URBAN NODE IN THE INFORMATION NETWORK

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SUMMARY

In this discussion we consider some of the major contemporary problems of cities and ask how the fast developing technologies of computers and communications can help. In the process we take a glimpse of an evolving role that future cities may play as nodes in national and trans-national information networks.

INTRODUCTION

Man has a dual nature, and this is where some of the problems of our cities can be said to begin. His ambivalence takes many forms. Here are five examples chosen at random:

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1) The home owner enjoys having people next door, but plants a hedge on the border between his property and theirs, and builds a fence. "Good fences make good neighbors."

2) The infant reaches out for novel experiences and seeks adventure, but only when within sight of its mother and familiar objects.

3) The liberal urges social reform and innovation in procedure, but he digs in his heels along with the rest of humanity when change jostles his <u>own</u> established ways.

4) The prophet sends disciples around the world to proselytize and demonstrate the validity of his ideology, but he bristles when anyone gets too personally inquisitive about its performance at home.

5) The manager is constantly alert for new means of improving his operation and surpassing competition, but waves aside the possibility of gaining efficiency by automating part of his own responsibilities.

In each of these examples an outer-directed or extroverting force is being opposed or offset by an inner-directed or introverting need. The outer-directed force is due to something called sociability, curiosity drive, desire for recognition, or need for achievement, depending on the context. The inner-directed need is for something called privacy, security, space, freedom, or individuality, again subject to context.

In this discussion we take up two other aspects or illustrations of man's duality, specifically implicated in some of our urban problems:

6) Man likes to "get together," yet chooses to live apart.

7) People spill into cities in great effusion to work and to play, while all the time complaining bitterly of the self-inflicted pollution, noise, congestion, hubbub, and anonymity of their crowdings.

Why don't people stay home, so to speak? Why do they cluster? The tendency is as natural as the sun, and is shared with most animal species. Some refer to it as the herding instinct. The tendency has been reflected through history in the formation of tribes and in the growth of cities.

At first only a small percentage of the population lived or worked in cities; but in the past few decades there has been mass migration from rural to urban areas as the temper of society has grown more commercial and industrial, and as the productivity per farm worker has been increased by scientific methods in agriculture. Today less than eight percent of the population of the United States resides on farms. Over 60 percent resides in cities as defined by the Bureau of the Census. Figure 1 shows how the urban population of the United States has grown during the past century and one half.

The centripetal movement that has brought large numbers of people into cities for work and social exposure (or occasionally for anonymity) has been accompanied by a centrifugal counter-movement that has caused dispersion into suburbs, satellite towns, and country retreats for living and bringing up children. The centripetal movement is directed outward from the individual and inward with respect to the city. The centrifugal movement is exactly the reverse, taking the individual away from the city back

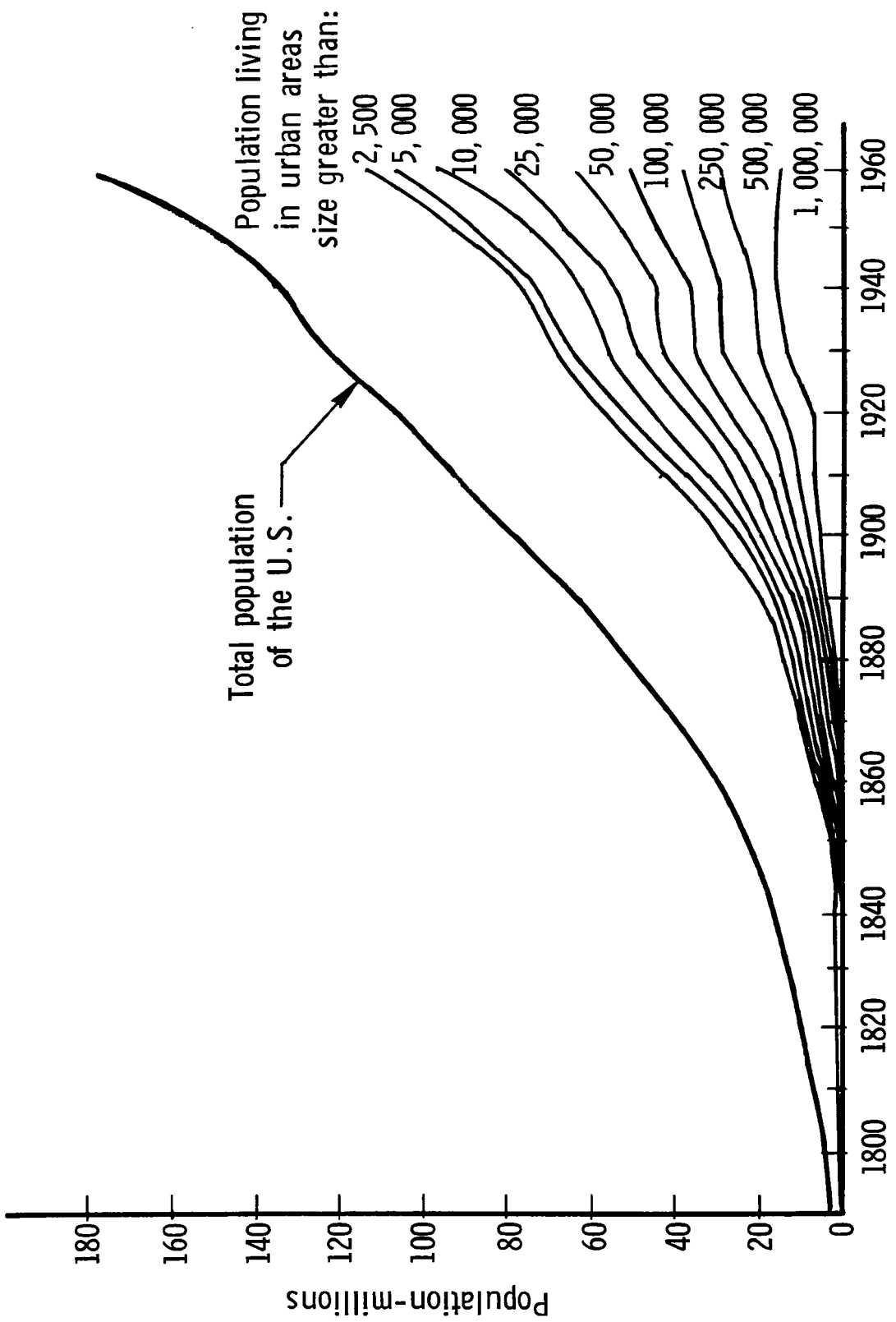

Fig. 1--The changing population distribution within the United States

toward himself and his family. Its effect is illustrated by Fig. 2, which shows how the percentage of the urban population living in very large cities has decreased since 1930.

(We lack good statistics on the boundary lines of "cities." The only numbers at our disposal are of standard metropolitan statistical areas (SMSA) and of incorporated cities. The boundary of the domain of a "city" is fuzzy. However, these numbers are sufficient to give us insight into what may be happening.)

The typical pattern that has emerged from man's duality is that people who can afford to work inside the city while living outside. The city is deprived of their taxes and at least part of their civic conscience. It is left residentially with a thick residue of the immobile and impoverished, plus, in sharp and sickly contrast, a thin crust of very wealthy.

COMMERCE AND CONCENTRATIONS

Spurring the suburban spread are hyperactive and supersaturated cities. Man is a trader as well as a herding animal. With sophistication and variety unique to his own species, he has divided his labors into a rich assortment of specialties. He offers to exchange his differentiated skills, and the goods and services they produce, through intricately coordinated and interdependent systems of markets and organizations of people in communication.

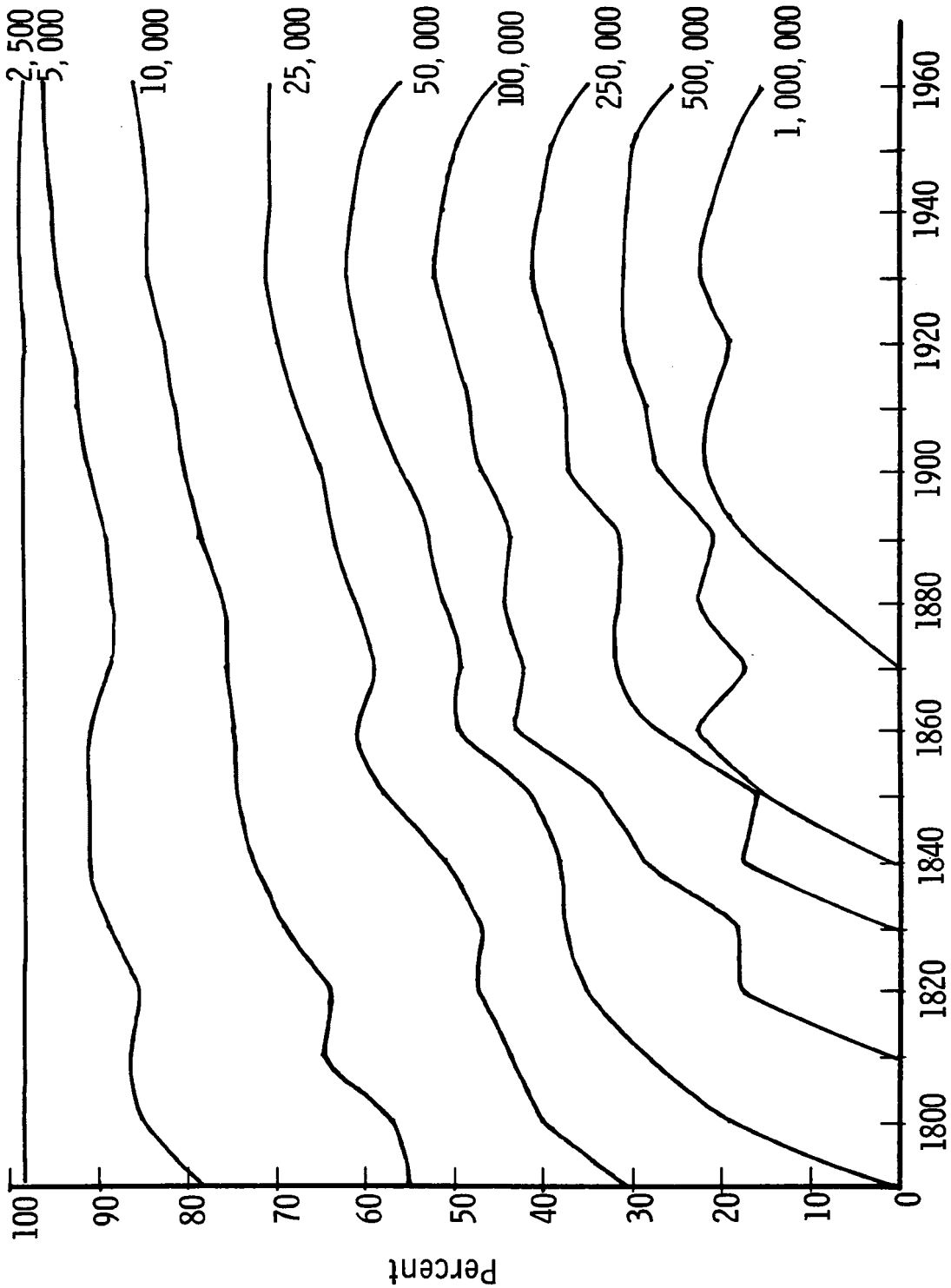

Fig. 2--Percentage of urban population living in cities greater than stated size

Some of this communication can be and is accomplished remotely: originally by letter, periodicals, and courier, and more recently also by telephone, radio, television, and telegraph. But modern communication facilities have not yet eliminated the need for face-to-face encounter and concentrations of people. In fact, by stimulating commercial activity they probably have intensified these needs. Physical proximity seems to remain crucial to much of present-day business. Men of affairs fly across the country for an hour of conferences or a few minutes of private conversation. People seem destined to spend ever-increasing proportions of their lives traveling to and from work and to and from each other.

The upshot is great agglomerations of people and greater problems of traffic congestion. The massive crush of human bodies in Manhattan far exceeds that attributable to the natural propensity to herd, and even surpasses what is good for coordination. The queues of planes waiting to take off and land at J. F. Kennedy Airport defly efficient scheduling and pose serious questions of safety and control. We are all too familiar with the car-clogged escape routes leading home, to the open country, and to vacation hideaways. People suffer and die in shocking numbers trying to get away from the concentrations of their own creation. Crime, grime, delinquency, smoke, corruption, pollution, impersonality, noise, and ugliness have soiled our cities. Unwholesome melanges have resulted from the haphazard development of urban concentrations.

DECENTRALIZATION

Many architects and urban planners, among others, viewed these unfolding problems in the early 1940s with grave concern. Eliel Saarinen, to name one, concluded that a concerted program of what he called "organic (by function) decentralization" of the city was essential.* Saarinen saw the automobile as the great hope and potential instrument of decentralization. But the subsequent flight of home owners and some business firms out of the city (which has spelled success for Hertz and Avis) has only increased the crippling traffic snarls and urban decline. There has been little, if any, of the healthy, biological kind of decentralization that Saarinen had in mind.

Saarinen may have been naive; or, to allow in a ray of light, he may have placed his hopes with the wrong technology. Two of the fastest growing technologies today are those of computers and communications. As they begin to merge with each other in imaginative systems for business and government,† their potential effect on society widens.

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*Eliel Saarinen, The City: Its Growth, Its Decay, Its Future, The MIT Press, 1965.

†For example, the SAGE system for continental air defense; the SABRE reservation system of American Air Lines; the Lockheed Automatic Data Acquisition system; the Westinghouse System for message switching order entry, and inventory control; the automation programs of the stock exchanges; numerous real-time systems for banking and price quotations; the information utilities under development; large time-sharing systems such as the one at M.I.T.'s Project MAC; real-time systems for control of railroad, vehicular, and air line traffic. See Martin Greenberger, "The Uses of Computers in Organizations," Scientific American, September 1966.

They seem certain to make a deep impression on the structure and function of future cities, just as the automobile has already left its imprint. Whereas the automobile has primarily influenced how and where we live, however, the impact of computer and communication technologies may be more on how and where we work. With creative and enlightened planning, we might hope to steer the changes wrought by these technologies toward the good of mankind, including the improvement of cities.

THE CITY

What is a city? What will it become? To attempt an answer to the latter question we should first answer the former. Yet, a real answer has never been easy to find. Any number of historians, sociologists, urban planners, and political scientists have searched for an all-embracing definition of "city" without avail.*

A city may be any or several of many things. At different times of history and in different locales, it has been a fortress and stockade, a terminus, a depot, a forum, a market, a fair, a resort, a university, a factory, and a port. A city is a place to get information, a place to eat, a place to meet friends, a place to buy books, a place to enjoy art, a place to get credit, a place to shop, a place to work, a place to exchange ideas, a place for learning, a place to seek justice, a place to incarcerate criminals, a place for recreation, a place to store goods, a place to trade, the seat of government, and a hundred other things.

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*See Oscar Handlin and John Burchard (eds.), The Historian and the City, The MIT Press, 1962.

Common to all cities are congregations of people. Most of the people are there for a purpose, and the purpose often is some version of communication with other people. By harboring diversity, the city offers choice. By allowing concentrations, it furnishes advantages of scale. The city encourages specialization and mechanization, and thus promotes industrial progress. The city facilitates the transfer of information, the lifeblood of commerce and a thousand occupations. No one aspect of the city summarizes its total role; yet of all its functions, the communication of information may be the most central and the most vital. Some observers consider the human communications function as the single most important reason why cities came into being.*

NEW OPPORTUNITY

With communications occupying center-stage, it is natural to inquire about the possible consequences for future cities of the remarkable progress now being made in information-based technologies. Can these technologies be applied to help alleviate some of the urban sores which previous technologies have aggravated? There are two extreme, but defensible positions.

1) Far right. Although the widening use of computer-communications systems will probably increase the pace and scope of life, the substance of life will not change. The structure and nature of cities will remain pretty much as they are today. We must tap our hearts more than our minds for solutions to urban problems. We must call upon people rather than machines.

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*For example, see R. L. Meier, A Communications Theory of Urban Growth, The MIT Press, 1962.

2) Far left. In the foreseeable future, audio-video, computer-communication networks will permit people to transact almost all of their business remotely. The need and wish to get together in urban concentrations will be vastly attenuated. Cities as we know them today will become largely superfluous and unnecessary. The opportunity will exist for a complete re-designing of how we live and how we work.

Truth undoubtedly lies somewhere between these two extremes. The enormous complexity of the city argues against the position on the far left, and history contradicts the position on the far right (with the most recent counter-evidence being the aforementioned influence of the airplane and the automobile). Three forces have been crucial historically in shaping the form of the present cities.*

a) Development of a centralized national state.

b) Transformation of the economy of traditional households into a rational capital-using basis.

c) Technological destruction of distance.

Emerging computer-communication networks promise further technological destruction of distance. Unlike faster means of transportation, however, they will allow people to stay apart, rather than encourage them to come together. They will offer a healthy and much needed counter poise to the excessive magnetic attractions and cohesive bind exerted by urban concentrations. They could turn out to be the next major force in the evolution of

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*Handlir and Burchard (eds.), op cit.

the city by loosening, in effect, the urban knots that tie people to each other unwillingly. People would still get together, but more for reasons of sociability, friendship, and intellectual discourse, than of coercion and economic necessity.

THE FUTURE

From this point of departure we would like to address ourselves to the future and ask the following questions:

1) What new things are conceivable with improved communication-computer systems? In particular, to what extent will they reduce the need for people to cluster together?
2) Assuming a significant reduction in this need, how may patterns of employment and leisure change?
3) What are the bounds on these changes?
4) Where do we stand today and how rapidly are we advancing?

First, what new things are conceivable? The recent development of time-sharing and person-to-computer terminals has opened up some intriguing possibilities: information utilities, automated libraries, computer-aided instruction, financial information networks, on-line systems for hospitals, schools, travel agencies, and the stock exchange.* By bringing desired information to people in the form they want it, future computer-communication systems will reduce the need for man to be a peripatetic seeker of

*For a discussion of some of the possibilities, see Martin Greenberger (ed.), Computers and the World of the Future, MIT Press, 1964; also, "The Computers of Tomorrow," Atlantic Monthly, May 1964.

data. In a real sense they will be alternatives, if not substitutes for human transportation. (Human transportation poses more of a problem than the shipment of freight because of the delicate, impatient nature of the goods, so we shall concentrate on it.)

To make a personal meeting unnecessary the illusion must be created electrically that our friends, associates, or clients, are in the same room with us. "Eyeball to eyeball" was the expression used to describe the stressful US/USSR interaction during the Cuban missile crisis. The physical eyeballs were about 5000 miles apart. Yet with the excellent electrical communications that existed and were taken for granted, the feeling of emotional resolve was transmitted remotely without the need for a person-to-person summit meeting.

Despite such examples, present telephone communications still fall far short of simulating face-to-face encounter. To many people they do not give the feeling of privacy, sincerity, realism, personal rapport, physical closeness, and whatever else goes to make up the mysterious process of "getting together."

Consider Fig. 3, by C. C. Cutler, who asked acquaintances how far they would travel to avoid using the telephone in a given task.* To get a common measure, travel by foot was specified and rather ordinary tasks proposed. His conclusions are:

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*C. C. Cutler, "Spectral Lines," IEEE Spectrum, September 1966, Vol. 3, No. 9, p. 75.

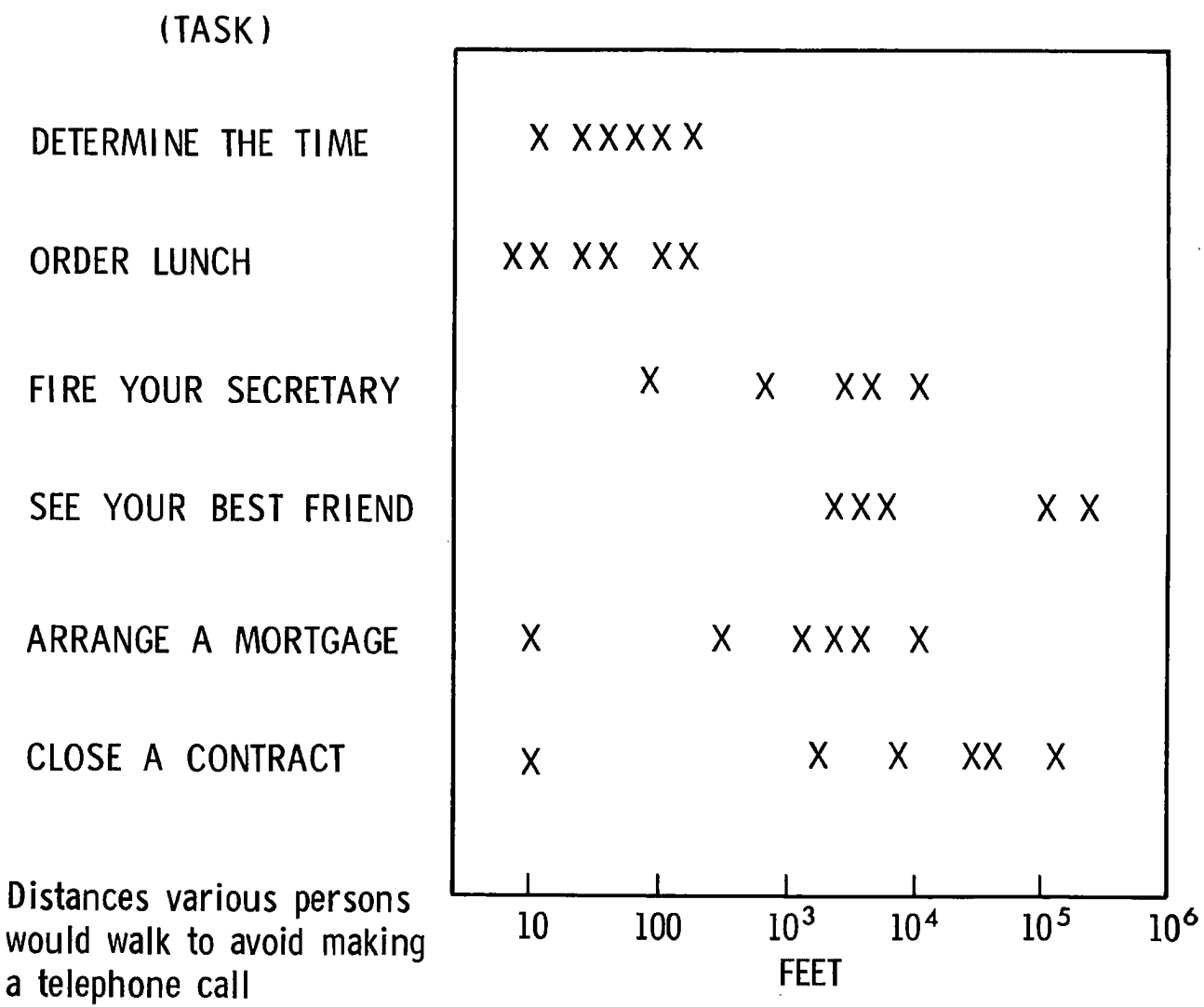

Fig. 3--Distances various persons would walk to avoid making a telephone call

(1) People will go to considerable effort to achieve a face-to-face situation.

(2) People do not like to walk. (On the more difficult tasks they admit they would go 100 to 1,000 times as far by other means of transportation.)

The telephone has revolutionized our way of life and its value would be hard to measure, but clearly it is only a substitute for our actual presence.

The telephone has not been a depressant to the success of the airlines; it has more likely been a stimulant. Movies and television have yet to put theatres and ball-parks out of business.

If future electrical communication systems are to reduce the need for face-to-face encounter rather than increase it, they must be given a personal tone and create an image of presence. Life-size color TV screens may be what is needed. What are the prospects? We think they are good.

We have briefly looked into the technological possibilities of new digital TV/computer communications systems composed of individual low-cost coaxial lines feeding every house, together with a switching system.

Let us consider the most difficult engineering target: secure, digital, color TV. We may factor this objective into several components. These include long-haul wideband transmission, local-area concentration of user lines, switching and digital processing equipment, keyboards and other data entry devices, and displays. The technology for most of these components is moving along rapidly.

The American Telephone and Telegraph Company is experimenting with "Picture Phone," but this seems to be

directed at the modest goal of providing subscribers with a small black-and-white image. The Picture Phone's design appears bounded by an implicit constraint to make maximum use of the existing telephone network. Its proposed use is envisioned primarily as a simple adjunct to the voice telephone.

We are suggesting an entirely new system to provide very high-quality, high-privacy, large-screen color television service. This would certainly enhance present person-to-person telephone facilities, but it could do much more. It could provide for an almost infinite number of "semi-broadcast" TV programs for educational purposes as well as entertainment. We choose the word "semi-broadcast" to describe simultaneous economic interconnection of many smaller common interest groups that are amenable to present broadcast techniques, and includes any size group beyond two persons. This may be thought of as an extension of the "narrowcasting" concept proposed by Licklider.* Perhaps most importantly, it could be used to drive picture output devices from the new information utilities.

One of the key distinguishing features of the proposed system is the use of digital technology throughout. This allows built-in, end-to-end secrecy provisions for

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*J. C. Licklider, "Televistas: Looking Ahead Through Side Windows," in Public Television, A Program for Action, Report of The Carnegie Commission on Educational Television, Bantam Books, New York, January 1967, pp. 201-225.

the maintenance of privacy,* and makes possible incorporation of the full potential of the emerging digital computer art. It might also someday permit the use of flat screens instead of the bulky cathode ray tubes of today's TV sets.

In order to obtain the desired high resolution at a data rate that can be transmitted cheaply, we are considering the use of very low frame rates using pseudo-random scanning. Some recent excellent work examining the feasibility of a pseudo-random dot scanning system ideal for a TV privacy system indicates that most material (except perhaps watching the rock 'n' rollers) requires only about two frames per second.† We would thus anticipate that a data rate of about 40 million bits per second will suffice.

Table 1 shows some of the differences between present analog TV standards and the proposed system.

Table 2 provides some subjective estimates of dates and probabilities of technical success in several successive levels of future communications development. Note, that we need not be successful in all component developments. Each subsystem has its alternative choices. It is not a matter of drawing to fill an inside flush.

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*For a discussion of the issue of privacy in future interconnected computer systems see, Paul Baran, in The Computer and Invasion of Privacy, Hearing before a Subcommittee on Government Operations, House of Representatives Eighty-ninth Congress, Second Session, July 26-28, 1966, pp. 119-135.

†See S. Deutsch and P. Balaban, Pseudo-Random Dot Scan Television Systems, Scientific Report PIB MRI-1256-65, Polytechnic Institute of Brooklyn, Microwave Research Institute, December 1964.

Table 1

DIFFERENCES BETWEEN PRESENT ANALOG TV STANDARDS AND THE PROPOSED SYSTEM

Parameters Desired	Present Analog TV Transmission	Proposed 40 megabits flat-screen digital TV Transmission
Resolution	200 to 500 lines	1000 lines
Color	Yes	Yes
Motion reproduction	Very good	Fair-Poor
Secrecy	Poor	Excellent
Future transmission cost	High	Low
Linearity	Fair	Excellent
Flicker	Excellent	Excellent
Future switching system cost	High	Low
Feasibility	Proved	Unproven
Growth potential	Limited	Good
Compatibility with digital computers	Poor	Excellent

Table 2

SOME SUBJECTIVE ESTIMATES OF DATES AND PROBABILITIES OF TECHNICAL SUCCESS

Subjective Probability of the Feasibility of	By 1970	1975	1980	1985
transmitting 40 megabits/sec over one mile of low-cost co-axial cable and being able to reconstruct the signal;	0.8	0.9	0.95	1.0
using cheap regenerative repeaters to extend the links to 200 miles or more;	0.9	0.9	0.95	1.0
developing a cheap digital privacy system,	0.3	0.8	0.9	0.9
developing an electronically controlled common-user TV system,	0.02	0.3	0.7	0.8
developing an all-digital high-resolution, black-and-white, flat TV screen	0.1	0.3	0.5	0.8
developing a very cheap, all-digital, high-resolution, color, flat TV screen.	0.05	0.2	0.4	0.6

DOING TASKS ELECTRICALLY

Let us visualize a society where each person has simultaneous access to a large life-size TV-like screen and computer input device that can communicate with one or more individuals or computers simultaneously anywhere in the country and at tolerable cost. Which tasks can now be done with instantaneous electrical communications as well as with old-fashioned transportation? Which tasks is it plausible to do remotely, and which ones still probably require physical proximity?

Remotely

Much of management, banking, and sales.*

Such secretarial work as typing, filing, and dictation.

Supervising such manual labor as the digging of ditches.

Delivering letters and printed matter.

Preliminary phases of trouble shooting, and monitoring the operation of machinery.

Meetings and planning discussions.

Writing, editing, and publishing.

Reading text, observing teachers, and taking both oral and written tests.

Synchronized gymnastics and intellectual games.

Face-to-face dining and visiting friends.

Sight-seeing and viewing spectator sports.

Surveillance for traffic infractions and controlling routine traffic.

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*"How much?" is a moot question left to the reader to answer for himself.

Legal work, including court trials.

Medical diagnostics using electrical transducers.

Defense planning, training, and staff work.

Command and control, guard duty, and controlling drone airplanes.

Requiring Physical Proximity

Non-automated production line assembly, janitorial work, and the delivery of goods.

Digging ditches, building things, and repairing defective machinery.

Corporal punishment.

Dipping girls pigtails into ink wells.

Engaging in contact sports such as baseball, football, and wrestling.

Boating, hiking, dancing, and putting out fires.

Checking the site of a crime, serving time in jail, providing emergency assistance, and controlling riots.

Detailed close physical examination.

Patient care and first aid.

This list is subject to all kinds of qualifications. We must not take it too seriously, but neither should we dismiss it out of hand. One interesting observation arising from the exercise is that most tasks requiring physical proximity involve small groups (e.g., playing baseball and boy-girl activities). This augurs well for the possibility of communications relieving the pressure toward concentration in the city. Man may find himself spending more time at home, and doing more of his work

from home. Climate and physical beauty could become the predominant factors in determining where he lives, rather than closeness to the plant and office, or convenience to downtown. Electrically, work and all our friends are near, yet we can spend most of our time in a rural retreat.

THE PRESENT

Today the movement of population in the United States is still toward the city. That is where the jobs are. Office space in Manhattan is being added faster than ever before in history. Nearly 70 million square feet of rentable area has been built in major office structures there since 1947. By 1970 the total will have approached 90 million square feet. By comparison, in the boom period of the 1920s when the city's lower Manhattan skyline was created, only 30.4 million square feet of space was built.

But we note that the Versailles was completed shortly before the outbreak of the French Revolution, and St. Peter in Rome was built about the time that the Protestant Reformation got started. The physical externals of a system may never be more impressive than at the turning point, as aptly described by Parkinson.*

CONCLUSION

Throughout most of history the family was the cohesive unit of society. Individual members were rarely

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*C. Northcote Parkinson, Parkinson's Law, and Other Studies in Administration, Houghton Mifflin, 1957.

out of earshot of each other. The industrial revolution and factories changed all that. The demands for cheap power and the growth of specialization transferred labor from the cottage to the mill. The family was separated, at least for eight to ten hours a day. The development of the concept of universal education further divided the family. Today, the home is sometimes a place where members of the family return to sleep and perhaps take a few of their meals together.

Some sociologists blame many of our social ills on the breakdown of the family as a unit. Given this as a premise, it is interesting to ponder whether computer-communication technology might help move society backward to a healthier state of family life. The notion of the family as a continuing social unit, even in a computerized world, is natural and appealing.

The picture that we are suggesting is one of a widening, sparser distribution of people around the world, with urban pockets of active personal interaction among intellectual, commercial, industrial, and political leaders. These urban assemblies will serve as input nodes to the information networks that spread across state and national boundaries. As sources of ideas and top-level decisions, they may be considered the cities of tomorrow.

There is another way to view the future city. The Greek city of Plato's Republic was completely self-contained and self-sufficient. It stood in virtual independence of any other community. What we are beginning to see is the opening up and spreading out of the Platonic city, with links and flows being established to many other

cities. As this network continues to expand and enlarge, all the world may eventually be said to be one city. Will this help stabilize the world and moderate the divisive forces of nationalism? Will it reduce subversion among people and the dangers of surprise and miscalculation? We hope it will; but we can do more than hope. We can "design in" these goals in planning for the future technology.

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