

THE INFLUENCE OF COMMUNICATIONS ON TRANSPORTATION
IN THE FUTURE

by

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(The opinions, findings, and conclusions expressed in this
report are those of the author and not necessarily those of
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SUMMARY

The report examines the influences of communication on transportation from various points of view. First, the historical influences are discussed as they occurred in the United States between 1776 and the present. Second, probable influences to the year 2010 are presented. Third, the influences are examined through responses to a questionnaire obtained from people in three types of cities. Fourth, influences are described as seen from an individual's perspective. Fifth, influences are discussed from a regional point of view. Finally, influences are presented as they are likely to occur in Virginia in the future.

The conclusion reached is that new communication systems will, in general, reduce transportation demands as compared to demands without these systems, although in some situations they will increase transportation demands.

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INTRODUCTION

The need to forecast future demands in transportation is vital, if not critical, in an industrialized society such as exists in the United States. It takes many years to plan and build transportation facilities, be it highways, airports, or rail lines. Lead times of ten or even twenty years are thus desirable for forecasting purposes. A host of complex factors must be considered in any forecasting methodology. Basically, the influences of population, economy, natural resources, governmental policies, social conditions, and technology have to be accounted for. Countless studies dealing with these factors have been conducted, although only a select few are listed in the reference section of this report. (1-7)

One technological factor that has not been addressed to any degree is that of possible new communication systems. It will be shown in this report that communication has had a significant effect on transportation. Its effect on transportation in the future is also going to be important. The specifics of how new communication systems are likely to influence transportation in the next ten to twenty years are thereby discussed in this report. A somewhat narrower focus on probable conditions in Virginia is also considered.

HISTORICAL RELATIONSHIPS BETWEEN COMMUNICATION AND TRANSPORTATION

To establish the relation of communication systems to transportation systems, an outline of parallel developments by time is shown in Table 1. The conditions are limited to the United States, beginning in 1776, the time of founding of the country, and continuing to the present. Under the heading of "Transportation", only the primary modes that involve some sort of vehicle to move people are listed. Walking, running, and the like are not included as such modes have not changed in any essential way. The various modes are listed by approximate degree of use, starting with the one most used. Under the heading of "Communication", again only the primary ones used by people are listed,

described in order of approximate degree of use, starting with the one most used. Face-to-face communication by voice or gesture is not included as these too have not changed essentially. Little used, inadequate transportation and communication modes, such as hot air balloons, skis, horns, flashing lights, and smoke signals, are not listed in the interest of avoiding a forest of nonessential minor factors.

Table 1

Parallel Developments of Transportation and Communication

| Time | Transportation | Communication |
|-----------|--|--|
| 1776-1799 | Horseback Horsedrawn vehicles Boats (oar power) Ships (sail power) | Handwritten letters Printed material (pamphlets, newspapers, books) Drawings (hand done) |
| 1800-1849 | Horseback Horsedrawn vehicles Boats (oar power) Railroad trains (steam power) Canal boats (human or animal power) Ships (sail power) Vessels (steam power) Bicycles | Handwritten letters Printed material (newspapers, pamphlets, books) Drawings (hand done) Telegraph Photography (still) |
| 1850-1899 | Horsedrawn vehicles Railroad trains (steam power) Bicycles Boats (oar power) Vessels (steam power) Ships (sail power) Canal boats (human or animal power) | Handwritten letters Printed material (newspapers, pamphlets, books, magazines) |

Table 1 (continued)

| | | |
|-----------|--|---|
| | Horseback Automobiles (steam, electric, or petrol power) Streetcars (animal or electric power) | Telegraph Photography (still) Grooved records (audio) |
| 1900-1949 | Automobiles, trucks and buses, (gasoline powered) Trains and trolleys (steam or electric) Boats and ships (steam or petrol) Boats (oar) Airplanes Horsedrawn vehicles Dirigibles | Printed material (newspapers, books, maga- zines, etc.) Radio Handwritten letters Grooved records (audio) Photography (still and movie) Telegraph Teletype Television Wire recording (magnetic) |
| 1950-1984 | Automobiles, trucks, buses, carts, and motorcycles, (gasoline, diesel, and electric) Airplanes and helicopters Trains (electric or petrol) Boats and ships (petrol) Bicycles | Printed matter (diverse forms) Radio (diverse forms) Telephone (diverse forms) Television (diverse forms) |

Table 1 (continued)

| | |
|---------------------|--|
| Boats (oar or sail) | Letters (typed) |
| | Photography (still & movie) |
| | Grooved records (audio) |
| | Letters and drawings (hand done) |
| | Audiotape record- ing (magnetic) |
| | Computer (diverse forms) |
| | Videotapes and discs |
| | Teleprinters |

With an overview of transportation and communication as shown, it is possible to establish a number of generalized relationships between the two modes.

In the period between 1776 and 1799, the number of choices for both transportation and communication were quite limited. Virtually all forms of communication listed required transportation of some sort. Letters, books, and the like to be carried any distance required either horsepower or vessels. Communication was consequently slow and unreliable. However, as there was little choice but to use transportation for communication, such communication as there was tended to increase transportation demands. At a local level, communication in the form of posters, handbills, and the like increased transportation by inducing people to travel to various local events. To a lesser extent, letters and drawings from remote regions induced some people to travel to these faraway places, for business or adventure. An estimate of the overall increase is approximately 20%. However, communication also had an inhibiting effect on transportation in that communication (particularly from remote regions) called attention to the many dangers and hardships of travel. Allowing for a negative effect of about 10%, an estimate of the net increase in transportation caused by communication in this time period is roughly 10%.

In the first half of the nineteenth century (1800-1849) several new modes of transportation came into popular use, along with one important development in communication. A system of canals (particularly in the northeastern part of the United States) augmented natural rivers and lakes to form an inland waterway system. Canal boats, drawn by animals or poled by people, provided an alternate method of transportation to animal drawn land vehicles. Soon after, the development of the steam

engine enabled large ships to be driven across water independent of wind, weather, and muscle power. Similarly, railroad trains could be powered by steam to move people and freight across land, wherever tracks could be laid. At a personal level, the introduction of the bicycle enabled people to travel faster and often with less effort than by walking.

All of these new modes, in conjunction with the older modes, encouraged people to travel more, further, faster, and with greater safety and reliability.

The invention of the telegraph was the first major advance in communication whereby people could reliably communicate with one another over long distances almost instantaneously and without the need for any sort of transportation facility. Once wires capable of carrying electricity were in place, information in the form of words and numbers could be transmitted by a series of electrical pulses. Although not the ultimate system of communication, it greatly facilitated and stimulated business transactions and, to a lesser degree, personal communications. It is worthy of note that most of the telegraph lines followed transportation corridors as roads and railroads, so that the development of transportation networks also aided communication, as well as the reverse. The telegraph, in particular, made possible the timetable scheduling of trains in that messages could be relayed well ahead of the trains at station stops. Time scheduling of railroads also gave emphasis to the need for coordinated time zones across the country, another matter of great importance to electrical forms of communication.

Photography was introduced in the latter part of this time period, but its use was limited to "professionals" due to the cumbersome nature of its operation. Its effect on transportation was minimal as drawings and paintings were still the dominant method of showing people and places. Scenes of faraway places continued to attract certain people to these places, thus resulting in some increase of transportation.

Considering all modes of communication available to people in the period from 1800 to 1849, it is estimated that the resulting increase in commerce generated an increase of transportation (for goods as well as people) in the order of 40%. At the same time, travel was decreased by approximately 20% in that people could send telegraphs or mail with reasonable reliability, speed, and economy, thereby reducing the need for personal travel. Communication thus resulted in a net increase of transportation of about 20% in the first half of the nineteenth century.

The United States, in the second half of the century (1850-1899) started out preoccupied by slavery issues (culminating in the Civil War) and ended with a surge of industry and commerce. At the same time, the country was rapidly expanding westward, due to a combination of the

expanding population, the establishment of the railroad, and economic opportunities in the west.

Railroad lines proliferated over the country, connecting east to west and north to south so much so that canal traffic dwindled. Sailing vessels gave way almost completely to steam vessels, thus promoting reliable water transport. In cities, new modes of transportation began to appear, namely automobiles and streetcars, along with improved versions of the bicycle. In the realm of communication, the telephone was developed, along with grooved recordings that could preserve sound. The process of printing became more automated and inexpensive, with the result that there was much more extensive and widely distributed printed matter. Newspapers and magazines became media for truly mass communication, particularly as carried rapidly across the country by railroad trains.

Central to this study, however, is the manner in which communication affected transportation. All the influences discussed for the first part of the century hold true for the latter part as well, with greater vigor. Commerce and industry in particular were benefited by better communication, which resulted in the need for more and better transportation. The railroads, pushing into the open plains of the Midwest and West, generated business by use of the printed media which encouraged people to move westward.

A reasonable estimate of the increase in transportation due to communication in this time period is of the order of 50%. At the same time, approximately 25% less travel was required because of the ability to communicate in one or more of the various modes without having to travel, as would otherwise be the case. In summary, communication contributed to a net increase of transportation of approximately 25% in the latter half of the nineteenth century.

Between 1900 and 1949, both transportation and communications continued to grow. The development of reliable gasoline and diesel engines coupled with mass production manufacturing made automobiles, buses, and trucks the most dominant vehicles for transportation in this era. Many ships, as well, became diesel powered, burning high energy petroleum rather than coal. Many trolleys and trains ran on electricity fed from a feeder line that eliminated the need to carry on-board fuel. Airplanes and dirigibles also began to appear. The dirigible was used but for a few decades, while usage of the airplane grew continuously.

The radio made a great impact on communication, at first as a wireless method of transmitting Morse code, then as a device for transmitting any audio signal. Eventually, radios could be found in almost every home.

The radio, as did the telegraph, changed the nature of transportation. Instantaneous communication through space made it possible to do things never before possible. The radio (one-way or two-way) provided the ability to stay in constant touch with moving vehicles, as ships, planes, trains, and even some automobiles. This ability made navigation more precise and travel more safe. Weather reports and other operational messages kept the system functioning smoothly and enabled large volumes of traffic to be monitored and controlled (particularly at airports).

Small, portable radio receivers and transmitters also allowed individuals to travel to remote regions of the earth and yet stay in touch with the outside world. Thus, in a variety of ways, the radio fostered the use of transportation systems. It is improbable that air travel would have developed to the extent that it did without the radio.

The radio, along with other popular forms of communication (as newspapers, magazines and movies), at different times both encouraged and discouraged travel. Media promotion of events, advertising, and the like encouraged travel. Tourism grew to new heights. Bad news, such as warnings of storms, generally had the effect of discouraging travel and inducing people to stay at home. As another example, news of disastrous airliner crashes dampened the appeal of air travel for many. It was such crashes of dirigibles that led to their demise as a general means of transport; in particular the on-the-scene broadcasting of the tragic burning of the Hindenburg.

All that was discussed previously in regard to the promotion of travel for reasons of commerce or industry by the various communication systems was equally true in this period of the twentieth century.

With all factors considered, a figure of about 60% would not be unreasonable as an estimate of the increase in transportation attributable to advances in communication. At the same time, good modes of communication (economical and easily available) as mail, telephones, and cameras reduced the need for travel about 30%. The net influence of communication on increasing transportation between 1900 and 1949 was, therefore, in the order of 30%.

In our contemporary time period of 1950-1984, the main new mode of transportation has been the space rocket. Its use, however, has been limited to a handful of carefully selected military and scientific people. Also limited in use to select people have been nuclear powered ships and submarines. Although ships and submarines existed before this period, the generation of power by nuclear fission has enabled ships to stay at sea for very long periods of time without refueling and submarines to stay submerged for months on end. Helicopters have grown in popularity, not only for the military, but also for the transport of civilian passengers.

Automobile, bus, truck, and plane traffic have increased to almost explosive levels, jamming many facilities, despite the construction of numerous new transportation networks and facilities.

In communications, there has been an even greater explosion of use. Almost all homes have a telephone, radio, and television. Satellites in space beam microwave television signals across the country and even around the world. The print media have become highly automated and networked to other communication systems, resulting in up-to-date printing of news and information from around the world. In commerce and industry (and some homes) not only have telephones, radios (one-way and two-way) and televisions been used, but also the new instrument, computers. The use of computers has been extended to both words, graphics, and audio. Computers can be linked to other computers by wire, microwave, or fiber-optic cables to create vast communication networks. Businesses have begun using the networks of telephone, television, and computers for teleconferencing of meetings in lieu of travel.

Computers in high performance vehicles as aircraft, missiles, and ships actually control the movement of such vehicles. In addition, electronic viewing screens located in these vehicles enable pilots to see things outside the vehicle that could not be seen normally by the naked eye. Even remote control of vehicles can be done by signals beamed through space. Clearly, space travel would have been impossible had it not been for sophisticated communication systems.

At a more common level, air, sea, and train travel has been greatly expedited by virtue of computerized reservations. Many hotels and motels also have computerized reservation systems. Booking arrangements for long-distance travel thus has become easy and almost instantaneous.

As costs for audio and video recorders and video cameras have decreased due to developments in microcircuitry, their use by the public has increased. Personal communication by sending magnetic tapes instead of letters and photographs has emerged.

As previously discussed, communication in our contemporary period continues to both promote and reduce transportation, for essentially the same reasons. On balance, it is believed that the net difference between fostering and reducing travel remains at a plus 30% between the years 1950 and 1984, the same as for the preceding period of 1900-1949.

FUTURE RELATIONSHIPS BETWEEN COMMUNICATION
AND TRANSPORTATION

Driven by the momentum of new communication concepts in electronics and optics, further developments will surely take place in the near future. In this report, that future is taken as the quarter century between 1985 and 2010. Transportation too will change as well, but not to the same degree as communications. As was done for historical parallel listings of improvements in transportation and in communications, probable parallel developments for the near future are shown in Table 2.

Table 2
Probable Parallel Developments in Transportation
and Communication

| Time | Transportation | Communication |
|-----------|---|--|
| 1985-2010 | Automobiles, buses, trucks and motorcycles (petrol or electric) Airplanes and helicopters Trains (electric or petrol) Boats and ships (petrol and nuclear) Bicycles Rockets | Printed matter (diverse forms) Television Radio Telephone (audio) Letters (typed) Photography (diverse forms) Computers and electronic mail Letters and draw- ings (hand done) Audiotapes (magnetic) Videotapes and discs Videophones Grooved records Holography Pulsed lasers |

In the list of transportation systems, only the generic types are shown. Within each category will be dozens of variations. Wheeled vehicles for highway use (as automobiles and trucks) will become more energy efficient, with many being powered by electricity rather than petroleum. In keeping with population growth, more vehicles will continue to be on the nation's highways. Similarly, more airplanes and helicopters will populate the airways. The resulting congestion of highways and airways will promote better and faster rail transport. Old lines will be upgraded for higher speeds and many new lines for even higher speeds will be built, particularly between large cities. Introduced will be a new type of train, magnetically levitated and propelled. Rocket transport will greatly increase, but still be used mainly for military and scientific purposes.

In the realm of communications, many hundreds of new transponder communication satellites in space and extensive networks of microwave stations, coaxial cables, and fiber-optic links on the ground will make two-way video commonplace. Videophones and video teleconferences are expected to take a certain amount of pressure off the transportation systems. Large-scale use of computer hookups from business to business and home to business will not only improve communication, but also take additional loads off transportation. Communicating electronically (as by video or computers) will decrease the need not only to travel in person but also to transport paper type mail. Time Magazine (January 30, 1984) estimates that 15,000 electronic work stations are now in operation in the United States. The Center for Future Research at the University of Southern California forecasts that in ten years, approximately five million Americans will be working at home rather than at an office, through the use of computers and video systems. By the year 2000, it is expected that ten million people will be similarly working at home.

In reference 6, studies are cited indicating that as much as 20% of work and business related trips and about 10% of other kinds of travel could be eliminated through substitution of some mode of communication by the end of the century.

Even now, at Eaglecrest, California, an "electronic village" for over 700 people is being planned, where it is expected that most will be working primarily at home stations. Provision for educational computers linked to schools is also being made there.

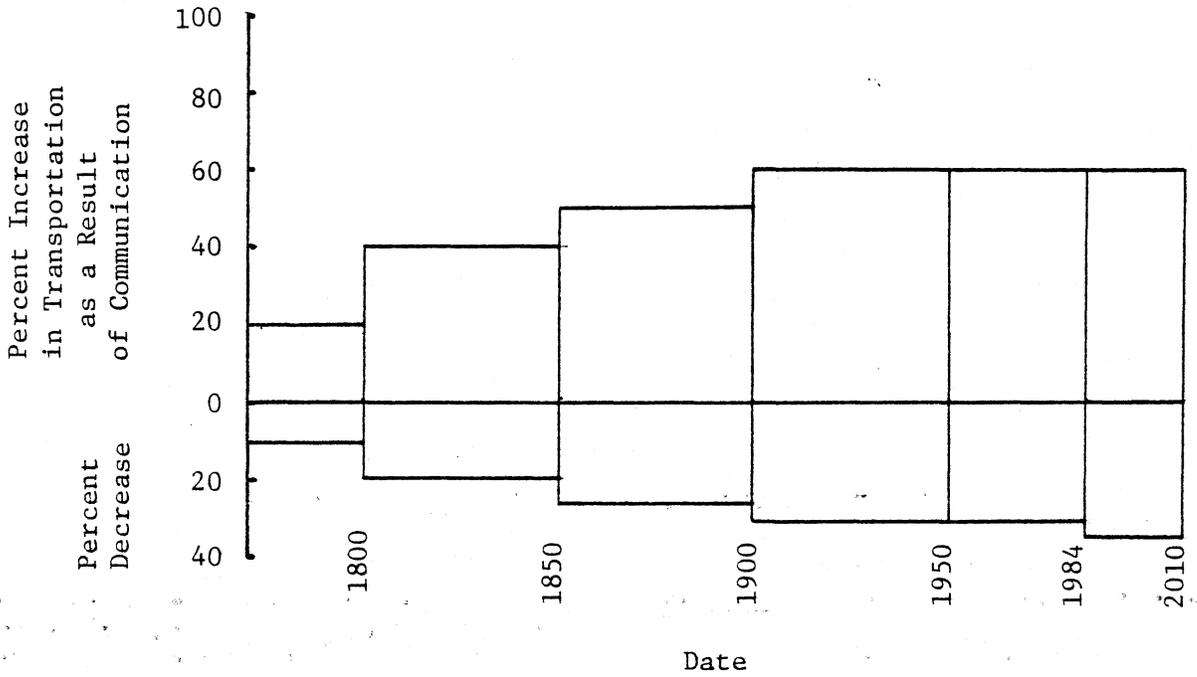
None of this is to say that transportation traffic will decrease in the next 25 years. Traffic in one form or another will increase as a result of increased population and growth of the economy. Rather, it is

forecast that the rate of growth of traffic will decrease from that of the previous 25 years. Curtailment will be due to five basic factors:

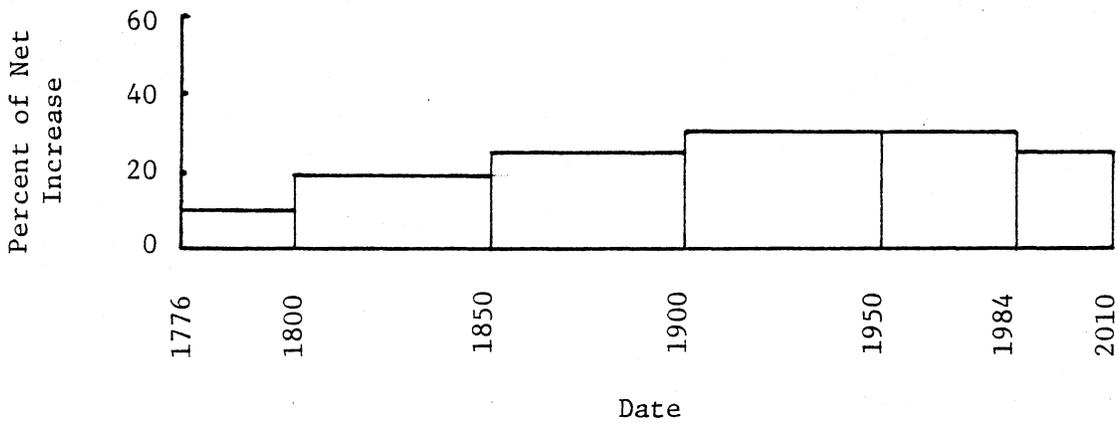
1. Lessening rate of population growth.
2. Slowdown in the economy.
3. Increase in the cost of energy.
4. Deterioration of the transportation infrastructure.
5. Improved alternates to transportation via communication.

To summarize, it is expected that the influence of communication in promoting transportation in the near future will remain at 60%. However, because of continued improvement in communication systems, it will have a 35% influence on reducing travel. Where communications can be substituted for transportation, time, cost, and energy consumption all will be significantly reduced. The net influence will be but a positive 25%, indicating a small reduction of about 5% over the previous 85 years. The change is significant, in that ever since 1776 the trend of communication generating more transportation traffic has been continuously upward. For the next time period in the future, a small falloff can be expected.

Figure 1 shows travel from the years 1776 to 2010 in graphic form. A related graph is shown in Figure 2. Line "A" indicates the relative influence of communication on the amount of travel in the United States. Line "B" indicates the total amount of travel in the United States, by all modes, from 1776 to 2010. The difference in the miles of travel between lines "A" and "B" is due to a combination of increased population, improved prosperity, and improved transportation facilities. Line "C" projects the travel in the future, not properly accounting for a slight falloff due to the five curtailment factors previously listed. Take note that the lines in Figure 2 show only general trends and do not represent precise quantitative values of megamiles.



1 a



1 b

Figure 1. Influence of communication on transportation.

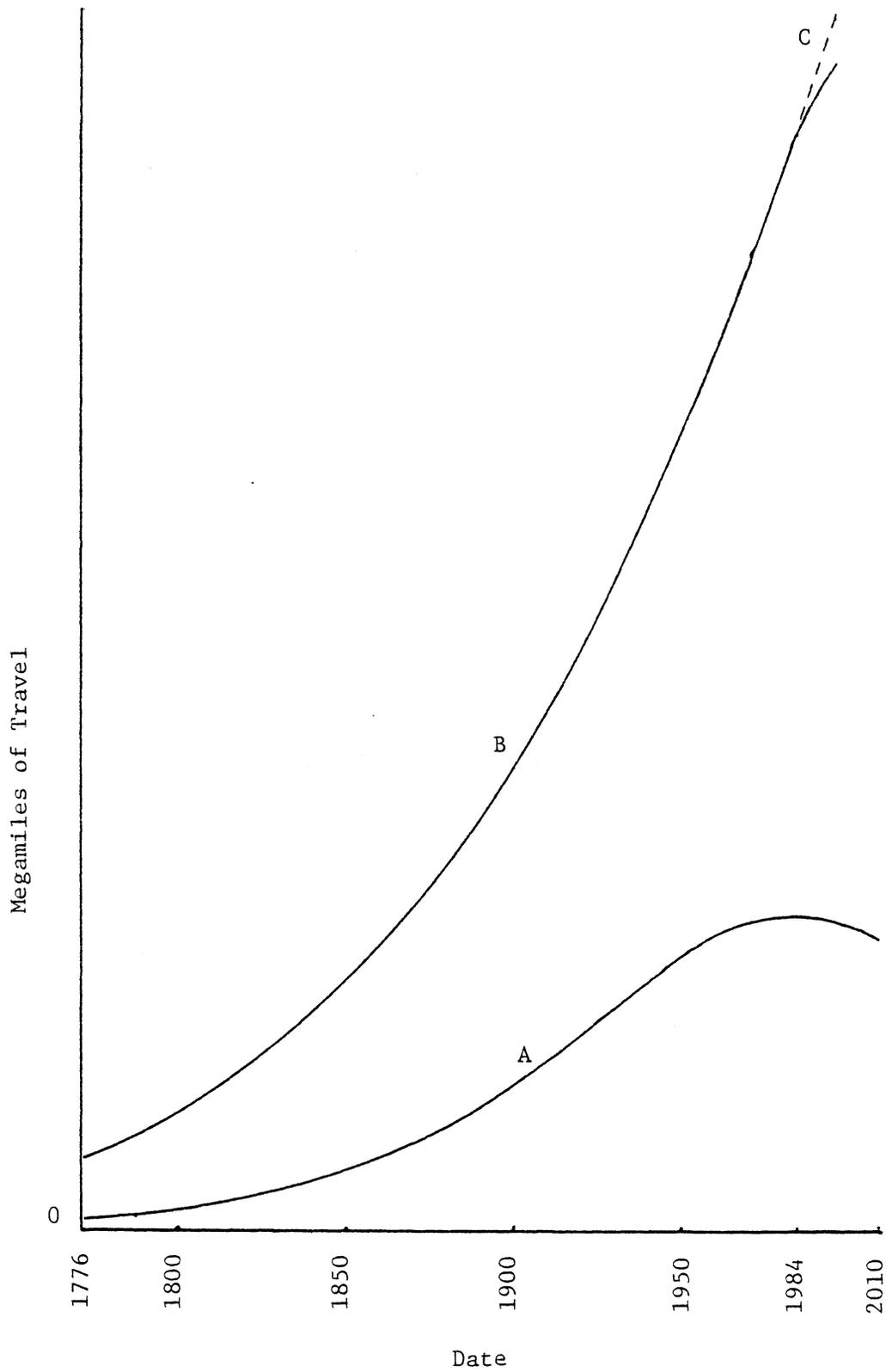


Figure 2. Total travel in United States.

QUESTIONNAIRE SURVEY

In an attempt to obtain a sense of the public's future choices in transportation and communication, a 12-item questionnaire was prepared and distributed in three types of localities. The questionnaire used was as follows:

Questionnaire on the Influence of New Communication Systems on Transportation in the Near Future

1. If you had an inexpensive personal computer in your home on which you could see and order any of thousands of items of merchandise for sale, would you travel to stores any less often? If so, approximately how much less often (in percent)? Assume a subsidized operating cost of the computer to you of \$2 per hour and a 25% increase in both time and cost for transportation over current conditions.

_____ %

2. If you could call most stores, offices, libraries, and the like on your telephone and they in turn could respond by video on your home or office television set, showing and describing what it is you want, would you travel to these places any less often? If so, approximately how much less often (in percent)? Assume that you pay only for the telephone call and that there is a 25% increase in both time and cost for transportation over current conditions.

_____ %

3. If you had a subsidized personal computer or word processor in your home and it was linked to your place of employment, would you travel to your place of employment any less often? If so, approximately how much less often (in percent)? Assume an operating cost to you of \$2 per hour and a 25% increase in both time and cost for transportation over current conditions.

_____ %

4. If you were a student and had at your place of residence a computer/TV monitor linked to your school classrooms and libraries, would you travel to your school any less often? If so, approximately how much less often (in percent)? Assume a combined subsidized rental and operating cost to you of \$2 per hour. Also, assume that you live beyond easy walking distance to your school and that there is a 25% increase in both time and cost for transportation over current conditions.

_____%

5. If within a mile of your home or place of employment there was a two-way video center available to you and linked to similar facilities around the country where you could communicate with other people, would you use this facility instead of traveling to these other people? If so, how many fewer trips would you take (in percent)? Assume an average charge of \$1 per minute for use of the facility and a 25% increase in both time and cost for transportation over current conditions.

_____%

6. If at your home or place of employment there was a two-way videophone linked to an extensive network of similar videophones around the country on which you could both see and hear others, would you use this videophone instead of traveling to these other people? If so, how many fewer trips would you take (in percent)? Assume an average charge of \$2 per minute and a 25% increase in both time and cost for transportation over current conditions.

_____%

7. If you could select for viewing at your convenience, on your television set, narrated scenes of places and objects of any of a vast number of such places and objects from around the world, how much less (or more) would you be inclined to travel to see them firsthand (in percent)? Assume a TV viewing fee of \$2 per hour and a 25% increase in both time and cost for transportation over current conditions.

_____%

Less

_____%

More

8. If you could select for viewing at your convenience, on your television set, a wide variety of current or past public events (as sports games, concerts, and speeches), how much less (or more) would you be inclined to travel to see these events at firsthand (in percent)? Assume a subsidized TV viewing fee of \$1 per hour and a 25% increase in both time and cost for transportation over current conditions.

_____ % Less

_____ % More

9. If your personal automobile was equipped with a programmable, automatic guidance and control system that could be turned on to allow the driver to travel for the most part simply as a passenger, how much more would you use your car (in percent)? Assume a surcharge on such travel of 5c per mile.

_____ % a. For city trips.

_____ % b. For intercity trips.

10. If you could perform most of your income producing work at home, where would you choose to live?

_____ a. In the city.

_____ b. In the suburbs.

_____ c. In the country.

11. Do you generally drive your own automobile for transportation?

_____ Yes

_____ No

12. What mode of transportation do you generally use for long trips?

_____ a. Car

_____ b. Bus

_____ c. Train

_____ d. Plane

One of the localities selected was Washington, D. C. and its surroundings. Washington represents a large urban center of population in the order of 1,000,000 people. It possesses almost all current forms of transportation as rubber-tired road vehicles (both public and private), light and heavy rail, aircraft, and shallow draft water vessels. The large majority of the working population commutes to work by one of these forms, which results in periods of traffic congestion, particularly on the road system. The existing communication network is both good and extensive, including much of the latest technology as satellite reception of video signals from around the world and computer and telecommunication networks to all parts of the country. Being the center of government, Washington is representative of a large city highly dependent on communication as well as transportation.

Twenty-three responses were solicited from Washington. This small number, of course, does not represent a scientific sample, but it does give some indication as to the thinking of those who live and work in the area. The results of the survey are given in Table 3.

Table 3

Results of the Washington Survey

| <u>Question Number</u> | <u>Mean Percentage</u> | <u>Comment</u> |
|------------------------|-------------------------------|----------------|
| 1 | 30.4 | 0 - 100 spread |
| 2 | 42.4 | 0 - 90 spread |
| 3 | 12.9 | 0 - 100 spread |
| 4 | 46.7 | 0 - 100 spread |
| 5 | 16.2 | 0 - 100 spread |
| 6 | 18.8 | 0 - 100 spread |
| 7 | 6.2 less/19.4 more | 13.2% more net |
| 8 | 22.5 less/0.9 more | 21.6% less net |
| 9 | 22.2 city/25.5 intercity | |
| 10 | 26 city/22 suburbs/52 country | |
| 11 | 100 yes/0 no | |
| 12 | 63 car/0 bus/2 train/35 plane | |

A second location selected was Charlottesville, Virginia, and its surround, which has a population in the order of 100,000 people. The area has a moderately good road system overall. Sectors are becoming congested by traffic, however, and some outlying roads are narrow and highly curved. It has a fair bus system, primarily in town. It also possesses one train station and one airport.

The communication system can be rated as moderately good, with telephone, cable television, radio, newspapers, and mail service available. Through the University of Virginia and one local TV station, video transmission is also possible. There are some computer networks operated through telephone lines (mostly at businesses and institutions).

The 24 replies to the questionnaire are tabulated in Table 4.

Table 4
Results of Charlottesville Survey

| <u>Question Number</u> | <u>Mean Percentage</u> | <u>Comment</u> |
|------------------------|------------------------------------|----------------|
| 1 | 24.5 | 0 - 75 spread |
| 2 | 35.0 | 0 - 85 spread |
| 3 | 17.1 | 0 - 70 spread |
| 4 | 37.3 | 0 - 100 spread |
| 5 | 23.1 | 0 - 80 spread |
| 6 | 32.1 | 0 - 100 spread |
| 7 | 9.8 less/7.5 more | 2.3% less net |
| 8 | 34.8 less/0.4 more | 34.4% less net |
| 9 | 2.9 city/17.5 intercity | |
| 10 | 8.3 city/29.2 suburbs/62.5 country | |
| 11 | 100 yes/0 no | |
| 12 | 50 car/0 bus/8.3 train/41.7 plane | |

The third location selected was Greenwood, New York, and its surround. Greenwood is a somewhat isolated small town approximately 40 miles from New York City. It is located on a lake and has a population in the order of 10,000 people. Its transportation systems are rated as poor, as the roads are narrow and winding, and it lacks rail, plane, and local bus service. There is, however, a stop for intercity buses. Its communication systems also are not particularly good. It does have telephone service, but television and radio reception are limited. Mail delivery is slow, and the local newspaper deals mainly with local events.

The 13 responses received are given in Table 5.

Table 5

Results of Greenwood Survey

| <u>Question Number</u> | <u>Mean Percentage</u> | <u>Comment</u> |
|------------------------|--------------------------------|------------------|
| 1 | 30.6 | 0 - 50% spread |
| 2 | 38.5 | 10 - 100% spread |
| 3 | 21.2 | 0 - 100% spread |
| 4 | 36.9 | 0 - 90% spread |
| 5 | 12.7 | 0 - 30% spread |
| 6 | 12.3 | 0 - 40% spread |
| 7 | 4.2 less/10.4 more | 6.2% more net |
| 8 | 31.5 less/0 more | 31.5% less net |
| 9 | 30.0 city/18.5 intercity | |
| 10 | 12 city/24 suburbs/65 country | |
| 11 | 77 yes/23 no | |
| 12 | 31 car/8 bus/8 train/53 planes | |

Because of the relatively small number of questionnaire responses received in comparison to the total population of the areas surveyed, the precise values are not to be interpreted too literally. However, some general observations can be made.

1. From Question No. 1, a significant number of people would want to shop by computer in order to reduce travel. Roughly the same percentage of people so responded, regardless of the size and location of the city in which they live.
2. From Question No. 2, a rather high percentage of people would like to use video in connection with shopping or communicating with their offices, as opposed to travelling to these locations, regardless of city size and location.
3. From Question No. 3, a relatively small percentage of people would use word processors instead of travelling to their places of employment. It is conjectured that the small percentages are because word processors are used in only a small part of the work required in most jobs.
4. From Question No. 4, students in all three communities very much like the idea of using computers and video systems at home, rather than travelling to school. This suggests that future schools need not consist entirely of a collection of buildings, but in large measure could be a network of communication systems. Travel to and from educational institutions could be considerably decreased.
5. In regard to Question No. 5, there seems to be moderate interest in communicating by two-way video, even if it means using facilities not in one's home or office.
6. Comparing the responses to Question No. 6 with those to Question No. 5, there would be somewhat greater use of two-way video systems for communicating if the units were conveniently located in homes and offices.
7. From Question No. 7, "on call" television viewing of places and objects from around the world elicited a mixed response. Some would travel less, but most replied they would travel somewhat more as a result. It is assumed that in viewing unusual places and objects, people's interest would be aroused such that they would want to travel to these places to experience them at firsthand. (Travel agents have known of this phenomenon for a long time.)

8. From Question No. 8, "on call" television viewing of events as sports, games, and concerts decidedly would reduce travel to these events by an appreciable percentage. This reduction in travel was expressed by people in all three areas surveyed.
9. Judging by the responses to Question No. 9, automated automobile travel would increase the use of the personal car. Overall, the biggest increase would be in intercity travel, with fairly consistent increases by people in cities of any size or location. However, for city travel, there is a puzzling spread of percentages, ranging from very little in Charlottesville, to a moderate increase in Washington, to a relatively large increase in the small town of Greenwood. Accounting for the large disparity between Charlottesville and the others may be the fact that city traffic in Charlottesville is manageable as it is.
10. From Question No. 10, country living is overwhelmingly preferred by people, regardless of where they may now be living. Thus, if electronic working at home becomes viable, a migration of people to the country may be expected. Local roads to these new developments would thus be needed.
11. From Question No. 11, most people drive their personal automobiles for transportation. It is safely forecast that even with new communication systems, most people will still own and operate personal cars.
12. The answers given to Question No. 12 indicate that for long-distance travel, approximately as many people use cars as use planes. Only a very few of the respondents use buses or trains. This general trend is expected to continue despite advances in communication. However, the trend would be modified by new breakthroughs in transportation technology, such as high-speed rail or automated highway guidance systems.

In summary, the responses to the questionnaires are clear evidence that new communication systems already on the horizon will reduce the need for travel to some degree. The exact degree cannot be pinpointed by this pilot study, as communication has the effect of increasing travel in some ways and decreasing it in others. More extensive surveys must be taken to produce an exact figure. However, it is believed that the trend is obvious enough to support the diagrams previously shown, namely, Figures 1 and 2.

OTHER INFLUENCES ON COMMUNICATIONS AND TRANSPORTATION

It is of interest to examine other factors which relate to ways communication affects transportation. First, from an individual point of view, a listing of basic situations is described which dictate when some form of communication is selected over some form of transportation. Then, some regional factors which give a broader view of how communications and transportation are related are discussed.

There are a number of situations where transportation is essential and no form of communication can be substituted. These are listed as follows:

1. Movement of people to specific sites because of the need of their physical presence. Examples of this would be the need for people to be at work to perform certain physical tasks, the need for people to be at a given location for personal recreation, and the need for people to be at a certain place for health reasons.
2. Movement of people for emotional needs. Some illustrations include the need of people to see other places as a release from boredom as for a sense of adventure, the need to be with, and perhaps touch, another person (as with a distant loved one) and the need to visit places that evoke deep emotions (as one's hometown).
3. Movement of people to disseminate or secure information where there are target ambiguities. Examples would include persons who go to a national convention where they are not certain who they will meet and what chance information might be obtained, news reporters who rely on chance encounters for much of their information, and travelling sales representatives who must convey information to people met at random.
4. Movement of people where there is a need to communicate, but where there is no good or reliable method of communication. Examples of this situation would be where secrets must be transmitted by personal courier, as on a battlefield where communication systems have broken down and a runner must be sent to headquarters, or in a wilderness where there is no communication network and someone must be dispatched for emergency help.
5. Movement of goods or freight (animate or inanimate). This situation is believed to be self-evident and thus requires no examples.

Where transportation is not absolutely essential as just described, six basic factors are evaluated by an individual in deciding whether to use some form of transportation or communication in achieving an objective. This is not to say that these factors are always analyzed systematically, but that consciously or unconsciously they have a bearing on the choice between using transportation or communication. The six factors are as follows:

1. Determination of what transportation and communication systems exist to carry out the objective. For example, in shopping for an item, one thinks over the possibility of taking the family car or taxi or public bus to the store, or to send a letter or telephone the store to find out if they have that item. As another example, if a national meeting of executives is called and the airlines are on strike (air being the normal way to get to the meeting), a conference telephone call is considered as an alternate.
2. Consideration of personal energy expenditure. The words "convenience, stress, and frustration" are often used in describing why one alternative is chosen over another. In this context, these words are largely related to that of personal energy expenditures, physical or mental. For example, one would telephone a store rather than take a bus because it takes much less energy, assuming the objective can be fulfilled either way.
3. Consideration of time requirements. The use of transportation generally takes longer than the use of most modern forms of communication. Thus, if one needs a quick answer as to whether a person across town can come to a meeting, telephoning that person is usually faster than getting in a car and driving to ask him or her. Or, if a stray dog is found, mass communication mediums of newspaper and radio are used to advertise for the owner rather than go through the time consuming "transportation" method of going door to door. On the other hand, many people intentionally do things that take longer, as driving a car to see someone in a neighboring city rather than talk on the telephones, just to get out of the office or home for a while.
4. Monetary cost of appropriate methods of transportation or communication. Within the options of transportation, one would consider the relative costs of going somewhere by car, bus, train, or plane (and possibly ship). Options in communications also exist, as mail, telephone, amateur radio, videophone and computers, each with their different cost. Assuming that reasonably the same objectives can be met, the

least expensive option is generally taken. For instance, rather than going to the expense of travelling to a sports event, most people would watch it virtually free on television. However, if one method excells another in some respect, more expensive options are often chosen. As an example, if one wanted to talk to an old and distant friend, one could do so relatively inexpensively by telephone. However, if it is felt that the conversation would be much warmer by actually travelling to see that person and talking face to face, the additional expense would be considered worthwhile.

5. Hazard to life or property in the use of transportation or communication. Generally, it is in transportation rather than in communication where there may be hazards. Many hundreds of thousands of people are killed or injured yearly in the course of travelling. Loss to property (as wrecked automobiles) runs into many millions of dollars. When travelling is not essential, and the risk appears high, some form of communication is opted for. A common example is to call someone on the telephone during a snowstorm rather than driving to that person.
6. State of health of the individual. Very ill or disabled people often have limited mobility, making travelling for them difficult and perhaps even dangerous to their health. Such people obviously would choose some mode of communication over transportation in situations where communication (however inadequate) is a possible alternative. Such people, for example, would write letters to people or telephone them rather than visit them in person. People suffering from agoraphobia, although in perfect physical health, also would choose some form of communication rather than venture from the familiarity of their homes.

Generally, a mix of these six factors is considered, although some may be more important for the individual than others. Trade-offs of benefits have to be evaluated in almost any decision whether to use a transportation or communication system. The advantage of speaking to someone face to face in another city may be outweighed by time or money constraints; thus dictating the use of the telephone. The reverse could also be true in other situations.

Of concern to planners are broader issues of transportation and communication as related to regional factors. Four such broad factors are considered here. They are as follows as pertains to a community or region.

1. Size and location

2. Economic and demographic makeup
3. Availability and conditions of the transportation and communication facilities
4. Special needs in regard to transportation or communications

Good data are currently unavailable to cite specifics in regard to the future influence of communication on transportation for those basic factors; so the following discussion is somewhat conjectural, although supported in part by the responses to the questionnaires previously described.

Currently, most large, highly populated cities suffer from traffic congestion problems. Those who must travel find it increasingly frustrating, stressful, and expensive. In the future, when communication alternates are provided, it can be expected that many in large cities will choose not to travel as much; thereby saving time, energy and money.

The situation in remotely located small towns is quite different, in that traffic congestion is not an overriding problem. However, people in these little towns are also expected to substitute a certain amount of travelling by using new communication systems, in that journeying long distances to larger cities (as for routine shopping) can be minimized. On the other hand, people in rural areas would be enticed to travel more outside their immediate area, lured by various media influences.

The type of commercial or industrial base a community or region is dependent upon affects the nature of transportation and communication. Manufacturing cities need good transportation facilities to move goods and workers while commercial or governmental cities depend heavily on communications. It is anticipated that the latter type communities will begin to use new communication systems to the extent that a significant percentage of people will not have to travel to work every day. Rather, they will work at home and stay in touch with their office by computers or video. The degree of affluence of these cities will control how fast they move in this direction. However, even in manufacturing cities, new communication systems are less expensive to install than new transportation facilities, so that it is reasonable to assume that even in such cities, industries that can substitute communication for transportation will do so. In farming regions, people generally both live and work on the farm, so that the primary travel is on the farm itself. The influence of new communication systems in such situations on the farm would be minimal. It must be noted however, that when linked to farms, new communication systems will modify the farmer and his family's travelling pattern off the farm.

It is only natural that transportation and communication facilities that are particularly good are used in preference to facilities that are less good. Thus, if a city has very good roads and a poor telephone system, one would find the roads used extensively. Conversely, if a city has a good telephone system and a poor road system, the telephone would be well used. It can also be said that if neither facility is good, but that a demanding need to use them exists, they will be used regardless of efficiency, except that in the latter case people will be actively looking for better alternatives. In looking to the future, consideration must, therefore, be given to the direction of development of the transportation and communication systems in an area, in addition to accounting for the existing infrastructure. Costs of upgrading a transportation network are very high in comparison with upgrading communication. As a result of this economic factor, it is believed that new developments in communications will outstrip those in transportation. Upgrading of much of the transportation system, of course, will also be done, but on a more limited scale. Affluent cities will go forward in both directions, but others will begin to rely more and more on improved communication systems. In doing so, some pressure to fully upgrade transportation facilities may be reduced.

Certain communities have special needs in regard to transportation and communication. Resort cities as Miami Beach and Las Vegas, for example, need good transportation access facilities (as roads and airports) to get people to them. Communication needs are minimal, as people go there to play and get away from it all. In contrast, retirement communities, where people travel very little, do not need exceptionally good transportation access. Cities heavily involved with government or finance (as Washington and New York) depend greatly on good communication systems, both internally and to the outside world. An extreme example would be Camp David in the hills of Maryland where U. S. presidents go for retreats. Transportation access is deliberately limited, yet communication systems are the most advanced.

In the next section of the report dealing with conditions in the Commonwealth of Virginia, these four basic factors will be applied with greater specificity.

CONCLUSIONS WITH RESPECT TO VIRGINIA

In reference 7, the writer divided Virginia into nine regions whose identities are generally physically and economically distinct. These regions are as follows:

1. Southwest Virginia
2. Southern Piedmont Valley
3. Northern Valley
4. Northern Virginia
5. Northern Piedmont
6. Southside
7. Richmond
8. Chesapeake Fringe
9. Tidewater

The exact boundaries are shown in Figure 3, along with the locations of the state planning districts (1-22). Forecasts in regard to such things as population, economics, social conditions and transportation are described in reference 7.

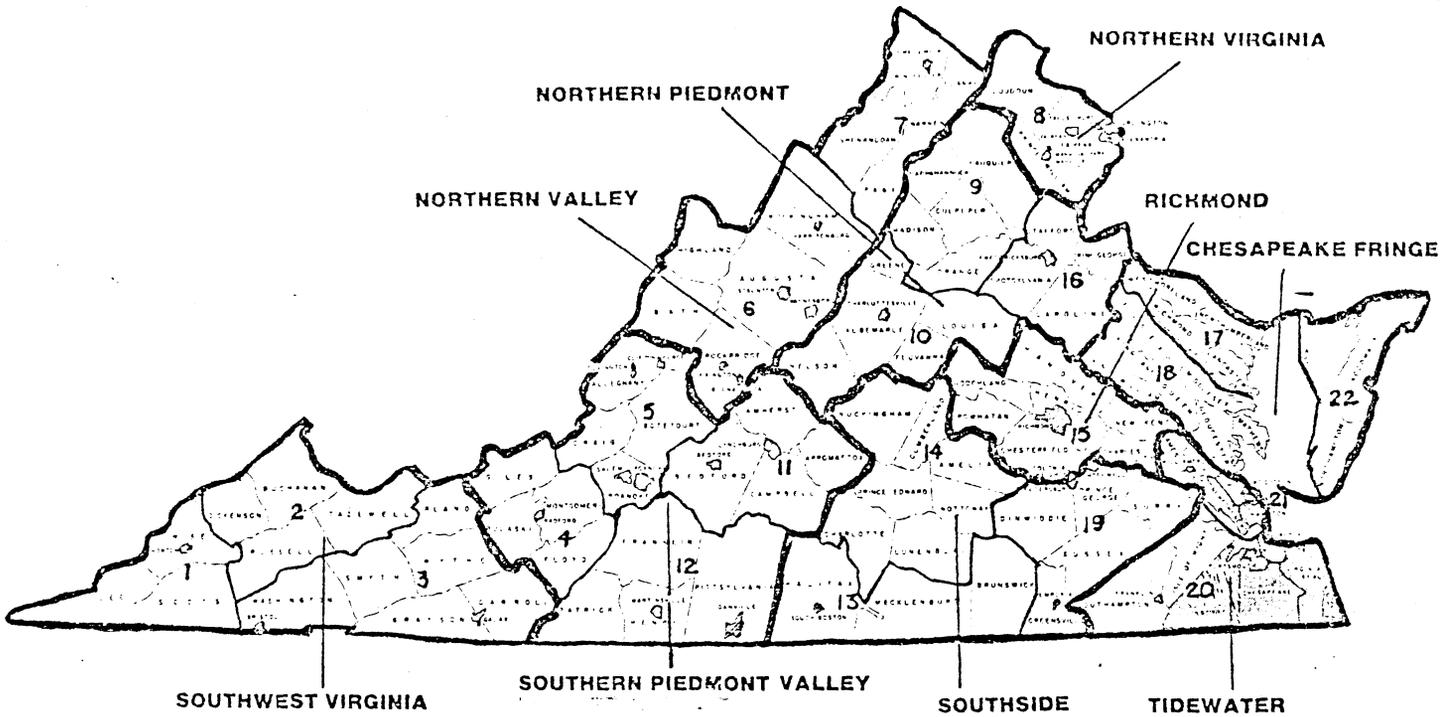


Figure 3. Contemporary Virginia regions.

This report will focus on only the effects of the communication and transportation systems in these regions between now and the year 2010.

1. Southwest Virginia

Improved communication in this previously isolated region will cause local city and county governments to become more cohesive. Improved communications will also affect local social traditions as the customs and aspirations of the people will begin to approach those of mainstream America, although with a conservative lag.

Technology in use at the personal level will also follow that of mainstream America. For those who can afford them, home computers, electronic entertainment centers, and video communicators will be available. The popular use of satellite communication facilities, which can penetrate virtually any topography, will upgrade the level of health care and educational resources to schools and homes.

No radical change in the transportation network in this part of Virginia is foreseen. Many of the narrow old roads will be improved but there will be little major new highway construction. The deteriorating condition of many rural bridges will require the lowering of load limits. As a result, heavy trucks will be replaced by tractors with two or more trailers, especially for the hauling of coal.

A number of rail branch lines will be abandoned due to the expense of maintenance. Service on the remaining lines will be only for bulk haulage.

With improvements in short-take-off-and-landing aircraft (STOL), the several small local airports in the region will be upgraded to handle more air traffic. Accessibility to this far corner of Virginia will be made much easier as a result.

Waterways in this sector are navigable only by small craft and as such are used only for recreational transportation. The same is expected to be true in the future.

Pipeline transport of coal slurry will be studied but political and economic factors will rule out its construction. Rail will continue to move most of the coal mined over any distance. A few small branch pipelines to carry newly produced natural gas, however, probably will be laid to connect into the major line from West Virginia.

As to the question, "How will communications affect transportation?" there will be both positive and negative influences. Media publicity of the resources of the region will bring in more people and goods for such things as recreation and new small industries. Satellite communication to this mountainous area will also induce local people to travel more extensively outside their region. These factors will generate more traffic on the interstate and primary road systems as well as the airports. At the same time, new two-way video and computers will decrease transportation on the bad local roads as the need to travel to stores, schools, and clinics will be reduced.

If a specific figure is needed regarding the anticipated influence of new communication systems on standard traffic projections, a correction figure of +10% is suggested for major roads and -5% for minor roads.

2. Southern Piedmont Valley

The adoption and possession of new technology at the personal level will be mainly a matter of affordability rather than availability. Consequently, a diverse mix is expected, although some sort of two-way communication system will be found in virtually all households, with the more affluent having more elaborate devices.

Vehicular traffic flow to the area, especially around Roanoke, will increase about 25%, generally requiring no major new highway routes. However, local and secondary roads will be added or upgraded on a need basis. Activity will be large at the interchange locations along I-81.

Rail transport will be down from current tonnages, with no regular passenger trains servicing the regions. Compensating for the loss of rail passenger service will be a sizeable increase in air service. All airports in the area will be improved or enlarged. The airport in Roanoke will become world class, and a second, smaller airport will be built for local traffic.

The outlook for water and pipeline transport will remain essentially unchanged.

Given the preceding background forecast, it is predicted that the areas around Roanoke and Blacksburg will be the sectors of the region most affected by new communication systems. The University at Blacksburg will use computers, video, and satellite extensively in its educational and research activities. Use of video and computer networks for business purposes will significantly increase around metropolitan Roanoke. The net effect will be to stimulate transportation to and from these cities, even accounting for the negative effects of communications

on transportation. An estimated correction to the standard traffic projection in the area is +5%.

3. Northern Valley

Low cost satellite communication facilities will be found in virtually all residences and will keep people in touch with developments in any part of the world. As a consequence, social attitudes will in general be those of most others in conservative American society.

The interstate highways through the Northern Valley will remain the main transportation artery. However, costs of maintenance to keep the system in good condition will be high. To accommodate the relatively large population growth, numerous other local roads will be constructed around new developments and be paid for by special assessment.

Rail transport will be at a low volume, although it will still survive. The several small airports that now exist will all be improved or enlarged to provide for increased commuter traffic. The number of small private planes at these airports will double. No significant change is expected in regard to water or pipeline transport.

Good two-way communications to this pleasant region will induce a number of people to travel and settle there. It is projected that many people whose primary business is in Washington, D. C. will be able to live and do much of their work in the Valley, connected to their D. C. offices by computer and video. However, they will still travel to Washington from time to time by auto or plane. Additional traffic will be generated by people travelling the interstate or Skyline Drive routes for pleasure, stimulated by new publicity of the region or regions to the south. Along these corridors, a correction factor for highway transportation due to communications is estimated as +10%.

4. Northern Virginia

Social and economic conditions in Northern Virginia will remain different from those in the rest of the state because of the untypical makeup of the population. Travel to all parts of the world will be important, as well as the need to stay in close touch with events everywhere by communications.

Communications technology will be so extensive at home, school and work that an information overload will result. Home-installed, interactive computers and word processors linked to offices will enable many people to work a great deal at home, with flexible

working times. At the office or place of business, a high degree of "paper work" will be done electronically, such that conventional paper work will be minimal. Conferences between people via video-phone and computers will be commonplace, transcending national boundaries. Automatic language-translating machines will further reduce barriers between people of the world.

With the high population growth, transportation of people and goods will become an increasing problem. Various electronic communication systems will alleviate transportation of people to some extent and allow an evening out of peak-hour traffic. However, because of westward growth, highways in that direction will be improved and widened. Major roads in and out of Washington will have numerous restrictions placed on their use, such as loads, passengers per vehicle, times of use, and separation of automobiles, buses, and trucks.

The existing rail system will be supplemented by an extension of the metro public transit rail lines to Fairfax and Springfield. The rights-of-way of Interstate Routes 66 and 395 will be used for these new rail lines, with station stops providing vehicle parking spaces for commuters. A rapid rail line from downtown Washington to Dulles Airport via I-66 and the Dulles airport highway is also probable.

Although some local flights from Washington National Airport will continue, there will be a large increase in traffic at Dulles Airport. The existing small airports in the region will be upgraded and a new small airport will be constructed around Middleburg.

Water and pipeline transport will remain essentially unchanged, except that a new pipeline to carry fresh water from western Virginia to this high growth region is probable.

Whereas new communication systems to rural parts of Virginia will, in general, have a small positive effect on increasing transportation, communications around large metropolitan areas will produce an appreciable negative effect on transportation. Thus, in the projection of traffic, there will be an overall increase, but approximately 12% less than otherwise forecast, because people will use computers and video more as an alternative to travelling physically.

5. Northern Piedmont

In technology, the biggest change will be in the increased use of electronic communication and information devices, at home, at

work, at play, and in travel. Such devices will permit many people to live much farther from their corporate workplace, yet with less physical commuting, as they will be linked electronically. In medicine and health, most high technology advances in life-prolonging methods will be available at the regional medical center in Charlottesville. Rapid air transport will provide quick treatment for ill people in the region.

Transportation systems will be incrementally improved, particularly highways and airports. Narrow secondary roads will be upgraded and airports will be enlarged. Numerous local roads for new housing developments in the counties will also be built.

All rail lines will be maintained. The lines from Washington to Manassas, Culpeper, and Charlottesville and the line from Washington to Woodbridge, Fredericksburg, and Richmond will see increased usage by passengers. Special rail shuttle service between these points is probable.

Sectors of this region close to Washington will be influenced by communication and transportation such as described for the Northern Virginia region. A second pocket differently influenced will be the area around Charlottesville, because of the presence of the University of Virginia and numerous professional and high technology oriented businesses.

As a consequence of the new communications anticipated, estimates of travel in and out of Charlottesville should be corrected by a factor of about +5%. Also showing increases will be the main interstate routes leading into and out of the District of Columbia, where tourist traffic will grow due to increased communication-generated publicity of the Nation's Capital.

6. Southside

Social traditions common to rural people will generally continue here. Even though advances in electronic communication will provide residents with magnitudes more information of all kinds, the majority will chose to live on the farm or in small towns. Improved will be the level of education, largely due to the greatly expanded worldwide communication system. More education and new skills required for scientific farming will bring higher standards of living.

No major changes in the transportation infrastructure in this region is foreseen. Interstate Routes 85 and 95 will continue to be the most heavily travelled highways in the area. Ship traffic on the James River will be more highly controlled in the future as

a safeguard against pollution and marine accidents. Pipeline transport will not change to any extent.

As is typical of rural areas, communications will induce local residents to travel more outside their home territory. Also, better communication will generate additional traffic as more commercial establishments settle there. Thus as an overall estimate of future traffic, a correction factor of about +5% is suggested over standard forecasts due to improved communications in the future.

7. Richmond

Being the seat of state government, Richmond's governmental policies will play a strong role in the development of the area. The influence of the Richmond city government will be strengthened by the presence of the state government. As population increases, so too will governmental controls and regulations. Restrictions on types of vehicles and time of usage will be imposed on travel in central Richmond, as an example.

With respect to technology, this sector of Virginia also will keep pace with other large cities in the northeast. Computers, electronic process of information, automation, and robotization occurring elsewhere will occur in Richmond as well. New energy-efficient transportation vehicles and materials recycling plants will also appear.

By the turn of the century, the second circumferential highway around the city of Richmond (I-95) will be complete. Other routes radiating out from the city will be improved and made into limited access roads. Numerous secondary routes in the counties will also be improved. Within the city of Richmond, main roads will have restrictions on use so as to reduce traffic congestion.

All existing airports will undergo expansion or improvement, with Byrd Airport becoming truly international class. A new small airport is likely to be constructed to the west of Richmond to serve that region as population grows in that direction.

The channel in the James River will be improved to accommodate more shallow-draft vessels. Additional navigational safeguards will be installed.

Rail and pipelines will remain essentially as they are now except for the probability that a new pipeline to carry fresh water from western Virginia to the Richmond region will be constructed.

The Richmond region, being essentially metropolitan, will have its transportation influenced both positively and negatively due to communications. Future communication activities related to government, commerce, and industry will generate additional traffic. However, as the expense and tribulations of travel in a large city increase, people will opt to travel less and communicate more whenever they have a reasonable choice. Thus, on balance, it is believed that a correction factor of about -8% appears reasonable.

8. Chesapeake Fringe

The large amount of land bordering on streams, rivers, lagoons, marshes, and bays is the region's greatest natural resource. The water provides a variety of seafood, navigational passage for large and small vessels, as well as scenic views. The geographical separation of Northampton and Accomack counties on the Eastern Shore makes travel and communication between them and the rest of Virginia inconvenient; however, technology in various forms is gradually reducing the inconvenience. In time, another highway tunnel under Chesapeake Bay in the vicinity of Smith Island is probable.

Despite the region's relative proximity to the city of Richmond, the area will continue to be somewhat inaccessible by ground transportation because the road conditions are not likely to improve appreciably. As a result, people living in the area will sense a certain separateness from the urban life-style of Richmond. Although the influence of easily accessible worldwide communication will move them in the direction of mainstream America in regard to social attitudes and behavior, they will still retain much of their traditional values because of the strong dominance of the water environment.

The heavily travelled arteries, as Routes 13, 17, and 360, will be upgraded to facilitate traffic to and through the area. In certain areas where rapid commercial development occurs on the coastline (as for sea farming or recreation), secondary roads will be improved or constructed. Otherwise, the road system will be little changed. However, all airports in the region will be upgraded or enlarged because of increased use of private and corporate aircraft. Waterborne transportation will continue at a high level, with the requirement that ships and small craft be equipped with electronic navigation and safety systems.

Changes in pipeline and rail transport will be minimal, except for possible use of pipelines to load and unload large vessels at offshore terminals.

Despite the increased use of air transport in the region, road transport (inadequate as it is because of water barriers) will essentially control traffic volume in the Chesapeake Fringe. As a result, extensive use will be made of new two-way communication systems as an alternate to travel across the region. A negative adjustment to standard traffic projections for this area of approximately 10% because of communications is suggested.

9. Tidewater

Urban Tidewater's vitality will continue to be water and port related. Technology will run the extremes from the most sophisticated electronic communication, missiles, and war machines at the military bases to the simplest radio and television sets in the homes of people in Southampton County. Businesses and industry will be using automatic information processing machines routinely.

Transportation, particularly highway and marine, will continue to be a priority concern because of the geography. Maintenance of existing roads and bridges will increase as deterioration sets in. New materials will be available, however, to resist saltwater corrosion. For reasons of national defense, supplementary money for maintenance will be forthcoming from the federal government. Constant improvement of existing roads on the outskirts will be made as growth takes place, along with some new road construction. Maintenance and upgrading of port facilities will also be ongoing. Numerous improvements will be made in safety and in the accommodation of larger ships. A new offshore loading facility is likely.

Most existing rail lines will be kept and maintained for transport of heavy freight, primarily to and from cargo vessels. Advances in computer controlled freight hauling will provide more efficient transshipment of goods.

Air traffic to the region will grow substantially, particularly in regard to cargo to and from foreign countries. An expanded Norfolk International Airport is expected to accommodate most of the cargo operations. Innovations in pipeline technology will provide for short-haul movement of solids as coal and grain. Additional pipelines for carrying fresh water will also be laid.

Two opposite effects of communications on transportation will probably occur in this region. As this is a commercial metropolitan area, new two-way and teleconferencing communication systems will reduce traffic. But, since it also is a naval and resort center, transportation to and from the area will be increased by communications. It is believed that the positive effect will be larger than the negative effect, resulting in a correction factor of about +8%.

Based on miles travelled, an overview of future demands in Virginia indicates that new communication somewhat decrease the need for roads and highways as tions made without considering the usage of future c tems. In some locations, there are likely to be inc a guiding general rule, communications will influenc cities negatively and traffic in rural areas positiv unusual characteristics may deviate from this rule.

All opinions, findings, and conclusions express are those of the author and not necessarily those of Highway & Transportation Research Council, the Virg' Highways & Transportation, or the University of Virg

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