In summary, this paper has laid out four major points. First, the assumption of predictability is pervasive in infrastructure planning and design. Second, it is not an accurate or a supportable assumption given the nature of the economy and the society in which we live. Third, assuming predictability can lead to facility obsolescence, poor utilization, and excessive government influence on the direction of economic development. And finally, a flexible approach that is consumer-focused, oriented toward quick payoffs, avoids irreversible actions where possible, and utilizes good market research is a much more appropriate way to plan aviation infrastructure.

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TELECOMMUNICATIONS AND BUSINESS TRAVEL: THE REVOLUTION HAS BEGUN

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President, The Arvai Group

It is a great pleasure to speak to a group concerned with the future of transportation about a topic which we believe too little attention has been paid -- future advances in telecommunications substituting for business travel.

In the novel, *Jurassic Park*, a character named Dr. Ian Malcom, espousing "chaos theory", clairvoyantly states that "nature always finds a way" to make a stable situation unstable. Today, I would like to modify that notion and apply it to the business community -- "new technology and entrepreneurs will always find a way."

Many of you in the audience might say "Here we go again, another forecast of videoconferencing reducing air travel demand. We went through this in the 1980s, and it didn't happen. What is so different today?" Our research indicates that those pipe dreams of the 1980s are becoming possible as we approach 2000.

We believe that the business world will soon undergo a *revolutionary* change, as important as the introduction of the personal computer. These changes in the way we communicate, driven by technology, will affect how we work, how we communicate with others, and how often we will need to travel on business.

The results of our recent research into the impact of advanced telecommunications technology on business travel indicate that a significant substitution effect will take place as desktop videoconferencing becomes affordable and commonplace. (Figure 27)

- **Telecommunications Will Compete with Air Travel through Desktop Videoconferencing**
- **It will Enhance Productivity and Substitute for Some Business Meetings**
- **Several Forces Will Drive a Fundamental Shift in the Market Dynamics of the Air Travel Industry**

FIGURE 27 The revolution has begun.

What is desktop videoconferencing? Our vision of desktop videoconferencing is full motion video communications between individuals utilizing their personal computers as videoconferencing units from their desktops.

Imagine your office in 2005. Your PC will likely have a large, multi-window, flat-panel display, which could be mounted on your wall. It will be connected to the phone network, and through standard interfaces with your combination scanner, fax and printer, you can send and receive documents from almost any user anywhere through standard protocols developed in the late 1990s. You will also have a micro-camera to transmit video and audio of your conversations and the capability to connect into multiple videoconferences from your desktop.

You still even have full-motion video voice-mail systems; and when these connections are made, you will be able to judge the reactions, body language, and expressions of the other party, something that is impossible with plain old telephone service today. AT&T's commercial showing a mother tucking in her baby by remote videoconferencing indicates that we are not far away.

Desktop videoconferencing can be effective for many situations and could substitute for direct contact. Sales people with established relationships will use desktop videoconferencing to substitute for some (not all) in-person sales calls. Rather than call on the company once every two months, a salesperson could videoconference monthly and visit quarterly or semi-annually, providing double the contact at a lower price.

Many internal company meetings, such as introducing a new product to a geographically dispersed sales force, could be conducted by videoconferencing. With time-based competition, just-in-time delivery,and more to do in less time, it may make more sense to videoconference than to call large national or regional meetings.

In our view, the question is not whether substitution will take place. The process has already begun, as evidenced by the now ubiquitous fax machine. The key issue is how large will the substitution be, when it will occur, and the types of business trips which will be affected.

By examining several forces driving this change, we estimated the impact of desktop videoconferencing substitution for air travel to be substantial. (Figure 28)

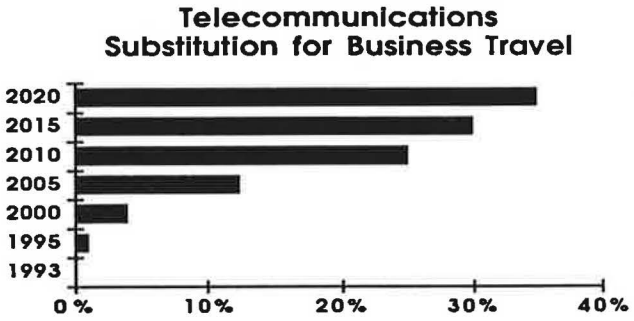

FIGURE 28 Our research projects significant substitution for air travel.

We project a 25-percent substitution for business travel by air by 2010, and potentially a 35-percent substitution by 2020. Desktop videoconferencing, now in its infancy, will become affordable by 1997 and achieve widespread adoption by 2005. By 2010, we believe desktop videoconferencing capability will be as common as a personal computers and telephones; virtually every office will have one.

Are these numbers realistic -- one in four business trips? Will companies really change the way they have done business for years? Some evidence has begun to emerge. A major Swiss bank has just ordered 75 videoconferencing units for its offices around the world. The real surprise, however, is that they have put them under the jurisdiction of their travel department, and a travel request will soon need to pass the "could it be done by videoconference" hurdle!

Take a look at some recent airline advertisements. One shows an executive complaining about the loss of 30-year customer and handing out tickets to his staff telling them to "visit every one of our customers", implying that reliance on the fax is not good enough. Another airline commercial shows a meeting and emphasizes that there is no substitute for face-to-face meetings. Is there something for the airlines to be afraid of.? We believe that there is. (Figure 29)

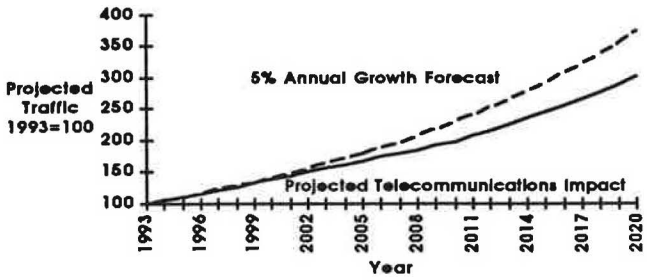

FIGURE 29 Telecommunications substitution for business travel.

The impact of these changes is significant. Telecommunications will have a dramatic impact on air travel demand. If we assume that 50 percent of the market is business traffic (a bit high today), our substitution estimates project the need for 2,000 fewer aircraft worldwide by year 2010. At $50 million each in 1993 dollars, the impact on manufacturing and balance of trade alone is $100 billion.

For the airline industry, substitution by their highest yield customers has significant implications for profitability and pricing. Because a 1-percent change in load factor can have a significant impact on the bottom line,maintaining the existing customer base will be a key priority. However, This will be an uphill climb.

Why do we believe this will happen? Four underlying factors are driving these changes. Telecommunications and computing technologies are advancing rapidly. Costs for air travel and advanced electronics are on markedly different paths. New technologies will be much more easily accepted by the next generation reared on Nintendo and virtual reality. And finally, demographics, life style and culture will also have an impact. (Figure 30)

- **Telecommunications Technology Advances**
- **Relative Costs and Productivity Impacts**
- **Acceptance of New Technologies**
- **Demographics, Lifestyle and Culture**

FIGURE 30 Several factors underly this coming structural change.

Where is technology going? Sematech, the semiconductor industry association, developed a forecast at its March 1993 technology workshop. (Figure 31)

Year	1992	2001	2007	% Change
Feature Size	.5μ	.18μ	.10μ	500%
Gates/Chip	300k	5M	20M	6,666%
DRAM bits/chip	16M	1G	16G	100,000%
SRAM bits/chip	4M	256M	4G	100,000%
k=kilobits, M=megabits, G=gigabits, μ=microns				

FIGURE 31 Technology will drive telecommunications advances.

Some of the advances projected are astounding. Dynamic and Static Random Access Memory, which facilitate advanced computer applications, will increase 100,000 percent between 1992 and 2007. Three orders of magnitude provides a lot of computing power -- - certainly enough for full motion video, which my portable Macintosh can play today.

How about the network? Like football, we seem to have a triple option:

- the telephone system with fiber optics and ISDN lines,
- cable companies which already bring high capacity infrastructure to both urban and rural areas, and
- direct airway transmission, via cellular or satellite communication, such as Motorola's Iridium network of communications satellites.

Combined with the Federal Government's interest in funding the "information superhighway", we believe the network will not be a limiting factor.

Airlines and desktop videoconferencing are at different places on the typical product life cycle cost curve. (Figure 32) Airlines are well down the curve, as

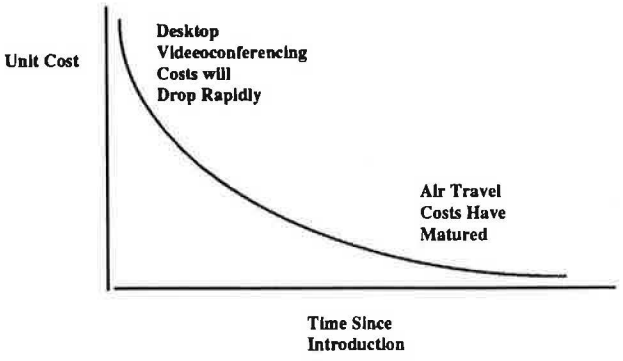

FIGURE 32 Airlines and telecom costs are headed in different directions.

the large, one-time gains in productivity from speed and aircraft size have slowed. With today's jets no faster than the 707, and new wide-bodies little larger than the original 747, productivity gains have resulted primarily from cost reduction, rather than rapid technological improvement.

Desktop videoconferencing combines several technologies -computing, data transmission, and their associated electronic components, which are still at early stages of development and on the high side of the cost curve. They will come down, rapidly, over the next decade. Air travel costs, by contrast, cannot fall much further; and the industry is looking to yield increases to restore profitability.

The IBM PC was introduced in the early 1980s -- only 12 years ago — and changed the way we do business. Can any of us imagine preparing our routine forecasts without a spreadsheet program? How many of us have used a typewriter in the past year? It was not long ago that we had to. Perhaps in 20 years we'll look back in the same way at the telephone and "stand alone" PC. (Figure 33)

- **Pocket Calculators Moved from InitiallyExpensive to a Giveaway Item**
- **Personal Computers Have Become a Major Industry in 13 Years**
- **The Fax Machine is Becoming Ubiquitous**
- **Desktop Videoconferencing Will be the Next Area of Growth**

FIGURE 33 Market adoption of new technologies has been rapid.

For desktop videoconferencing, the cost curves demonstrated by the pocket calculator ($200 for a four-function Bowmar Brain in 1972 to a giveaway item today), the fax machine (which has gone from expensive and slow to affordable and fast), and personal computers will soon be applied to desktop videoconferencing hardware. It will be extremely affordable for virtually every business.

Already the price of basic videoconferencing units has fallen from $40-50,000 several years ago to about $7,500 today. We project that desktop videoconferencing capabilities will be built into PCs and advanced telephones at only nominal cost within 10 years.

Demographics, life style, and culture will also influence the market. (Figure 34) My son is 8 years old and computer literate. He can play "Where in the World is Carmen San Diego", access drawing packages, and use other applications without me ever knowing he

- **The Next Generation is Growing Up with Computers and Video Games**
- **Desktop Videoconferencing Will Facilitate Telecommuting**
- **Videoconferencing is Well Suited to Certain Cultures**
- **Business Practices and Corporate Lifestyles are also Changing**

FIGURE 34 Demographics, lifestyle, and culture also influence the market.

was on my PC. Actually, that's a bit scary. But he is the type who would enjoy videotelephones and showing friends what he is doing. By 2010, he'll be out of graduate school and in the workforce, a part of the video generation.

Telecommuting has not yet emerged to its potential, despite the introduction of several telecommuting centers in California. It likely will, however, as life styles continue to change. I now carry my office computer with me on the road. It is a portable machine that allows me access to most of the information available in my office. With videoconferencing, I could join my colleagues for an office meeting from the road, whether I am at home in New Hampshire or here in Washington.

How many of us have done business with Japan? Their management style, which includes participation of virtually all departments of their organizations to build consensus, often results in meetings with more than a dozen people on one side of the table. Sending 12 people by air a business meeting is expensive. To have them participate in a videoconference is, on a relative basis, quite inexpensive. We believe that Japan may be an early adopter of desktop videoconferencing, just as they have been with conventional videoconferencing today. During the Gulf War, air traffic dropped and videoconferencing traffic between Japan and the U.S. increased 400 percent. That is not a surprise. The surprise is that it has remained at that high level while air traffic has not come back as strongly. Video-conferencing is gaining acceptance.

Business life styles are also changing. My recent "interrupted vacation" is evidence that time pressure is driving the executive life style. The fax, cellular phone and other mechanisms to "speed up" the business day are here and real. If desktop videoconferencing removes a long and arduous trip by air, it will be another arrow in the executive's quiver of technological advances to enhance productivity.

Airlines may need to rethink their pricing policies for business and leisure travelers as they face new competition from telecommunications. While we foresee substitution impacts for both domestic and international air travel, the impact may be more significant for "short trips over long distances", in which travel time may be greater than the productive time spent in meetings. While some executives will enjoy "getting out of the office pressure-cooker" to take such a night, others may see such a trip as threatening to their level of productivity and instead videoconference. In either case, emerging communications technologies will likely allow the executive to be in touch wherever he or she may be, even on board an aircraft. (Figure 35)

- **Airlines Face Slower Growth and Loss of Highest Yield Customers**
- **Aircraft Manufacturers and Suppliers Face Reduction in Demand**
- **Telecommunications and Computer Companies Will Integrate Products**
- **The Manner inWhich We Routinely Conduct Business Will Change**

FIGURE 35 The implications are tremendous.

Suppliers to the airline and aircraft industries may need to consider slower growth alternatives in their core businesses, or diversification into other areas for growth.

As telecommunications and computer technologies merge, who will become the leaders in desktop videoconferencing? How will the integration and standardization process evolve? Will the next PC operating system include videoconferencing capabilities?

Finally, how will we routinely conduct business 12 years from today. Will it be as different as 12 years ago, before we had personal computers?

Our research is continuing, and we have begun a survey aimed at identifying more clearly the specific functions most susceptible to substitution and the relative likelihood for such substitution.

The next few years will be exciting times, with dramatic change. I look forward to sharing them with you.