the fun begins. You can start drawing footprints. A blob that encompasses all the items your company sells is the footprint of your company. You can also draw your regulators, your anticipated future, your competition etc. You can add a third dimension. Pick what you care about: size, growth rate, employment level, profitability, amount of unionization - you can put it on there. We've heard the quote "half the information/communications 500 used your map as the central tool for their strategizing." We worked with many of them ourselves. The map kept coming back to us translated into new languages - 17 at latest count. The Dutch version was done and handed to us in person by the CEO of Elsevier. The Map appeared, among other places, on the cover of a Southwestern Bell Annual Report, with planners hunched over it.

One kind of "get out of the business" Bell thinking went like this: Executives would visit us, shut the door, pull down the curtains, get out the map, and ask, "where are people making money?". This was a good question and we checked it out. The answer: "everywhere on the map, people are making money and people are losing money." Ergo the real question is "where can I go that I'll be advantaged over whoever else is there?"

A lot of lists were drawn up, purporting to name the strengths and weakness of an RBOC. I marveled at how different they were, even coming from different people in the same company.

- One obvious answer is that they were good at the RBOC business. More than one reasoned that the answer was to buy another RBOC. Somehow this seemed the wrong end to an exercise that began with the assumption that they had to get out of the business they were in.

- Another was to suppose that they were good at what they did internally, even though the customer didn't see it as a product. Telcos own a great deal of prime urban real estate, and manage a lot of trucks, for example. Some went into real estate, fleet management, facilities management, equipment repair, personnel services, contract billing and the like.

- Another answer was that the essence of telco success was management of large networks. Some of them spawned contract network design or management divisions.

- Yet another was that we're good at lobbying and managing utility regulatory environments. Some Bells tried to get into water, gas, or electricity.

- "We're in the information business" - hence a try at any dimension of the same. Some

companies set up information utilities. Because they were prohibited from selling their own content, the utilities managed other peoples' content. Gateway services, messaging services, and Minitel-like operations were all tried.

- Another mode of thinking was more directly based on our map. Any number of business-school studies have shown that the remoter a new business (or acquisition) may be from the traditional business of a company, the greater its likelihood of failure; and conversely. This alone may explain why new industries (say computers, cable TV) have been dominated by new companies, rather than assimilated into older dominant companies. This effect can be portrayed clearly and simply on the map. The remoteness of another business from yours is simply the distance on the map. Adjacency means that you add or subtract some element of content or conduit, or make it a little more or less producty or servicey. The less distance you have to go, the more of your current skills, capital base, existing customers, etc. are useable. An example of this reasoning: if you are familiar with providing telephony (a service), why not also sell telephone network gear to corporate networks (a product)? All seven of the Bells became distributors of Northern Telecom's "Meridian" line of switches.

The territory adjacent to yours on the map is your most logical place to expand. It follows usefully that it is also the most likely locus of companies who might expand into your territory - "competition out of the woodwork" in traditional business language. The map helped a lot of companies avoid surprises.

Before we leave it, let me mention a couple of interesting asides about the map. First, the map is expandable in a fractal fashion. If you take a piece of it, and fill in the products and services at the next level of detail, it fills up again. It's like the starry sky. If you take a stronger telescope, you see more stars, rather than running out of them. Many of our affiliates have taken the part of the map that concerned them most and expanded it to see finer grain in their neighborhoods. Second, a time series over the history of the US begins with businesses that are all in the corners, and then later fill the center.

There was a considerable flap over the "videotext" (sometimes called "videotex) business. Videotext was a dial-up information service, provided over a terminal. Either a specially provided dumb terminal, like Minitel, or a computer and modem would work. The information could be anything, but usually ran to local information, such as city guides, airline reservations or restaurant menus.

Several major newspapers, including Times Mirror and Knight Ridder, set up videotext divisions. It was rumored that one of their motives was to show good faith to Congress, after getting the Bells shut out. Many foreign telcos tried as well. Perhaps you remember Antiope, PresTel, Bildschirmtext. The Bells were prohibited by the content restriction, and were livid with envy. They lobbied constantly, as well as planning to do it in two years when the restriction would of course be lifted. The newspapers editorialized against letting the telcos in. Of all the editorials I saw, only The Wall Street Journal consistently admitted its own stake.

The business was a bust worldwide. The screens were slow and annoying, content providers didn't flock to the opportunity, and no good model emerged for a revenue stream. Who came out ahead? The Bells. While the videotext operators were losing their shirts, they were also paying their telephone bills.

Minitel deserves a footnote. As part of a much-needed plant modernization in the seventies, France leapfrogged the world in installing digital lines, and also uniquely provided small domestic terminals to the home. The stated goal was to subsidize a technical advance, and then sell it to the world, as France had done with railroad and subway technology. They put on a good sales show, and for several years, telcos elsewhere were mesmerized with the prospect of a Minitel-like enhanced basic telephone (see strategy three, below). A closer look at Minitel economics, however, suggested that the stated cost was achieved by ignoring a lot of development costs and overhead, and the stated usage ran heavily to pornography and chat lines. Over half of all users polled said that they would drop Minitel if charged only $1/month for it. We described Minitel as a flop masquerading as a triumph.

Minitel, purchased or copied from the French, was tried in several other places, including by two of the Bells. Nowhere did it prove viable. In France it is still there. A European Commission survey in 1995 discovered that awareness and usage of the Internet was significantly lower in France than in other developed countries - and even than in less-developed European countries, such as Greece and Portugal. Good or bad, this gap is usually laid to Minitel.

Minitel was only one of several technologies that intrigued the Bells; and other companies, investors and policy makers as well. It seemed to be a trait of information technologies generally that they exploded in popularity and produced vibrant, rapidly-growing, profitable industries. Consider the copier, television, the calculator, color TV, the computer, cable TV, the VCR, the personal camera, the telephone itself; and later the fax machine and the Internet - blockbusters each one. Collectively they had evolved the world from the industrial age into the information age. Surely the next success story would be _____ (fill in your next product aspiration).

The success of information technologies is especially impressive if you forget the failures, like picturephone, the paperless society, cashless society, the Japanese fifth-generation computer and analog HDTV. The Bells, based on their own history of success, were quick to assume that any prospects in their own business - like Minitel or Videotex - would surge as well. In fact if they failed last try, it was only because of a little glitch, (screen too slow, cost a tad too high, customers not ready) but the future was theirs.

fifteen

After a few burned fingers, the companies (I am now speaking of the Bells plus almost everyone else, including the computer, media, and consumer electronics industries. We worked with all of

them) became more sophisticated.

Questions like “when will it take off”, and “what will the user use” became much more prevalent by the mid eighties in all industries. We developed a few techniques to help.

Looking more closely at these questions produces some useful information. For example.

- The technology that “takes off” is rarely new. If you’re looking for something that is going to take off, you can probably find it in technology that's been around for a while, and not in something brand new. This remark usually causes some spluttering followed by a counterexample or two, usually including the fax machine. We have always been able to counter the counterexamples by citing their lengthy history. The fax machine itself makes a particularly good one. Can you estimate the year in which the following quote appeared?

> The probable simplification of the fac-simile [sic] system of Caselli, by which an exact copy of anything that can be drawn or written may be instantaneously made to appear at a distance of hundreds of miles from the original; and the countless other applications of electricity to the transmission of intelligence yet to be made, ---- must sooner or later interfere most seriously with the transportation of letters by the slower means of post.

It’s from the Annual Report of the Postmaster-General of the United States for the Fiscal Year Ended June 30, 1872.

- However by itself the idea that the technology is already around doesn’t do the whole job. There are lots of technologies around, and most of them will fail. How do you find the winner? There are two forks to this exercise:

- - One is to look at the function that the technology will perform. If the function is already being performed, and there is a budget for it, and the technology will do it smaller, faster, cheaper, better etc., then the stage is set for the next iteration. Otherwise you can probably forget it. Thus it’s no surprise that the big four personal computer “killer applications” - word processing, graphics, spreadsheets and databases - are what they are. People have always done those things. Thinking about serving existing functions is a powerful tool for evaluating the prospects of a new company.

- - The other is to look for early adopters. The marketing community has a well-developed language for the penetration groups, including “early adopters”, “shoulder”, “early mass” and so on. Lots of technologies have no adopters. They’re probably not about to take off. Early adopters are usually found in identifiable communities, such as large corporations, the military, and the affluent. Then they trickle down. Examine where something is now and it becomes easier to guess where it might go next.

The Bells supposed that the best market for advanced phone services was the Fortune 500. Once

they had developed that one, the market would move down to the larger number of smaller companies. They were right and wrong. Right that the Fortune 500 were the early adopters. Wrong that they were a Bell market. The Fortune 500 were big enough to offer these services to themselves. The real Bell market was the medium-size firm.

- The knee-jerk commercial response to a new product (service, technology etc.) is to do a market projection, complete with focus groups, interviews, trial markets, price-sensitivity studies and the like. These tools are knee-jerk because they have an excellent historical record and are used every day with great success. But there's a limit to the environments in which they work. The customer has to be already familiar with the function performed by the product. No problem for soap and automobiles. But for technologies that do something the customer hasn't done before, the findings are bogus. Videoconferencing, Teletext, and interactive TV have come in way under the study results. Mobile phones have come in way over them.

sixteen

Yet another kind of thinking, value-added-chain analysis, led the Bells to yet other business ideas. The dreaded word "commodity" was beginning to crop up in conversations about their traditional service. Their offerings were turning into platforms, on which other people built things that made better margins. IBM and DEC were having the same problem. Where could they themselves capture margins like that?

Two answers presented themselves: applications and content.

Applications meant solving specific problems for specific market segments. IBM had made some money that way, but had been slowly forced back into the large-scale systems-integration business. The vast multiplicity of little high-margin applications was too diverse for them. The same turned out to be true for the Bells. Telephones and computing had become too easy to use. To serve application niches, you needed to know more about the niche than about computing and telephony. In most cases, these niches were being served by entrepreneurs coming out of the niches, not out of the information industries.

It is true that the successes made splendid returns. But the analyses that I saw the Bells do did not average the successes with the failures. I haven't done the arithmetic, but I suspect that if you count both the successes and the failures, you get an average return that's below the Bells'.

Content seemed to fascinate the Bells - as it has fascinated others. Once they were free to offer it, three of them set up a Hollywood enterprise, and hired Michael Ovitz as CEO. Then they lost him to Disney. I was told that the surviving Hollywood and telco people fell to squabbling with each other until the outfit was shut down.

In various regulatory and legislative drafts, the Bells got permission for a kind of "video dial tone" regulation that would permit them to provide their own content like a cable-TV company. But this hybridization made a lot of content suppliers nervous about equality of access - the essence of the principle of common carriage.

seventeen

By now we know that overall these "get out of telephone business" ventures have added up to a costly failure. And RB/ROR has gone away mostly in name. We also know that the Bells haven't gone down the drain - in fact they've outperformed the Dow as investments. What's the story?

The most common explanation for the failure of the RBOCs' other ventures is their own ineptitude. What can you expect of an ex-monopoly?

I will grant some truth to this reason. Their planning cycles were too long. They were too slow about recognizing and shutting down failures. Legal departments were accustomed to saying "no", rather than "how can we do this without setting a precedent". They hadn't honed their skills in a bruising marketplace. Incentive structures weren't tied closely enough to performance. But "ineptitude" fails to describe the Bells' staying power, smart people and capacity to learn.

There is another reason, and it became clear to us as we worked with the new or "unregulated" divisions. It derived from the old cost allocation problem, and the persistence of regulation. Regulators, egged on by the competition, were nervous about unfair competition. "How do we assure that you're not subsidizing the competitive products from the monopoly ones", or alternatively phrased "how do we assure that you're not benefitting the shareholders at the expense of the ratepayers?" It's a good question, considering that there's a huge common cost pool and no true cost of anything. The regulators responded by putting burdens on the unregulated businesses to satisfy the noisy competitors. There were obligations for a percentage of any profits, licensing fees for the use of the Bell name, mandatory assignment of overhead costs; surcharges for any personnel who moved from the regulated side to the unregulated; you name it. By the late 1980's we found ourselves working with entrepreneurs and venture capitalists who had concocted a business *because* it was in competition with the Bells. They figured it was good business to compete with someone who opened a market and then must serve it with one foot nailed down.

Just about a decade after my presentation to the Newspaper publishers, I was asked to do it again. "I was right the first time", we agreed. "The electronic information business is worth watching. But forget my example of the local telephone company and the weather forecast. They won't be the player to beat. When this business becomes viable, I'll consider quitting Harvard, getting an honest job, and setting up LeGates Enterprises. I won't be hobbled like the telcos and

I'll be a more formidable opponent. I won't do it though, because I can't think of anyone who has a natural advantage over you yourselves. You have the brand name, you own the content, you have the eye of the user, and you have financial and political muscle." It looks like a business in which newspapers have the natural advantage. Nonetheless, the Association President, Catherine Black, insisted for another year that: "mission number one is keeping the telcos out of classified ads." The mission only died when ANPA merged with the Newspaper Advertising Bureau (NAB) to form the National Newspaper Association (NNA). NAB won most of the internal power struggles, and the ANPA agenda faded.

But if the Bells didn't forecast their failures, they also didn't expect their successes. Four relatively straightforward businesses did very well for them - as our map would have anticipated.

- One was the traditional yellow-page directories. On divestiture the Bells were given the yellow pages in order to help subsidize local service. Earnings (from none to all, depending on the state) were imputed for that purpose. Senior telco management considered these divisions too humdrum for serious attention. Almost all directory companies tried to redefine themselves into something sexier, and to build higher-tech businesses. "We match buyers to sellers", "we are a marketing organization who can market other things", "we can print specialized directories" and "we can do all this on-line" were all redefinitions of what the business was deep down inside. Money didn't seem to come naturally in the fancy stuff, but the basics turned out to be a growth business with 100% margins.

- One was cellular telephony. We argued from the beginning that cellular was not a different business, but the ordinary telephone of the future. Each US geographic market was allotted two cellular carriers by the FCC. One was the local landline carrier, the other a new competitor. The landline carriers pretty quickly bought up most of the new competitors, but only in someone else's territory. It too was a very profitable high-growth business.

- One was telephony overseas. Service may be excellent and penetration may approach 100 percent in the US, but in few other places. By and large your regulators don't mind if you make a killing on customers, so long as they're somewhere else. The Bells have done well by doing good abroad. But both *foreign* regulators and currency exchange uncertainties have prevented this one from being a blockbuster thus far.

- Last was the surprise growth in extra access lines. At least partly at our urging, the Bells set up second accounting systems that didn't rely on regulator-assigned costs. These systems suggested that they didn't necessarily lose their shirts on each local loop, especially if they used long-run incremental costing methods. Second lines began to be sold for the teenagers or whatever. Then came computer modems, fax machines and finally the Internet. The "mature" market turned out to have a lot more growth in it.

eighteen – personal digression

Now that I was at Harvard and relating to a new collection of characters, I started getting a different kind of unsolicited job offer. I was asked, for example, to be Federal Under Secretary of Commerce for Telecommunications and Information. I was asked to be the Massachusetts "information czar". I was invited to join the Boards of several of our affiliates, including Apple Computer and one RBOC. Two high-tech multinationals and one startup asked me to be CEO. I considered all the full-time positions, and decided that I was happier doing what I was doing. I would have enjoyed being on Boards, but I had to turn them down to maintain the Program's impartiality. Tony and I often described ourselves as having taken vows of poverty and chastity.

One offer was particularly tempting. After divestiture, Wall Street smelled money in the (allegedly) newly freed telcos. I was asked by Robert Fomon, Chairman of E. F. Hutton to join the firm. If I would bring my understanding and contacts, he would teach me the investment banking business ("you will not find this challenging to learn") and put me in charge of all the information/telecommunications industries, a #2 slot in the company. I might have done it, but a temporary (I didn't know it was temporary at the time) back problem was too troublesome.

Most of these invitations were appealing. I had a fondness the for-profit environment. Most offers started above triple my current pay plus equity. It took a strong love of what I was doing to make me say "no".

nineteen

The third Bell strategy for beating the RB/ROR bind gets us into the front-page issues of the 1990s - "convergence", "the information superhighway", "the national information infrastructure", "the new communications act". It was also their principal shot to the foot. In essence it's "redefine basic service upward". Or, "if the plain-old-telephone-service market is saturated (universal service), then make something grander the new universal norm."

Telcos had been incrementally creeping up on broader-bandwidth offerings. "Big pipes" were already being sold to the commercial market. They had been in use for internal communication among major switches for many years. A service called "ISDN" which offered two channels of 64 kilobits/second plus a smaller signaling channel (full-motion video-cassette-quality movies require about 1500 kilobits/second) had been on the market for some time, but hadn't found a clear application. Doubters said that it was an acronym for "I Still Don't Know". Nippon Tel. in Japan announced a plan to fiber the whole country in 25 years, and then abandoned it. Doubters called it "the high fiber diet". Various Bell plans were floated, Congressional hearings were held, and all that.

Ideas this big and this public come with not only business plans, but with vocabularies and social philosophies. The full-blown version was the “information superhighway” fever of the 1990's. It held that society had a lot to gain.

These lists usually began with telemedicine, telelearning, telecommuting (and therefore less pollution), access to job opportunities for the poor and homeless, and the like. They neglected to point out that earlier advances in information, from Gutenberg through Minitel, had been driven by pornography, entertainment, and chit-chat.

We testified before both the House and the Senate in 1990 that the economics of universal-fiber-to-the-home didn’t look good. The telcos themselves floated costs of 200 to 400 billion dollars to provide connections. What would go over these fibers and what would people pay for it? We pointed out that the only proven product was video entertainment. People already had that in the form of cable TV and video rentals, providing a rough check on the revenue opportunity. The entire industry brought in gross revenues of about thirteen billion dollars, with profits running about 10 per cent. Even assuming that the telcos captured 100 percent of that revenue (meaning that the cable guys rolled over and died when confronted with competition), the business was a loser.

twenty

Those hearings were a kind of watershed. They marked the end of the era when telcos might hope that government would fund universal fiber, even if only by permitting telcos to charge for it. But then how to solve the RB/ROR problem by building up the plant? The Bells next move was to look at the economics of paying for it themselves - shareholders and not ratepayers. Most concluded that one (or maybe both) of two approaches made sense for the next step:

- One was to continue the already clear pattern of building fiber out from the central switches, to smaller switches and even to the big customers. As costs continued to drop, this approach might eventually get you there. Meanwhile telcos could explore the matter of usage and payment on the margin.

- The other was that they might be able to pay for fiber with cost-savings on maintenance. It is true that maintenance of old copper plant is very expensive. It is true that digital switches and fiber are easier to maintain than the old stuff. The Bells seemed to about to embark on a quieter, pay-as-you-go era of incremental bandwidth growth.

twenty one

However the information superhighway was about to gain a lot of friends and take on a life of its own.

Remember “convergence?” It meant that different information businesses were using basically the same, basically digital, technology. For all these businesses “smaller, faster, cheaper, better” had been at work during the eighties. Just as in telephony, they were finding reduced costs, increased functionality, new technological opportunities, and plummeting barriers to business entry. Those quiet changes were setting up a new kind of convergence: If each industry took a big enough leap, they could maybe all leap into the same monster business: the fusion of carriage and content, data and pictures and voice: products and services. “The information superhighway” was the term suddenly on everyone’s lips. Several industries, each coming from its own corner, and each with its special set of imperatives, could now think about snatching the whole prize.

> Let me ask you this: Who started the information superhighway? Who really talked about new technology allowing interactive two-way information and entertainment services? We did. It wasn’t the telephone companies.

said John Malone, CEO of TCI, the largest cable company, speaking to Wired magazine in July 1994.

Why so public? Why then? Why interactive? Malone, whose earlier remark about offering 500 channels had touched off a content-building frenzy, had two solid reasons:

- For some time there had been a growing outrage about the rise of cable prices and the decline of service quality since cable deregulation. In 1992 Congress began to get serious about some form of reregulation that could limit rates and restrict flexibility. The cable business was eager to equate its own well-being with the promise of the information superhighway. Any limitation on the industry’s income could then be seen as cramping the superhighway’s development. Legislation was passed in the autumn of 1992 nonetheless, and became the first piece to override a veto by President Bush.

- Also in the early 1990's a new wave of competitors appeared on the horizon (no pun intended): the satellite TV broadcasters. About ten of them published business plans, and two got financial backing - the standard test of reality vs. dreaming. These companies posed the most serious attack on the cable industry since the 1950's, when it had established itself in face of opposition from television broadcasters. To the customer, a satellite broadcast looks just like a cable connection.

Except that if cable wants to, it can - at least in theory - add something that broadcasters can’t: “interactivity” or “two-way information flow”. And sure enough, the cable industry pounced on just that feature. In essence it said, “The future is interactive and broadband. It will bring revolutionary benefits to society. So let’s steer the money, the customer’s attention, the entrepreneur’s focus, and government benefits in that direction”.

Government adoption of this vision might cause all sorts of good things for the cable companies:

funds to dry up for non-interactive technologies (like terrestrial and satellite broadcast); interest by possible content providers, reduced priority for the painful government processes of spectrum allocation, anti-trust approvals, protection from competitor lawsuits, and the like.

Although the interview with *Wired* didn't name it, "broadband," was another prominent feature of the cable rhetoric. Broadband was aimed at another hot debate of the moment" Who can get there first with broadband interactive service, cable companies or telcos? Telcos were given credit for having interactive switchable connectivity, but needed to implement broadband. Cable companies were given credit for broadband, but lacked interactivity and switchability. Needless to say, it was to the advantage of cable companies to promote the virtues of "broadband."

Seeing an opening, the telephone industry, especially the local telephone industry, became vocal again. They flooded the public and government forums with more studies and lobbying efforts. These purported to show, for example, that each dollar spent to develop the telephone infrastructure would return many dollars to the economy; that electronic access could cut the cost and raise the quality of health care; the same for education, and so forth. The "incremental" strategies I described before got a new vocabulary. They were now the companies' commitment to the superhighway.

With the publicity rolling forward, yet another constituent chimed in, lending a new kind of credibility - the personal computer industry and, in particular, John Sculley, then head of Apple Computer. Apple had built a strong following and an image as a maverick. To this, the company added the credential of stunning success. Sculley went public with a "vision" of the electronic future. He portrayed a convergence of the computer, telecom, office equipment, information vendor, media and publishing, and consumer electronics businesses. This convergence would create a single, huge on-line marketplace, soon to generate $3 trillion annually. (Sculley acknowledged his debt to our Program for the visual centerpiece of his presentation: diagrams built on our "map")

Why Apple? Why now?

Apple, it turns out, was experiencing its deepest downturn and first downsizing ever. It was increasingly seen as losing the competition with DOS-based (later WinTel-based) machines for the personal computer market, which it had virtually created. With its superiority in human interface and multitasking, who better than Apple to be at the center of the new marketplace, pulling it all together and making it possible?

Sculley did something else novel for Apple. He got involved in politics. "Novel" is perhaps an understatement. Apple had begun with a strong counterculture mentality. In its early years it refused to do business with the federal government at all; and for a while afterward refused to do business with the Department of Defense. But in 1992, Sculley pitched into the Presidential campaign on the side of the Clinton-Gore ticket and subsequently became a media star in their Administration's information highway program. He got the seat beside Hillary Clinton at the first

State of the Union address.

Did I say “Administration?” Our Program has worked with every administration since our founding in 1973, and we’ve seen a consistent pattern:

Each new administration brings in a new White House staff, made up mostly of bright people with a political background. Three to nine months later we get a call from whoever’s got the communications portfolio. The conversation goes like this:

White House: “This is a tremendously complicated business - the most complex and confusing item on our plate in fact. (One specifically claimed it to be far more complex than nuclear war, energy, foreign policy or the environment). And all the experts are trying to sell us something. We need to talk to someone who understands it and who isn’t partial.”

Us: “OK, let’s talk.” We point out that there is no voter concern about communications, probably no White House decisions that would affect the national interest, and the industry is a very aggressive bunch with hopelessly divided stakes. Any Administration stance will have vocal opponents.

After a little thought, all administrations have come to the same conclusion: “This area has no political gains and a lot of possible losses. Keep the Administration’s head down in the foxhole and stay away from it.”

Not so the Clinton Administration, specifically, Vice President Albert Gore, Jr. The information superhighway and the National Information Infrastructure (NII) played a central role in Gore’s vision for American economic and cultural advancement and American world leadership.

Why? I can only offer guesses. Gore is a Harvard graduate. This fact both inhibits our Program from saying anything bad about his abilities and background, and disqualifies us form endorsing them. He did his senior thesis on information policy development: he should have a sense of what he was getting into. My own best guess is that he was inspired by his father. Senator Albert Gore, Sr. is best remembered as a prime mover of the Interstate Highway System.

Vice-Presidential priority or no, the Administration didn’t actually do much. The amount of money budgeted for the NII, was trivial both by the standards of the industries involved and of other government development programs, such as NASA or transportation. And most of that budget was never appropriated.

twenty two

As it evolved, the information superhighway story took a subtle but definite twist. Its imprint in the world of reality was being overshadowed by its separate existence in the world of theater. There was something there, but the image was much bigger, and took on a life of its own. It was

a kind of technological tulip mania or South Sea bubble.

It reached its frenzied peak on October 13, 1993.

I woke up a little groggy on October 14. Part of the problem was the usual jet lag. Part of it was the usual letdown after a dialogue with a large high-level audience. I had spent the evening before as solo performer before about 150 people in Kuwait City. The Emir wasn't there. But the heads of the major banks were, as were most of the cabinet secretaries and heads of Parliamentary committees - in short the shakers and movers. They were well-informed, and asked pointed questions. I had insisted that there would be major confrontation and/or accommodation between the telcos and the cable business over the information superhighway: the bandwidth guys versus the switched guys. But, I also insisted that there were too many reasons why nothing important would really happen despite the noise.

Even in Kuwait the headlines and the television news of the 14th were completely dominated by "The Deal of the Century" - the merger of Bell Atlantic and TCI. It would be the largest merger ever in the information industries, and one of the largest in industrial history. There were concrete next steps and budgets. The highway was coming to your neighborhood soon. When I visited the headquarters of two other Bells in the next month or so, I could almost smell the testosterone when I got off the elevator. Why wasn't it *WE* who did that? There were several hasty copycat mergers.

There was also a new level of scrutiny about how practical all this was; most notably by the financial analysts and "due-diligence" departments on Wall Street. What they found looked less like the millennium coming and more like the apocalypse:

- TCI was loaded with so much low-quality debt that it could seriously dilute Bell Atlantic's cash flow and lower its debt rating. TCI hadn't made a profit in four years.

- Cable plant was way below telco standards by the standard quality measures.

- What regulated company wants a bedfellow that has just been raked over the coals by Congress for price-gouging and lousy service?

- And especially there was no sign of a new market for the information highway's services. Hence what money could cable companies and telcos go after but each others'? And there wasn't, as we already know, enough of that to pay for the plant upgrade.

The rest, as they say, is history. The merger fell apart four months later, and the copycat mergers copied shortly thereafter. The price of cable stocks fell sharply. The share price of telcos with cable holdings declined, while the others rose.

The words "information superhighway" started being seen with words like "much vaunted, "

much hyped," or "so-called". There was a steady parade of negative stories on the topic.

On May 18, 1994 The Wall Street Journal ran a pair of articles on the first page of the "Marketplace" section. One was entitled "They'll Spend Lots, But Lots Less Than They Say." It had only one graphic, titled "Hype and Reality." The caption was "Companies brag about spending huge sums, but their announcements are padded with money they would spend anyway." The other article was titled "Interactive Trials Are Trials Indeed - Tough to Start and Tough to Judge." Its only graphic was titled "Big Plans, Little Action." Harsh words, I would say, for companies that were behaving prudently and trying to get a little credit for what happens on their watch.

The Journal again on September 26, 1994: "Now the notion of telephone or cable-TV networks' delivering vast amounts of video, data and voice traffic is dubbed the 'superhypeway.'"

Speaking at the National Press Club on October 19, 1994, Sumner Redstone, CEO of VIACOM and Paramount said, "It seems apparent that the information superhighway, at least to the extent that it is defined in extravagant and esoteric applications, is a long way coming, if it comes at all."

On Sunday, October 30, 1994 The New York Times "The Week in Review" used the phrase "If you're sick of all those information revolutions, press 1", in an article titled, "Slow Mo - Changing the Wiring Takes Time."

When SBC announced its plans to buy Pacific Telesis, the spotlight fell on Edward Whitacre, the Chairman. Among his frequently-cited credits was that he had ignored the information superhighway all along.

With the perspective of a few more years, an article in Fortune of October 13, 1997 examined "Transforming Telecom: The Big Switch". It said, "As their data networks take shape, the phone companies must avoid the sort of fiasco they had on the information superhighway."

And I have been called a "hero" in Kuwait ever since (though I haven't heard the word "prophet").

twenty three

When the United States sneezes, the rest of the world catches a cold. The European Commission committed itself to the superhighway, basing its convictions on the "Bangemann Report", wholly paid for by the national carriers. Japan (The Japan Information Infrastructure project, "JII"), Korea (KII), Singapore, Hong Kong and many others soon followed suit. The two national carriers in Australia were on a fiber-to-the-home arms race until mid 1997. There was (and is) even a "Global Information Infrastructure" (GII) Commission. Most of these flurries are still

alive and well-funded.

I have always enjoyed words that encapsulate a complex concept. “Relictual” has been coming to mind lately. A species is “relictual” if it has died out in its original location, but is still populating some other places. Can we call the information superhighway “relictual” yet? Is it on its way to being an outright relic? The answer would seem to be yes. But once again something new has changed the game.

twenty four

Just when the whole issue was almost asleep on the back burner again, a previously unknown student at the University of Illinois named Marc Andreessen started to give away the “Mosaic Browser” in 1993. It enabled easy use of an obscure format released by CERN in 1992 called the “World Wide Web”, which ran on a network unknown outside the research community called “The Internet”.

The Arthur D. Little Forecast of Information Technology and Prductivity, published in 1991 didn’t mention the Internet. Neither have I in the Harvard part of this history, despite my natural affinity for it. It was too small for the policy and strategy radars. By 1995 it was on the cover of Time Magazine.

The communications world took it as a tsunami from nowhere. It was even bigger and less expected than the VCR, which forced the broadcasters, the cable companies and Hollywood to restructure themselves; or the fax machine, which wiped out Zapmail (but hasn’t yet done in the Postal Service). We know of course that the Web had its logical precursor in the library at Alexandria, circa 300 BC, - or thirty centuries earlier with the Babylonians - and its electronic precursors in the sixties. The Internet had been around for a quarter century.

The VCR took off when it hit a price point. The fax machine took off when the Group Three Facsimile standards were settled The Internet took off when it got easy to use - courtesy of the web browser. True, quality, price, reliability and the like have to be right, but it seems that the explosion trigger can’t be found by formula.

As a European researcher put it to me: The governments and companies have literally spent billions on the highway, and now it’s collapsed. They’re desperately looking for a way to save face, and the Internet might just do it for them.

It’s hardly fair to write off the various information infrastructure commissions (and USWEST - the only Bell to still have an announced program in 1997) as exploiting the Internet to save face. There’s really something going on here, and it’s worth serious attention. The agendas have changed. Now there is a mix of the old (high bandwidth interactivity and the social goodies) and the new. What does the Internet mean for us? It’s a fun question.

NOTE FROM 2011: THIS ENDS THE CHRONOLOGICAL NARRATIVE. WHAT FOLLOWS IS SOME OF OUR IDEAS in 1997 ABOUT THE INTERNET. “WHAT IS IT, WHERE IS IT GOING, AND WHAT DO WE DO WITH IT.” BECAUSE WE NOW KNOW WHAT HAPPENED NEXT, THIS DISCUSSION IS A HISTORICAL CURIOSITY.

I CONCLUDE WITH SOME GENERALITIES ABOUT THINKING ABOUT THE INFORMATION FUTURE, ALSO WRITTEN IN 1997.

twenty five

I participate weekly in well-funded efforts to understand the future, done by intelligent people whose attention is focused by having real stakes. Most of them are inside corporations. I have done so for thirty years. Their thinking is the best available. They are usually only trying to forecast the big things, like major trends or a technology explosion. And their record is appalling.

I remember walking into the new office of the Chief Financial Officer of AT&T when headquarters had just moved to Madison Avenue. I looked around. It was of course expansive; with views, mahogany, artwork. He looked at me. He knew what I was thinking and he knew that I knew what he was thinking about it. "This office," he said, "was built for the chief financial officer of a corporation that could forecast its revenues out for a decade to within 4 percent." That had been true for so long that it was an unstated assumption in the company. But by the time he said it, we both knew that it was gone forever.

There are some ways of thinking about the Internet that can help.

For starters, there are some success factors that we’ve learned from the past. I’ve named several already:

- The technology has been around for some time.

- It does something better than the way it is currently being done..

- The “something” is a normal, natural, common human use.

- The budget is already there.

- There is an early-adopter community that is not especially hard to find.

These observations have a fairly clear negative value: if you don’t see them, then a technology is very unlikely to take off. They can be used to scout for promising items as well. For the Internet, they all seem to be present.

Here are some of the certainties and uncertainties of the Internet to date - obvious truths first.

twenty six

- Unlike the information superhighway, the Internet is driven by events and not hopes, ambitions or forecasts. No matter what any planner says or does about it, something happens. The highway was driven by supplier push, not user demand, and on a visionary or “field-of-dreams” basis.

- The Internet not only became a big phenomenon suddenly, but it has changed course and character suddenly several times. It’s adaptable.

- It shows no sign of the kind of stability that would lead us to say, “OK, now we know what it is and how big it will be.”

- As it grows, it seems to become more like society at large. From an initial population of almost 100 percent white educated 20-45 year old males, for example, it has diversified to include a representative slice of minorities, women and the elderly. From a medium on which everything was accessible and free, it has evolved into a medium full of firewalls that separate communities, and locations requiring registration or payment for access. From an instrument not subject to apparent rules, it has sprouted ownership structures, behavioral codes, and legal enforcement.

- The disconnect between usage and payment is well known, but moderating. In 1995 a survey showed that 80 percent of all users thought it was free. The flow of money tracks usage much better now, but still much less than in the economy at large.

- The Internet has had several explosive growths, and there are different versions of what they are, depending on what you choose to measure. One way is to look at web sites and their intended audiences. The first eruption was individuals communicating with individuals. Then came corporations communicating with individuals. The .com domain (for-profit organizations) became the largest single domain in 1994 and had over half of all hosts by July 1995. Around then Cisco, Netscape and others discovered that 80 percent of their market was becoming large corporations building intranets - corporations talking to themselves. These are real, funded markets.

- As might be expected, the patterns of behavior and funding are different for personal and professional use - even if it’s the same person doing the using.

- On the personal service side, no supplier seems to be profitable, including the most obviously successful entities, such as Amazon, America On Line, and Netscape.

- By contrast, equipment providers, and companies that lease lines to the net are doing very well

indeed. They are not dependent on whether other players win or lose, just so long as they try. There's a good analogy here to a gold rush. By and large the prospectors didn't do as well as the folks who sold them picks and shovels.

-On the corporate intranet and extranet side, making money is not usually the expressed purpose, so much as saving money or enhancing productivity. These two virtues have been hard to measure for computers, partly because before/after comparisons are usually measuring different things. They are even harder to measure for the Internet.

- The Internet has blown away all forecasts for long-distance data bandwidth. This once stable business always had reasonably predictable growth. Now that it's (at last!) turning into a data (rather than voice) market, requirements are larger and as capricious as the Internet itself. More serious, perhaps, the basic unit is no longer voice requirements (reasonably stable) but data requirements (unknown territory). We know how much capacity a minute of talking will require: not so for a minute of browsing.

- If we use some of my criteria in searching for a killer money-making application, we come up with an obvious candidate: Internet telephony. It serves an obvious need and goes after a several-hundred-billion-dollar existing budget. Lots of players are going for it. But there are some intriguing uncertainties:

- - The first invention of packet switching, Paul Baran's 1962 Rand study, was in response to a voice-only need, and was not implemented. Ever since then, Internet technology has had a problem with voice. The heart of it is the need for a voice signal to arrive on time (unlike, say, most data transfers). Even the half-second delay caused by a geosynchronous satellite connection is way too slow. Packet switching basically sends a packet on its way to compete with other packets for the next available route to its destination. How long it will take to get there depends on the traffic, just like cars on a highway network. Every time I have looked at the state of packet switching, including when I had a role in its design around 1970, the "latency vs. accuracy" dilemma was a key problem. Several of the major milestones, such as the development of TCP, was stimulated by it. In each case, the latency hitch was about to be fixed. It still is.

- - One of the keys to solving this problem is some kind of data-prioritizing scheme, and several have been tried. Most have proven to be improvements but not solutions - like the high-occupancy-vehicle lane in a highway. A real solution, of course, is to have a lane all to yourself, even if a virtual one. But then what's the difference between that solution and good old effective-but-inefficient circuit switching?

- - Which leads to the question: is Internet technology really more cost-effective than circuit switching? Packet switching fills in the spaces between calls, and even between words - a big winner. However in the local loop efficiency is not relevant - it's used only minutes a day and at a fixed price. In the high-density interswitch segments, traffic is already being handled by high-density packet switching technologies, such as frame relay and asynchronous transfer mode.

Gigabit Ethernet may become a contender as well. TCP/IP (Internet) protocols do not provide an improvement. A number of studies have suggested that Internet technology adds something only in medium-density environments. And this improvement is true only when packet switching is not mimicking circuit switching.

- Another apparent killer application is shopping. We are starting to learn a bit about Cybershopping.

- - It works beautifully in some corporate environments. An auto manufacturer can shop for brake linings, and even electrical systems. But there are some environmental simplifiers helping out. The purchaser and the seller know each other, and each other's reliability and ability to deliver and to pay. They are each expert on the nature of the product. They know they have recourse if there's a failure. The orders are relatively large. The people involved are professional buyers and sellers.

- - In the retail environment, things are considerably less clear. From the universe of possible products, only a few are showing any promise at all. Of those, only a very few - mostly offered by very small players - are showing a profit. Basic uncertainties are cropping up all over the place. Does the customer need to see, smell and touch the vegetables, chemises or luggage? Does the customer want the social experience of being out of the house? How about in the store? Do people believe the Internet is a safe place for their money? Even if so, are they in the habit of paying that way? If I want to shop around for a pot, do I prefer a cybershoppingmall, do I click on a kitchen supply store, or do I just do a search for "+pot +'for sale' ". Or in other words, who might be set up to disintermediate whom? Practical answers are coming hard. Neither the advertiser-supported nor the subscriber-supported model has proven itself an adequate source of revenue. If they don't do so someday, shopping activity on the net will decrease from its present level.

twenty seven

Now let's think about the future - not specifically of the Internet, but of the electronics/information/communications world generally.

The kinds of thing that we can call "certain" turns out to be regrettably obvious - we knew them all along. For example:

- "Smaller, faster, cheaper, better" and Moore's law will produce results into the foreseeable future.

- If you're a user, your personal computer will get more powerful, and maybe also cheaper. You will have more choices for your video entertainment and information. There will be more suppliers, more channels, more stuff, better video quality, more interactivity etc. etc.

- If you're a supplier, life will change ever more quickly. You will *benefit* from SFCB because you are also a user. You may also benefit from the new markets and the instability - someone always does. But you may also be *harmed* by it because it makes the product and competitive situations so much more messy.

- The structural ways that SFCB plays out will also continue into the indefinite future. If you're a user, they are probably working to your benefit. If you're a supplier, they could be your friend or your enemy, depending on where you sit and how well you adapt.

- - They break down barriers to entry.

- - They drop the cost of doing anything.

- - They make new things possible, then easy.

- - They weaken the priesthoods of suppliers and experts.

- - They put the power in the hand of users.

- - They make previously unimagined products and services commonplace.

- - They lead to a sense (probably permanent) that we are on the threshold of a grand and unpredictable future.

- - They guarantee that almost nothing in this realm will stand still.

- Regulation is not going away. Government-imposed barriers to entry, overall, seem to be slowly diminishing. But the amount and complexity of government involvement is going up, especially if you include the courts, and the standards-setting bodies - some of which are a flavor of regulator.

- There is no reason to believe that some of the eternal dualities will settle down on one side or the other. Organizations will continue to oscillate between centralized and decentralized structures, with the war between local control and central control going on indefinitely. Likewise the intelligence in a distributed information or communications network will also continue to oscillate between central and peripheral, with strong forces pushing each direction.

- Human nature will not change. The latest technological excitement always produces a bevy of visionaries who think that their gadget will alter basic human behavior. Nope.

However once we get past these generalities, the details get fuzzy pretty fast. I think it's fair to say that anything you are already doing, you will be able to do better. Is there some feature missing on your spreadsheet on Management Information System? Does it cost too much? Is it

too slow or unreliable? Won't fit in the desk drawer? Does it force you to get expert help? Relax in the long run - it will get better.

But how about things you aren't already doing - the breakthroughs and surprises? Yes, they will happen. Yes they may change your behavior - though not in a way that's contrary to your nature (for those, you'll change their behavior). No you can't figure out what they will be. Yes you can get an idea by looking in the labs and at early adopters and at the functions you're already using and needing. If you want to guess at likelihood and timing, you can get some help from looking at the players and stakes, the forces and trends, the rules,.

And if you're in the business, heed some more words coming from Intel: "paranoia pays"