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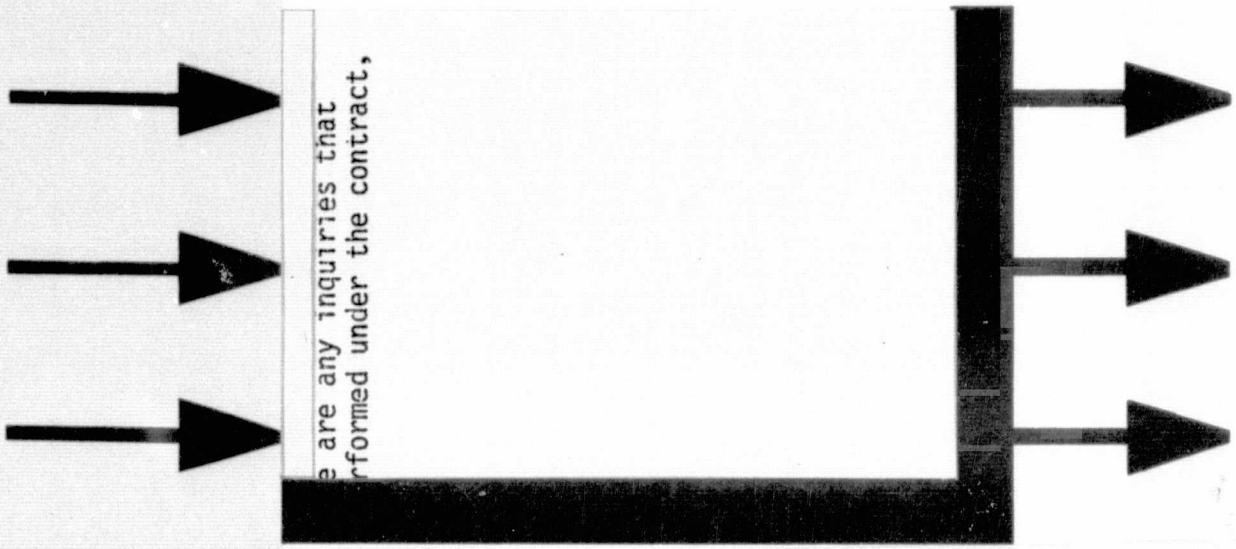

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SUBSTITUTING COMMUNICATIONS
FOR TRANSPORTATION:

A STUDY OF THE REMOTE NEIGHBORHOOD OFFICE CENTER CONCEPT

Final Report, Contract NASW-2743
31 August 1976

prepared for

NASA Headquarters
Washington, D.C. 20546

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ABSTRACT

The substitution of communications for commuting to work is examined from several aspects, *viz.* how many individuals might be able to take advantage of it and what their occupations are, the potential benefits it could provide to these people and to the nation, the costs of implementation, and the chief obstacles to its acceptance. Attention is focused on the possibility of certain groups of white collar workers conducting their business affairs through a network of Remote Neighborhood Office Centers (RNOC's) located near their homes. Typically, employees would walk or bicycle to work and from desks at the various RNOC's communicate with their headquarters organizations by means of voice and digital circuits. Although current technology is readily able to support such an RNOC network, the main problems confronting would-be implementers center around the need for establishing its operational viability, that is, demonstrating that a sufficient number of business operations can be carried out in such a decentralized configuration as efficiently as they are under more conventional circumstances. To address these latter points, the description of a pilot program is presented which is intended to identify pacing issues that must be settled before firm conclusions can be reached on whether the concept is operationally viable.

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I. BACKGROUND

Substituting communications for transportation can hardly be considered an innovative idea. Depending on one's personal point of view, the concept can be traced backwards in time to the first use of the mails, to smoke signalling, or ultimately --at the risk of belaboring the point--even to shouting. However, our purpose is not to present a historical development of the subject, but rather to examine in a contemporary context how modern electronics and communications technologies might be used to the practical benefit of business and commerce in certain situations that involve heavy commitments to transportation.

Although the telephone has for almost a century served as the keystone of modern communications, the past twenty years has seen the rapid emergence of video, facsimile, and high-speed data services as viable new tools to complement it. This has prompted speculation about startling new options, seemingly just around the corner, which promise tomorrow's businessman the convenience of participating in nationwide (or worldwide) meetings, perhaps face-to-face, without having to leave his office; to have instant access to unlimited computer resources; and to perform countless administrative and executive functions from locations far removed from the office, perhaps even at home. These services are supposed to result in reduced travel and provide a concomitant increase in time available for pursuing other activities. Such services would, it is claimed, eliminate many of the paper records used in routine business transactions, and motivate the development of special communications features uniquely tailored to individual and corporate requirements. And such claims, in turn, have spurred the formation of many business ventures to capitalize on the potential markets for equipment and services that would presumably follow hard on the heels of these advances.

And, say the proponents of substitution, business is not the only aspect of life that would be impacted, for it is also claimed that the application of telecommunications to purely social and cultural pursuits could reduce the need to travel by bringing educational opportunities into private homes, while (e.g.) allowing students to communicate with lecturers, and hospital staffs and private physicians in cities to be shared by clinics in small remote communities. It could even allow cultural attractions like plays, operas, ballets, and museum visits, which are normally available only in metropolitan areas, to be enjoyed by people in outlying regions as well. Indeed, Dr. Peter Goldmark, the inventor of the LP record and a pioneer in the development of color TV, believes that telecommunications could play a key role in restoring a balance in population density between the city and the country by making life in outlying areas more attractive to those who would like to live there.[1]

Encompassing as it does so many aspects of technology, finance, politics, social welfare, utopianism, and even science fiction, the general subject of substituting telecommunications for travel inevitably qualifies as one of the most fascinating and intellectually fertile topics in all of technology. Untold numbers of authors have produced countless articles, reports, and books about it, most of which (perhaps justifiably) are so optimistic in outlook that the sympathetic reader cannot help but perceive the outlines of a rosy future, almost here, in which travel becomes virtually unnecessary except for reasons of personal pleasure and where the user of these services sits spiderlike at one node of a giant communication network, plugged into it by electronic terminal devices, constantly interrogating and supplying information for the benefit of his own affairs and for humanity as well.

So it was understandable that when, in 1974, a NASA-wide task team surveyed methods by which the Agency's wider use of

teleprocessing and telecommunications might produce significant savings in its consumption of energy and scarce resources, its attention was drawn to the popular topic of substituting communications for travel. One important facet of NASA's involvement in this subject, the task team noted, is teleconferencing, i.e. analog signal communications:

Established in 1965, the Apollo Teleconference Network had been used to good advantage by Headquarters, the Manned Space Flight field centers and their prime contractors to expedite procurements, coordinate schedules, and track progress in managing the lunar landing program. Faced with diminishing travel budgets in the 1970's, the Agency decided to maintain the network in operation through the Skylab period, again with highly successful results. Bolstered by this experience and by reports of similar successes from other (domestic and foreign) groups, and with the continued pessimistic outlook for travel serving as a rationale, the task team recommended that the network be further expanded so that all major NASA installations would be included within its scope. The goal of this project was to demonstrate that annual net savings in excess of one million dollars could be achieved without compromising the management effectiveness of ongoing projects. If this expanded approach proved successful, then new avenues could be explored to improve on it, including video augmentation, perhaps via NASA experimental satellites. Duly approved by NASA management, this program is currently under way, and results of evaluations of the effectiveness will soon be reported elsewhere.

However, when it came to assessing the role of *digital* telecommunications in reducing travel and conserving resources, no suitable body of experimental data could be found on which to base estimates of its value to the Agency. Most of the studies undertaken to date had been purely speculative,

citing statistics* that describe the potential benefits of proposed concepts under a variety of assumptions of demand and economic conditions, or enumerating different ways in which organizations could be split between the Central Business District (CBD) and remote sites[2], but offering little in the way of observational evidence to support the specific approaches, if any, recommended in them. One reason, no doubt, is simply that the technology for undertaking tests or demonstration programs; e.g. communicating word processing terminals, digital common-carrier and value-added networks, fast fax, etc., was not readily available until very recently. Another is that significant tests of the total concept in any of the forms usually described in literature would involve prohibitively huge sums of money and considerable time for planning, coordinating and conducting them, not to mention evaluating their results. And yet, the incentives to pursue the concept were quite compelling. Much of NASA's work is "information-intensive". That is to say, it deals with the manipulation of information rather than physical objects, and this type of work is especially well-suited to communications substitution. Moreover, the task team agreed, besides saving money, significant reductions in the expenditure of fuel and in the consumption of resources could be achieved as well -at least in principle- if the means were provided for certain groups of employees to work near their homes, communicating with their offices downtown using appropriate terminals. Added to all the above savings, significant reductions in commuting time were forecast, as well as high employee morale, and hence improved efficiency.

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*These are all too often based on questionnaires of a speculative nature, a notoriously unsafe way to test whether the public will really support a proposed concept.

The remote office concept is itself nothing new. Many authors have considered it, significant among whom are Harkness[2], and Krzyczkowski and Henneman[3]. Harkness postulates that if all workers worked in centers nearest their homes, from which they could interact electronically with other members of their organization, then all work trips could be made on local streets, "thus requiring no investment in new transportation facilities" -an overly optimistic view perhaps, but nevertheless interesting and in itself valid enough to make the concept quite worthy of careful investigation.

Reference 3 considers the RNOC to represent "the ultimate in freedom of locational choice at the macrolevel." Adopting a somewhat utopian outlook, the authors state that "every need would be satisfied via a communications center located either within walking distance of, or actually in, the home; and the length of nearly all trips to work, shop, visit, and conduct personal business would be reduced to the length of the trip from home to cmmunications center--zero, in the case of a home-based center." Two highly imaginative RNOC scenarios follow, in one of which a hypothetical couple living in Bishop, California, both communicate from their home, he to his employer in Washington, D. C., and she to her clients throughout the nation. Their home contains such equipment as a large-screen color television with built-in audio and video recording equipment, a computer terminal, etc. The second scenario provides a sample application for a type of desk-top communications unit described in Reference 4, intended to permit the "conduct of all types of managerial, administrative, or creative activities that do not demand actual manual services....". "A 10-button keyboard serves as the telephone dial, the source of numerical input to the computer and the interrogator for the libraries and record center. The modular concept would allow one to carry the telephone or calculator in one's pocket to any location in

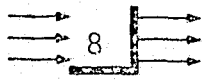
the home or, within limits, to a variety of locations outside the dwelling. This communications center has access to microfilm images of books, records, tabular data, and so forth, located in a centralized library and records center. The film is read by a TV camera. The library would contain magnetic tape units for storage of verbal records or any type of audio-recorded information. Library information is located and viewed from the desk by dialing an indexing system that appears on the desk TV receiver. Selection of desired material is then made from the index lists..."

This sort of romantic visionry permeates much of the literature on communications substitution, for it is very interesting and very intellectually stimulating to propose new forms of application for intricate concatenations of sophisticated communications equipment that is beginning to find its way into the electronics marketplace now that large-scale integrated circuit technology, reliable equipment performance and effective microminiaturization processes have become affordable. All well and good as far as it goes, but what would it cost to provide such options? How would the equipment and the data networks be financed? And what would it save? What sorts of social, economic, and political side-effects would be likely to attend the introduction -or even the proposed introduction- of such a concept?

These questions prompted the task team to recommend that a study be undertaken to examine more closely the economic and technological foundations of the neighborhood office center concept so that its practical merit could be determined, and to develop a plan for testing and evaluating it on a scale modest enough to be affordable in an era of shrinking budgets yet realistic enough to be inferentially significant in terms of ultimate application to the real world, but at the same time brief enough in duration that

meaningful conclusions could be drawn from its results within a reasonable time. This recommendation, approved by the Deputy Administrator, led to the study whose results form the basis for this report.

Fuel for transportation accounts for one-quarter of the nation's entire energy demands. Automobiles consume about half of this amount, and half of this in turn goes for daily commuting to work, so it seemed especially worthwhile in the light of energy conservation as well as NASA's own interests to focus this study on telecommuting. A system of Remote Neighborhood Office Centers (RNOC's) was to be considered, as in Reference 2 and other studies. Situated in or near residential neighborhoods, their convenient locations would permit people employed in certain fields of activity to go to work by walking, bicycling, by jitney bus, or by short rides in cheap, pollution-free electric cars which modern technology is sufficiently able to produce in quantity. Any office center would have various types of data and voice terminals, as well as access to a commonly shared communications network. Then it would be possible, for example, for a secretary employed by Agency XYZ to work in an office center next to an accountant who is employed by Firm ABC. Each would communicate with his home office by means of these terminals tied into the data network. Of course, "home office" loses its meaning here because there might eventually be no need for a central facility, or perhaps only a small one in which the organization's most senior officers would be located, and where visitors could be received officially in the name of the company.



Specifically excluded from consideration here is the work-at-home option, not because it is technologically unfeasible but because this arrangement is administratively more complex. more difficult to supervise, and more costly to operate.

The goals of the present study were:

1. to estimate the potential benefits -as measured in manhours, financial expense, fuel , power, and resources that would follow from the implementation of RNOC's by selected segments of the nation's population,

2. to analyze the costs, equipment, and communications requirements associated with establishing and operating a hypothetical network,

3. to examine the social and economic implications of orienting the conduct of the nation's business towards such a concept,

4. to identify the barriers to the acceptance of the concept, and to indicate what direction might be taken to surmount these barriers,

5. to specify the gross design requirements of a typical RNOC, including terminals, communications, and office management and maintenance procedures, and

6. to outline the elements of an experiment program that could be implemented as a first step to test the usefulness of the RNOC concept.

The remainder of this report is devoted to a discussion of the factors cited above and includes recommendations on areas in which further work seems worth pursuing.

II. POTENTIAL BENEFITS

Justifying the concept depends on establishing the financial and social value of benefits that can be brought about through its adoption; all this naturally must be weighed against the costs of implementing it. This Section discusses these benefits, while Section IV treats the associated costs in their broadest sense. A remark on costs is in order here, however: throughout this entire report they are expressed in terms of their values in a contemporary time frame, and monetary values are understood to be expressed in "1975 dollars". Perhaps it may seem somewhat anachronistic to apply the fiscal worth of today's world to a scheme which might not bear fruit until the turn of the century. But expressing expenses in terms of current prices at least permits the reader to evaluate costs against value yardsticks that are familiar to him, instead of forcing him to add still another dimension of uncertainty to a technological situation projected years hence, and which is at best difficult to see with any clarity. By the same reasoning, we shall also assume in our estimates that the work force is frozen at its current state. Therefore, no estimates will be made of e.g. CBD* growth, or additional costs to support highway system expansion, etc. If anything, this assumption penalizes the case for the RNOC and is a further conservative bias in our calculations.

Travel is expensive; it takes time, it consumes fuel, and it is usually mentally and physically fatiguing. Consider, for instance, the annual energy costs incurred by NASA employees in commuting to work. Some 26,000 employees commute an average of about ten miles each way during 220 working days per year. This means that 114 million passenger miles are expended annually in such travel. At an overall speed of 20 mph, some 5.7 million manhours are spent commuting. Assuming

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* Central Business District

an average of two passengers per vehicle, there would then be 57 million vehicle miles travelled. At 12 mpg, this accounts for a yearly consumption of 4.75 million gallons of gasoline. Gasoline retails for about 60 cents per gallon, so this represents an annual expenditure of almost three million dollars--for NASA employees alone!

Nationwide, about 90 percent of all intercity passenger-miles as well as vehicle-miles travelled within the U.S. is done on roads and highways, and virtually all of this takes place in passenger cars[5]. Earning a living is the most frequent use of the automobile. Thirty-two percent of all auto trips and 34 percent of all auto vehicle-miles are devoted to home-to-work commuting trips by wage earners[6]. All told, the nation's cars consume some 75 billion gallons of gasoline per year[7]. From the figures cited above, it follows that about one-third of this, or 25 billion gallons of gasoline yearly, are used throughout the U.S. for commuting to work. This figure is apt to be more like 30 billion if one considers the kind of inefficient stop-and-start driving that characterizes most commuting travel.

2.1 Work Candidates for RNOC's

Of course, not all work can be performed away from the firm's main business location. For example, blue-collar and manufacturing jobs usually require the physical presence of the worker at the plant and likewise for personnel employed in most service industries. However, some fifty percent of the American working population are employed in positions which involve the handling of information, not hard goods, and these are the individuals for whom the concept of the Remote Neighborhood Office Center has strong relevance. Who are these people, what lines of occupation are they engated in, and what are the potential benefits to them and the the nation?

To address these questions, consider the Census Bureau's Occupation Classification System[8], which identifies 441 of the most commonly recognized specific job categories, while arranging them into twelve major occupation groupings. The twelve occupation groupings are in turn gathered into four basic functional divisions, as follows:

1. "White Collar," which includes Professional, Technical, and Kindred Workers; Managers and Administrators, except Farm; Sales Workers, and Clerical and Kindred Workers.

2. "Blue Collar," which includes Craftsmen and Kindred Workers; Operatives, except Transport; Transport Equipment Operatives; and Laborers, except Farm.

3. "Farm Workers," which includes Farmers and Farm Managers; and Farm Laborers and Farm Foremen.

Occupation	1970 Total (thousands)	Percent Substitutability	1970 Affected (thousands)
Accountants	700	100	700
Computer Specialists	260	40	100
Engineers, technical	1,210	20	250
Social Scientists	110	30	30
Managers, Officials & Proprietors	3,750	20	750
Bookkeepers	1,600	100	1,600
File Clerks	310	10	30
Payroll & Timekeeping Clerks	110	60	70
Secretaries	2,700	100	2,700
Stenographers	120	100	120
Typists	950	100	950
Insurance Agents	400	50	200
TOTAL AFFECTED	12,200	61%	7,500

TABLE 1. OCCUPATIONS AFFECTED BY THE RNOC CONCEPT.

4. "Service Workers," which includes Service Workers; and Private Household Workers.

Specific job categories included within each of these groupings are listed in Appendix A, from which it is clear by inspection that only within the White Collar division would there be jobs that impact on the present study.* And even here, many of the occupations listed, such as physicians and airplane pilots, clearly do not qualify for consideration becuase of the nature of the duties involved.** Those that do qualify, at least in part, are listed in Column 1 of Table 1. Column 2 presents the total number of individuals--male plus female--who were registered within each such category in the 1970 census.

Even within these categories, it is unlikely that all of the workers will be well-suited to function in an RNOC environment. Consider salesmen, for instance: Although most of them require office services that could be supplied through telecommunications, (viz. record retrieval and update, typing, etc.) very few salesmen spend all of their time in the office, no matter where it is located. Clients must be visited and new accounts solicited. Certain other kinds of sales workers, e.g. sales clerks, have almost no need for the services that

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*Although one might argue that some blue collar jobs, e.g. lathe operators, are susceptible to teleoperator technology, it appears unlikely that the kinds of equipment required would be located in RNOC's; also, the expense of such equipment and the limited numbers of jobs affected by these operations hardly makes the consideration of such opportunities worth including within the scope of the present study.

**Telemedicine has met with some success in the past[9], but we exclude it from consideration here because it is primarily video-based, and therefore more properly belongs under the heading of teleconferencing rather than telecommuting.

RNOC's could offer.* Therefore, it is only proper to assign to workers in each job category some measure of their expected involvement. This level of utilization is very often referred to in the literature as "susceptibility," or "degree of substitutability". An issue that any serious study of communications substitution must eventually tackle, it is critical to the concept because it poses the time-honored question that any would-be developer of a new idea must ask himself: How large a market is there for my idea? If the analysis indicates that enough demand will exist to sustain the costs of implementation, then there is a rational incentive to proceed more seriously with the plan. In the present context, there is very little statistical evidence on which to base figures for substitutability, and one finds not only that published estimates vary considerably from one author to another, but also that some analysts prefer to bracket their estimates within upper and lower limits.

Many investigators[10-14] have pursued the subject of susceptibility. Mitchell[10] developed two sets of figures for his estimates, one set which established "reasonable" upper bound percentages, and the other "greatest" upper bounds. These numbers are reproduced in Columns 2 and 3 of Table 2. For comparison, Van Vleck's[11] "greatest" estimates of these same parameters are presented in Column 4. The numbers we have chosen to adopt here are shown in Column 3 of Table 1, which is broken out to one finer level of detail. Our figures correspond somewhat more closely to Mitchell's than

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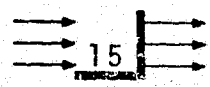
*A case might perhaps be made for including some categories of clerks within the scope of the RNOC concept, e.g. bank tellers, who could conceivably perform their duties through RNOC's using a network of automatic deposit and dispensing terminals for conducting case transactions. However, this does not appear to be a significantly important or feasible area of application. However, Electronic Funds Transfer (EFT) is included within the category of Accountants, which *is* actively considered here. In any case, some allowance for these former groups has been made in applying susceptibility estimates to each category, as is described below.

to Van Vleck's, especially in regard to Clerical Workers, most of whom (after training) could probably function very effectively from communicating terminals and word-processing equipment in remote office centers. It should be noted that while Mitchell and Van Vleck both allowed work substitution

OCCUPATION	Mitchell[10] "REASONABLE"	Mitchell[10] "GREATEST"	Van Vleck[11] "GREATEST"
Professional & Technical	65%	75%	90%
Mgrs., Officials & Proprietors	20%	30%	?
Clerical Workers	75%	80%	50%
Sales Workers	5%	20%	70%

TABLE 2. COMPARISON OF ESTIMATES OF SUBSTITUTABILITY.

at locations other than office centers, our own study is restricted to the latter case only. So when we considered, say, social scientists or engineers our estimates did not cover those whose work would require them to participate in laboratory, factory, or field environments, or even those who work in their own homes; consequently, our estimates of substitutability for Professional and Technical Workers are lower than those furnished by the above authors. On the other hand, our estimates of substitutability for Managers, Officials, and Proprietors tend to be higher than theirs because we felt if one accepts the premise that essentially all of their office support staffs will be working in remote centers, then it follows that most managers would derive no advantage from working at a central location. To put it another way, in order for ninety percent of the clerical and administrative staff to function effectively in locations



far removed from their managers, the reverse must naturally be true as well, i.e. managers must also be able to work effectively at a distance from their staffs. However, we do assume that Officials and Proprietors will continue to require a high degree of contact with their clients, associates, and customers, so that the substitutability for these subcategories, which is chosen to be null, will serve to reduce the overall percentage for the combined category of Managers, Officials, and Proprietors* to the figure of sixty-two percent as shown.

As an additional point of interest, let us remark that while our overall projection of 7.5 million affected workers constitutes a more conservative figure than that of Wise[13] (who estimated that twenty percent of all travel to work could be eliminated), the two numerical totals are nevertheless of the same order of magnitude. However, these figures are both at some considerable variance with Jones'[14] conclusion that substitution susceptibility might reach as high as thirty-one to forty-seven percent. One reason for these high estimates is that he allows certain categories of travel substitution that were disqualified in our own study, such as: working at home; commuting to work, but not during rush hours; and relocating to other sites which, although not in the city, are not necessarily in remote office centers. He also accepts or rejects job categories on an all-or-none basis so that, say, Research and Development Services, or Finance, Insurance, and Real Estate Services, are considered totally susceptible rather than partly so as we have done.

In 1970, among white collar workers, some sixty-three percent of the nation's Professional, Technical, and Kindred Workers drove their own cars to work. The same was true for fifty-three percent of Managers and Administrators, and fifty

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*No detailed breakout of figures within this category is available.

percent of Clerical Workers[15]. Because the workers addressed in this study are predominantly clerical and administrative, we shall adopt the value of fifty percent for our own estimates. This means that of the 7.5 million workers of interest, half of them, i.e. 3.8 million, drove cars to work in 1970. The civilian labor force during the period 1970-1975 has been growing at an average yearly rate of about two percent. Thus, assuming steady, proportionate increases in all job categories of present interest and assuming no major changes in driving habits, there should currently be a total of about four million commuter-drivers and an equal number of passengers who might be candidates for working in RNOC's.

2.2 Fuel Savings

The automobile commuter's daily round trip runs about twenty miles on the average[15], so that the four million automobiles cited above account for a total of eighty million car-miles per day. National statistics indicate that passenger vehicles used for all purposes get about fourteen miles per gallon. For commuting, this figure can be expected to be somewhat lower, say twelve miles per gallon, from which it can be concluded that the commuters in question use about 6.7 million gallons of motor gasoline daily, i.e. of the order of 160,000 barrels. This is of the same magnitude as the nation's daily motor gasoline import rate[16]. At a cost of $13.00 per barrel for imported oil, the savings would amount to about $2 million per workday, or almost one-quarter billion dollars per year. As seen by the consumer, the cost of refined gasoline is about sixty cents per gallon, so that in these terms the savings would be about $3.75 million per working day, or $1 billion per year. If one allows fifteen cents per mile for the cost of running an automobile, then the total savings to consumers would be increased to over eleven million dollars daily, or $3 billion yearly.

Office administrative support personnel (i.e. typists, stenographers, bookkeepers, and secretaries) constitute the most significant and eligible subset of the total population because their work is very compatible with the RNOC concept. Together their numbers add up to a total of 5.4 million, which is two-thirds of the total discussed above. Daily savings are, correspondingly, 100,000 barrels (i.e. half the nation's imports of motor gasoline), $1.3 million in wholesale costs, and $2.5 million to the consumer.

2.3 Savings to Consumers

Now consider the potential savings from the viewpoint of the individual commuter: Round-trip commuting expense tends to run to about $2.00 per day[17]; that is, if one travels by bus or train, fares generally run on the order of $1.00 each way. If travel is by car, using the twenty miles round trip average cited above, costs will run about fifteen cents per mile, less reimbursement by other riders, or its equivalent, such as taking turns driving.

If one works close to home, there is a greater tendency to either eat lunch at home or bring lunch from home. The food expense for an employee accustomed to buying lunch and snacks at work will run about $1.50 per day. An equivalent meal at home might typically save half this amount. If, say, the 5.4 million typists, stenographers, bookkeepers, and secretaries cited above were to avail themselves of this opportunity, then it would amount to a savings to them of $4 million per working day. Surprisingly enough, this is of the same order as the fuel cost savings!!

2.4 Lives and Property

Fewer cars on the road would mean fewer accidents, and therefore fewer lives lost and less property damage. In 1975 about 50,000 deaths were associated with the nation's

140 million motor vehicles[18]; 100 million of these motor vehicles are automobiles so that (assuming that simple, linear laws of scaling proportion hold) 35,000 of these deaths were due to automobiles. About forty percent of all accidents, fatal plus non-fatal, occur during commuting hours[19]. Thus, again assuming linear laws of proportionality, this means that 14,000 of the 35,000 deaths occurred during commuting hours. As mentioned earlier in this section, some one-third of all auto trips and an equal percentage of all auto vehicle miles are devoted to commuting. During commuting hours, however, it is likely that about twice the percentage of vehicles on the road are commuting. Thus, of the 14,000 yearly deaths that occur during commuting hours about 10,000 can be attributed to commuting itself. The 1975 estimate of 8 million commuters capable of working in RNOC's (Column 5, Table 1, page 12) constitutes fifteen percent of the total of 55 million workers who commute by automobile[20]. RNOC candidates, therefore, might be estimated to account for about 1,500 deaths annually. As a check on the reasonableness of this figure, consider Reference 19 which cites a figure of four deaths annually per 100 million vehicle-miles travelled. The 8 million commuters in our sample use 4 million automobiles to commute twenty miles per day for 250 working days per year. From this it follows that they account for 900 - 1,000 deaths annually, a figure not very different from the 1,500 estimated above.

Finally, from Reference 18, the total annual costs associated with all motor vehicle accidents, fatal and otherwise, amount to an estimated 20 billion dollars. These costs include losses due to temporary inability to work, lower wages after returning to work due to permanent impairment, present value of future earnings lost by those totally incapacitated or killed, medical fees, hospital expenses, insurance administrative and claim-settlement costs, property damaged and destroyed by fire, and the money value of time lost by workers other than those with

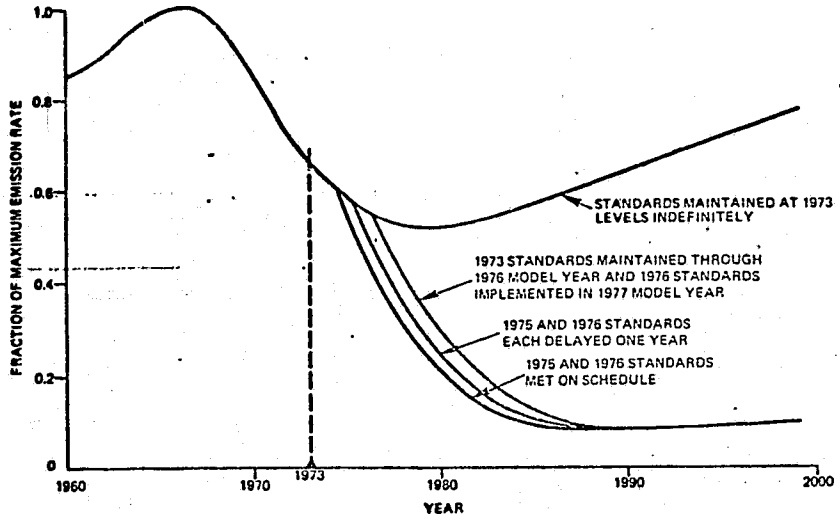
disabling injuries who are directly or indirectly involved in accidents. The $20 billion figure does not, however, include costs for police, firemen, courts, damages awarded in excess of direct costs, or indirect costs to employers, etc. The figure of $20 billion applies to the national total of 135 million vehicles of all types, so the 4 million RNOC-associated automobiles would thus save perhaps one-half billion dollars in annual costs related to such accidents if they were not used for commuting.

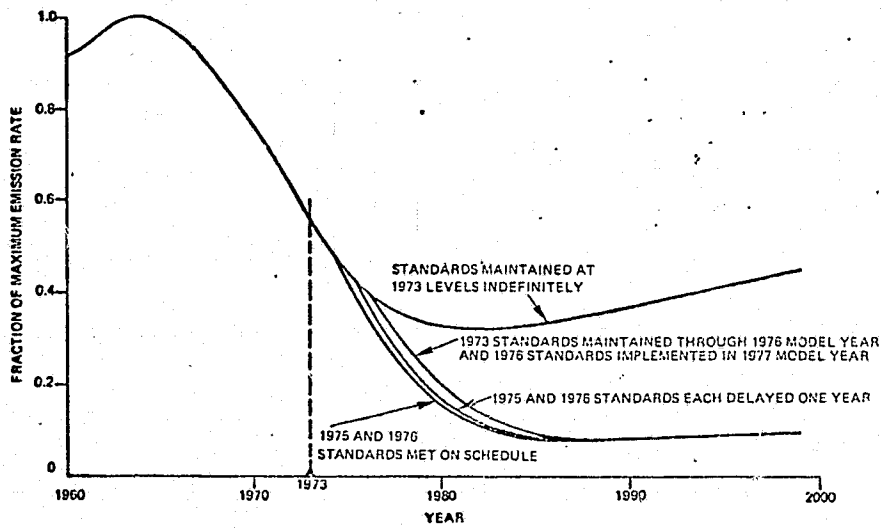
2.5 Pollution Reduction

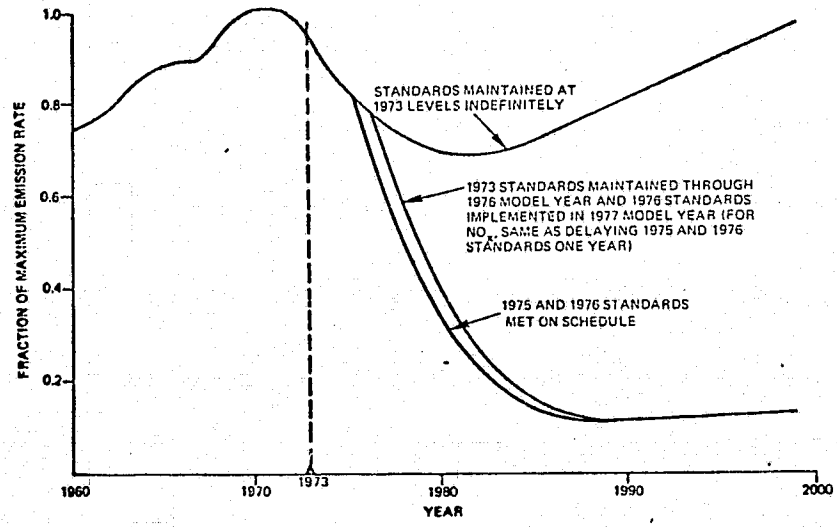
The most direct effect on environmental pollution will be in the reduction of chemical and particulate emissions from automobile exhausts. This effect, however, may be less dramatic than is generally supposed. Levels of emissions from gasoline-burning light load vehicles at the start of 1974 were[21]:

.Particulates	-	.36 million tons/year
.Sulfur Oxides	-	.21 million tons/year
.Nitrogen Oxides	-	5.13 million tons/year
.Hydrocarbons	-	10.92 million tons/year
.Carbon Monoxide	-	59.28 million tons/year

We assume that these were mainly due to private automobiles. Then, adopting the earlier statements that one-third of all auto vehicle-miles, or 250 billion, are devoted to commuting and that, of these, 10 billion vehicle-miles could be eliminated by the replacement of commuting by communications, it follows that about five percent of the atmospheric pollution figures cited above could be cancelled. Now, it should also be recognized that the implementation of automobile emission standards starting in 1974 has of its own accord been drastically reducing emission levels since that time. Figures 1(a)-(c), reproduced from Reference 21, show that it is likely that







Source: National Academy of Sciences, *Report by the Committee on Motor Vehicle Emissions*, February 15, 1973

FIGURES 1A - 1C (TOP TO BOTTOM). EMISSIONS OF: (1A) CARBON MONOXIDE, (1B) HYDROCARBONS, (1C) OXIDES OF NITROGEN BY AUTOMOBILES IN URBAN AREAS.

these emissions will cease to be a serious consideration by 1985, providing that 1975 and 1976 standards are met and maintained on schedule, so the beneficial effects of substitution in this regard may very well be neutralized.

One further aspect of the reduction in atmospheric pollution is worth mentioning: If telecommuting on a serious scale were to be adopted, then the reduction of pollution from this action would relax some of the need for automobile emission controls and presumably reduce the costs of producing, purchasing, and running automobiles. A figure of $200-450 is generally quoted as the additional cost added to the price of the average new car due to the installation of emission-regulating devices.* The additional costs of lead-free gasoline and control device maintenance can be assumed to add about 0.5 cents per mile.

The issue may be moot, however, because, having adapted to such devices, their beneficial effects and their costs, it may very well be that society, business, and our national leaders will choose to keep the controls in force (at least to some degree) even if some relief from pollution can be sought elsewhere. In other words, the policy of "If-it-doesn't-hurt-let-it-stand" may prevail, although a strong determinant may be the economic health of the nation at the time such decisions are to be made.

Water pollution is another matter, though. Oil-carrying tankers account for dozens of spills throughout the world each year. In 1971-1972, for example, 376 incidents produced a

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*GM Statement to the U.S. Senate Government Operations Committee, 2 December 1974. Also cf. statement of L. Iacocca, Ford Motor Co. to Newspaper Advertising Bureau, 9 December 1974. GM's 1974 estimate, consonant with Ford's, was that $215 per car would be required to meet 1975 standards, $110 more for 1977 standards, and $150 still more for 1978 standards.

total of 439,054 long tons of outflows from all oil tanker casualties around the world[22]. This includes incidents at piers; within harbors; at entranceways to harbors, bays, rivers, etc.; in coastal regions; and at sea. Some 2.2 million barrels per day of crude oil, i.e. about ten percent of the world's oil-tanker shipments, are bound for the U.S.[23] Full adoption of the RNOC substitution concept which, according to the analysis presented above, would eliminate virtually all oil imports, would perforce reduce worldwide water pollution from oil spills by ten percent (once again assuming simple laws of proportionality). Such incidents occur with a high degree of randomness, and yearly figures therefore fluctuate drastically. Even in the absence of firm data, however, it is indisputable that a significant percentage of yearly pollution from oil-spills would be prevented. And besides the savings in oil losses, the property damages sustained and the cost of cleaning up after the oil spills would be saved as well. These costs are by no means negligible themselves: the settlement for damages resulting from the Santa Barbara Channel oil spill in 1969, for example, came to almost 10 million dollars, and this does not even include the legal expenses incurred over the five-year period of litigation.

2.6 Depletion of Resources and Commodities Supplies

Abandoning the automobile as a means of getting to work will mean less use for four million commuter cars if the RNOC concept is fully adopted. This figure amounts to one-half of the nation's yearly purchases of new cars, imports included[24]. However, it does not necessarily follow that annual sales of new cars will dip by fifty percent because many "commuter" cars will probably still be retained for reasons of convenience during evenings and weekends, or for emergencies, or for a host of other reasons. Even so it seems plausible to assume that since the "commuter" car will be used less it will be

kept longer before it is replaced.* Let us assume that, on the average, half of the new cars purchased each year will be used twice as long as before. Annual sales of automobiles will then decrease by twenty-five percent. What this would mean in terms of diminished consumption of mineral resources and manufactured products is discussed in the following paragraphs; its possible impact on employment and the economy is treated below in Section III.

Although percentages naturally vary from one model to another, the major material components used in a "typical" automobile are apt to be distributed (by weight) in the following general proportions[25 26]: steel, 61%; ferrous castings, 14%; rubber, 5%; fluids and lubricants, 5%; nonferrous metals (zinc, copper, lead etc.), 3%; plastics, 3%; glass, 2%; aluminum, 2%; miscellaneous (upholstery materials, sound deadener, etc.), 5%. A twenty-five percent reduction in new car demand, viz. 2 million, would likely have the following effects on the use of these materials[25-28]

2.6.1 Steel

Of a total U.S. consumption of 110 million tons, the automobile industry accounts for about 25 million, i.e. 22 percent. A twenty-five percent reduction in demand rate would amount to savings of 6.3 million tons annually, the equivalent of almost half of the nation's total steel imports.

2.6.2 Malleable Ferrous Castings

About one million short tons are shipped each year, half of which is consumed by the automobile industry. A twenty-five percent reduction in demand would mean savings of one-half million tons per year.

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*In multi-car households the diminished usage will probably be distributed among all cars rather than be assigned to one car, although the total reduction in that household will be the same. For convenience, however, we will associate the reduced usage with one single car.

2.6.3 Rubber

Domestic consumption is about 750,000 long tons of natural rubber and 2.5 million of synthetic. Automotive consumption of these products is 550,000 and 1.5 million, respectively. Savings would therefore be 150,000 and 375,000 tons annually.

2.6.4 Fluids and Lubricants

These are mainly petroleum-derived and are included in the figures cited earlier. Most of the products in this category are manufactured expressly for the automotive industry, so that national consumption and industry consumption are virtually synonymous. For automobiles alone, about one billion gallons of lube oils and greases are consumed per year, as well as 200 million gallons of coolants.

2.6.5 Non-Ferrous Metals

About 1.3 million short tons of zinc and zinc alloys are consumed in the U.S. yearly, forty percent of which is imported. The automotive industry uses more than 350,000 tons of raw zinc and zinc die castings in the manufacture of automobiles. A reduction of twenty-five percent will relieve the demand for almost 100,000 tons, which is twenty percent of the amount imported. Four billion pounds of new (primary) copper and an almost equal amount of recovered (secondary) copper are consumed in the U.S. annually. Although imports and exports more or less balance each other out, some 700 million pounds of copper are used in automotive manufacturing, an amount of the same order of magnitude as total imports. The twenty-five percent demand reduction would be equivalent to half the amount of manufactured copper imports.

As for lead, more than 1.5 million short tons of refined primary and recovered secondary are consumed yearly. About two-thirds of this is used in automotive applications, of which a good deal enters as additives into fuel, much of the remainder being used in the manufacture of storage batteries. About 350,000 tons go into the production of tetraethyl and methyl lead products alone. However, with the conversion to lead-free gasoline, automotive consumption will diminish markedly, perhaps by fifty percent, irrespective of the success of RNOC's.

2.6.6 Plastics

The heavy use of plastics in automobiles ranges from fender/headlamp housings to thin-wall plastic ignition system moldings. Some commonly used types of plastics include cellulosic resins, polyvinyl chloride, impact polystyrene, ABS polymer, various resins, high-density polyethylene, polypropylene, RF polyester, urethane foams, artificial rubbers, sheet molding compounds, and reinforced plastics.

In all, half a billion metric tons of plastic materials enter into the manufacture of automobiles each year, and its use is increasing by about sixteen percent annually. Even a twenty-five percent reduction in use would barely serve to hold consumption steady, although the increased use of plastics in manufacture also tends to relieve the demand for mineral ores and products.

2.6.7 Glass

Two billion square feet of flat glass are produced yearly, about half of which is unrolled (window) sheet glass. The automotive industry consumes 200 million pounds per year most of it for windows. This amounts to percent of the total.

2.6.8 Aluminum

Twelve billion pounds are produced by U.S. mills, virtually all from imported bauxite. One billion pounds are used in automotive manufacture, i.e. almost ten percent of the total U.S. consumption. The twenty-five percent reduction would amount to 250 million pounds annually, or two percent of U.S. consumption, and 0.2 percent of the world's production.

2.6.9 Cotton

Automotive consumption amounts to two percent of the U.S. demand, which stands at almost 8 million 480-pound bales per year. Cotton is by and large a harvestable commodity; and, barring serious crop blight or failure, it can be regrown each year.

2.6.10 Energy

The consumption of energy for power in manufacture by the U.S. auto industry amounts to some 500 billion BTU per year, the generation of which requires an expenditure equivalent to some 20,000 tons of bituminous coal or 80,000 barrels of residual fuel oil (or 6.75 kg. of fissioned U235). The twenty-five percent reduction in manufacturing would thus save 5,000 tons of coal, or 20,000 barrels of oil, 1.69 kg. of U235, or some combination of these fuels.

2.7 Maintenance of Roads and Highways

Expenditures of road and highway dollars by federal, state, and local units of government amounts to almost thirty billion dollars per year[29]. Over two billion of this is spent by local agencies on the maintanance of local municipal roads and streets and almost one billion by state agencies for the maintenance of municipal extensions of state highway systems. Road deterioration is caused partly by the natural forces of weather and geography and partly by the

erosive action of traffic on it. Neither statistics nor pertinent literature is available on how much of the deterioration is attributable to each cause, so we shall assume it to be fifty percent from each cause in all urban and suburban areas throughout the nation; this value may be too low in regions with mild climates and too high in regions with harsh climates, but it seems to be a not-unreasonable compromise to adopt. A twenty-five percent reduction in commuter traffic (which itself represents some one-third of all vehicle-miles* travelled) would then be reflected as about five percent decrease in total road and highway wear-and-tear, and hence a five percent relaxation of maintenance demand; expressed in dollars this amounts to about $150 million yearly. In terms of major expenditures for highway construction materials[27], it is: Steel - $45 million, Petroleum products - $45 million, Cement and concrete - $38 million, Aggregates** - $38 million.

The cost of administering highway law enforcement and safety programs amounts to about two billion dollars per year, and the reduction in commuter traffic will no doubt permit some relaxation in the costs of providing these services, e.g. for special traffic police during rush hours. Even a five percent reduction in such services would amount to savings of $100 million.

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*cf. page 17 discussion, above.

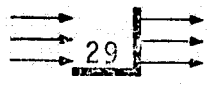
**Includes sand, gravel, clay gravel, slag, crushed stone, bases and subbases, concrete surfaces, bituminous surfaces, structural concrete, and drainage work.

III. OBSTACLES TO ACCEPTANCE

If it were to be adopted, this new approach to business is bound to have a profound effect on peoples' lives, either directly or through (sometimes catastrophic) influences on the organizations they are accustomed to dealing with. So even if its technical feasibility and financial advantage could be established beyond any doubt, vested interests allied with the very natural forces of social inertia can be expected to pose a most serious obstacle to its adoption. For, just as in the case of the digital computer, now all but indispensable, whose technical capabilities were proven twenty years before it finally became socially accepted, entrenched business and political interests, social dynamics, and an all-too-human resistance to change will undoubtedly tend to retard the acceptance of RNOC's, perhaps permanently diluting their influence in some potential areas of application.

3.1 Business Resistance

Every coin has two sides. The very process by which RNOC's generate savings in the use of scarce resources will act to reduce the level of business among industries that manufacture and utilize the products of these resources. So, for instance, when we speak above of reduced commuting leading to diminished use of materials for street and highway construction, it should also be noted that this reduced activity will tend to lower sales and employment throughout the construction industry. Van Vleck[11] states that "jobs would not be lost in the same ratio that telecommunications would be substituted for travel, since the substituted telecommunications itself would produce many jobs." However, true or not, this opinion does not make allowance for the fact that many who lose their old jobs are incapable of being trained for the new ones that open up. When diesel and electric locomotives replaced steam, could railroad firemen be retrained as diesel mechanics? The history of this case indicates no. Or, if digital watches replace mechanical ones,



billion annually in these areas, not to mention the concomitant layoffs among parking attendants, toll collectors, safety and traffice police, road maintenance crews, etc., that would be bound to follow in its wake.

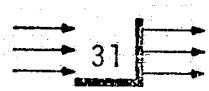
The Federal Highway Trust Fund is used to finance a wide variety of highway programs, safety research efforts, and mass transit subsidies. Incomes are drawn from motor fuel taxes, tires, tubes and tread rubber; track, bus, and trailer fees; oil; and truck/bus parts and accessories. About $7 billion yearly is collected. Losses due to the changeover to an RNOC system might well run over $1 billion, although one can argue that a reduced level of motor traffic should require correspondingly less supportive funding of this kind.

3.1.4 Office Occupancy and Related Matters

RNOC's may have a serious effect on urban form because the decreased demand for office space in established downtown commercial centers will accelerate urban deterioration. Office buildings will be most strongly affected. Even now seriously underoccupied in many large cities, many buildings will suffer still higher rates of vacancy. Heating and cooling will become less efficient in buildings with significant amounts of unused area; vandalism may increase, and in the presence of significant unoccupied areas, security in general will become a very serious problem. Secondary effects will be felt by supporting businesses such as banks, restaurants, office supplies distributors, parking garages, and specialty shops, which cater to the corporate needs of these organizations as well as the private needs of the individuals who staff them.

Once it has been established that living away from the city requires no more time, effort, or expense for commuting than living in it, there will be added incentive for city residents to move away. It may become difficult to support cultural centers, downtown sports pavilions, theaters and other arenas of social interaction. At some point, the functional viability of the city could itself be placed in jeopardy if its population and revenue base should become inadequate to support such basic civic functions as power, water, sewerage, public transportation, emergency services, etc.

There is no way at present of telling how seriously these speculations should be taken. We were unable to locate any significant studies or predictive analyses of the socioeconomic consequences that might attend business decentralization on such a scale. Some fragmentary statistical data may be illuminating, however: An unofficial nationwide survey[30] based on voluntary responses indicates that 350 million square feet of competitive rentable office space exists throughout the nation. Personal inquiries made by us in the Boston and New York City real-estate marketplaces have established that the figures cited in the survey are perhaps 3 to 5 times too conservative. That is, the national areal total of rentable office space is probably more like 1,500 million square feet. Roughly speaking, about 30 million white collar workers are employed in offices[27]. This averages to 50 square feet per employee, a not-unreasonable check on the assumed total of 1,500 million square feet. The 7.5 million white collar workers assumed to be affected by RNOC's (that is, working at new locations near their homes) constitute about twenty-five percent of the office labor force. One might thus expect a corresponding reduction of twenty-five percent in the



demand for existing office space in favor of RNOC space. Numerically, it would amount to about 400 million square feet which, at an average current nationwide rental rate of, say, $8 per square foot, would mean a loss of office rental revenues amounting to $3 billion yearly. Of course, this would be largely offset by the rents received from RNOC offices; but in any event, the landlords of downtown buildings and stores would not normally be the beneficiaries of these incomes. To be profitable, office buildings must be about eighty percent rented. Even assuming a one hundred percent rental rate at present, if one fourth of each building were to become vacant, many of them would fail to be profitable. More than likely, the basic law of supply and demand would probably force prices downwards to where some newer buildings, more efficient to run and pleasant to work in, would attract enough tenants to remain solvent, but older ones would be abandoned, their owners faced with catastrophic losses.

Construction of new office buildings would probably not decline because the space would still be needed, albeit now in more dispersed locations. Initially however, the changeover to RNOC's might create building booms in some locations if it were to be carried out too precipitously.

Power companies would be affected seriously. About sixty-five percent of all electric power generated is provided to commercial and industrial firms. Perhaps half this amount is used in office buildings. The change to RNOC's would not diminish the need for electricity, but the new locations might be served by different power companies, so large-scale shifts in customer patronage might result, with the power companies serving downtown areas the losers. In the central districts of many big cities electric power companies supply steam byproducts

from their generators for heating office buildings through a distribution network of underground pipes. Thus, service would also be adversely affected because it is economically unfeasible to provide it to dispersed, relatively remote, residential locations.

About 2.5 billion kwh of electric power are consumed yearly for rapid transit, surface rail, and trolley lines. Also, approximately 300 million gallons of motor fuel by buses and other public urban transit vehicles that use internal combustion engines[12]. Together, these modes of transportation account for the equivalent of over 11 million barrels of oil, or 2.5 million tons of coal. And while it can be said on the one hand that a decrease of ridership might save an appreciable portion of this fuel (and maintenance cost to boot), one must realize on the other hand that the same diminution of ridership will induce layoffs of transportation workers on what might prove to be a relatively massive scale. The transit industry employs about 150,000 people[27]; this includes workers on local bus lines, electric street railways, elevated and subway lines, interurban electric railways, and trolley coach routes. Hence, layoffs to the extent of 20,000 to 25,000 transit employees are not inconceivable.

3.1.5 Merchant Marine

Decreased use of fuel (and natural gas) will surely diminish the amount of oil imported into the U.S. As stated above*, about ten percent of all oil

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*cf. p. 23

tanker shipments are bound for U.S. ports. Of the world's total 4,600 tankers, U.S. ownership accounts for over 300, virtually all of them owned by private shipping lines. Some 800 more sail under the Liberian flag, and 200 under the Panamanian. Reductions in motor gasoline imports equivalent in volume to the nation's total import rate* would be disastrous for the owners and crews of the shipping fleets that bring oil to the U.S., for domestic tanker production (6 per year) would no doubt be all but discontinued, except for the construction of replacement vessels or possibly ships to ply foreign trade routes. But of course it would be a mistake not to recognize that any degree of success achieved with RNOC's in the U.S. would certainly influence foreign nations in a similar way. They too would naturally want to conserve fuel imports in the same manner, so foreign oil trade would also decrease.

Most ships have lifetimes of about twenty years, but to keep their fleets modern many owners sell off their used ships earlier, while they still command good prices. A slump in shipping would leave owners with a lot of ships not paid for, and many more still not completed but with commitments for funds still in effect. For example, the shipping recession of 1973-1975 forced Norweigan owners to lay up 110 tankers and cargo vessels in the coastal fjords -a total of thirty-two percent of all Norweigan merchant tonnage- and was a leading cause for adding $2 billion in 1975 to a total 1974 debt of $12 billion, and this even in spite of the offsetting influence of burgeoning North Sea oil revenues.

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*cf. p. 17

Ten to fifteen percent of the 135,000 employees in private domestic shipyards and 25,000 merchant seamen would face layoffs. The use of domestically owned vessels would surely be stressed, so that foreign shipbuilders and shippers, as well as their governments, faced with disportionate losses in U.S. sales could be expected to exert whatever legal and political pressures might be at their disposal to retain their place in the market. Further, surviving domestic shipping lines would find increased competition in a foreign marketplace already too small to handle a glut of available tankers. And oil supplying nations themselves, faced with important losses of U.S. customers for their products, could likewise be expected to retaliate by resorting to diplomatic, economic, and political devices in time-honored as well as exquisitely-conceived new forms.

3.2 Opposition by Individuals

Technological innovation evokes resistance by individuals who see themselves threatened by it. Sometimes they are concerned that a new advance will make their jobs obsolete; sometimes they see their families or neighborhoods menaced; and sometimes the life styles to which they have grown accustomed are at stake. Automation eliminates jobs, and for this reason world history since the industrial revolution abounds with examples of opposition to the introduction of labor-saving machinery. Airports or highways which will improve the business climate of an area are often the targets of local resistance groups whose first interest is towards the well-being of their neighborhoods.

In the present regard, one must consider the attitude of the office manager who is used to dealing face-to-face with his staff on all business matters, or his relationship with his secretary who may occasionally run personal errands for him.

Whom can he turn to at the RNOC for these services? Working near one's home is for many people a strong inducement, so managers might consider taking special steps like hiring personal secretaries from their own neighborhoods to work alongside them at the remote office. But until it has been demonstrated and widely accepted that a comfortable and professional supervisory relationship can be maintained at a distance, it must be assumed that managers will be among those most resistant to the idea.

How confident can managers be that their telephone conversations and the digital transmission of sensitive data are carried on in complete privacy? Telecommunications security is a perennial communications bogeyman, but in truth it must be recognized that electronic scrambler systems have been used successfully for years by military as well as civilian patrons. Besides, in this era of sophisticated technology, it is probably no more difficult for unauthorized professionals to intercept conventional mail or bug conferences than to tape digital and video electronic transmissions.

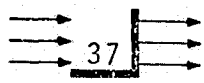
Nonmanagerial personnel -typists, accountants, secretaries, etc.- would welcome the idea of working near their homes, or so it might seem. But how many of them lack the confidence, or even the intelligence, to be retrained on communicating office equipment that is certain to be differenct and probably a good deal more complex to operate than what they are used to? How many would be willing to learn the new procedures, conventions, terminologies, and rules that will be required in a radically new office communication environment? Indeed, how many "slide-rule" engineers retrained themselves as computer programmers when digital computers were introduced? Not many. Most senior engineers and mathematicians over forty, trained on slide rules, never did learn to program, and some still regard programming with suspicion as something of a black art. The stereotype of the "programmer-engineer" is that of a younger man who has grown up in the environment of computers

and who has trained in programming as a part of his formal education. Perhaps the lesson to be learned is that RNOC employees may also have to come from the next generation of typists and managers and accountants, unprejudiced by long experience with the old machines, younger and more receptive to new ideas and devices. Perhaps, as in engineering, it may take fifteen years to produce a trained cadre to staff the new office centers. At any rate, it seems likely that many of the people who stand to benefit from RNOC's might be those most negatively disposed towards accepting them.

Citizen's groups have been mentioned above as being a source of opposition to changes that affect local neighborhoods. In this case, however, one would not expect such resistance to arise because RNOC's act to improve the quality of life in the neighborhood. They do not pollute; on the contrary, they help reduce pollution. They are not noisy or obtrusive, and with careful attention to architectural design and site placement they can help beautify an area as effectively as any other group of contemporary small office buildings. Finally, the presence of an RNOC nearby would probably tend to increase property values in any middle class neighborhood because people would want to live as close as possible to their offices.

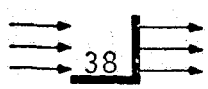
3.3 Misuses and Abuses of the Concept

The old saying that any invention can be used as well as abused holds true even for the RNOC system. Misuses, abuses, and perversions of the concept, in some cases unforeseen prior to its implementation, may in themselves prove serious enough to threaten its viability. For instance, what mechanism can be provided by which the ubiquitous telephone circuits will not be constantly engaged by personal calls? Perhaps it may prove necessary to eliminate acoustically coupled connections if personal calls should turn out to be a serious cause of wasted time and increased operating costs.



One potentially disastrous abuse comes to mind immediately: People began to flee the urban core after World War II, in large measure because of the availability of cheap and plentiful land areas in the suburbs. A larger measure of privacy, reduced congestion, a cleaner environment, and lower living costs were overpoweringly attractive to most; and the surge in automobile manufacture and highway construction during those years guaranteed quick, inexpensive access to their jobs in the city. Now, if the RNOC permits people to avoid commuting to downtown offices by working in the suburban centers, what is to prevent them from beginning to move still farther out into the countryside and commute by car to the suburban RNOC every day? After all, land is still relatively cheap in the country, privacy (this time away from <u>sub</u>urban congestion) is once again guaranteed, the environment is clean and, like in the years after World War II, the roads to their offices will be comparatively free from heavy traffic for the first few years. Of course, this tendency will defeat the fuel conservation goals of the RNOC and begin another round of the pollution, congestion, and commercialization. There is no reason to expect that appeals to the public's aesthetic scruples will prevent such development, because this approach has rarely been successful in the past, so some built-in or externally imposed limiting mechanism may have to be included as part of the implementation scheme if it is truly to provide the benefits intended.

The discussion earlier in this section under "Business Resistance" makes it obvious that an excessively rapid changeover to RNOC's might be disastrous to both management and labor. For social responsibility is no less important than technological innovation. So while engineering advances that save costs and resources are admirable in themselves, still, if these same savings carry with themselves a serious risk of unemployment and business bankruptcies on an epidemic scale, then steps must be taken to lessen the impact. Action on this subject most properly lies in the hands of legislators



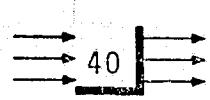
and the executive branch of government, and their attention should be directed to these considerations, which could constitute another serious misdirection of the concept.

IV. RNOC CONFIGURATION, MANAGEMENT, AND COSTS

4.1 Configuration and Management

Outwardly, the individual RNOC will resemble any other office configuration. In room and corridor layout as well as furniture arrangement just as much flexibility is possible as in conventional office groupings. Certain individuals may have private offices, others may share offices, and still others may be located in bullpens, either completely open or with low banker's-wall dividers. To the casual observer, the equipment will not be very much different from what one has become used to seeing in many contemporary buildings: electric typewriters, desktop CRT displays, facsimile transceivers, perhaps some muted electronic dot-matrix printers of the type one finds in stockbrokers' offices. Occasionally there may be a specialized instrument, such as a high-speed line-printer or a pen-plotter.

We do assume that a small superintendent staff will be required to attend to the common administrative needs of all the workers within an RNOC. This staff might also serve to handle physical maintenance and facilities emergency problems, function as receiving clerks for shipments delivered to the building, be responsible for site security, etc. It might be useful to have an RNOC-wide adminsitrator distribute and collect time cards, monitor attendance, or even ensure productivity and enforce discipline in some situations. One superintendent for every twenty or so employees would probably suffice, but individuals who fill such positions, employed by none of the tenants but answerable to all, would be required to be conscientious, mentally flexible, and capable of independent action because of the varied and often sensitive nature of their responsibilities.



Conference rooms may be required, but certainly not in as high a ratio of floor-space-to-employees as one finds in conventional offices. This is because the employees of each company would be physically dispersed to a much greater extent, and most discussions would therefore take place as teleconferences. Occasionally however, there will be cases where personal conference visits are required, so some modest facilities should probably be provided in each RNOC either as common space or rented by one tenant or another for his own dedicated use. For larger RNOC complexes, lunchroom or even cafeteria facilities will be financially feasible, and these would be similar to what one might find now in conventional office buildings. They would be managed and staffed by private vendors, following current practice.

In general, cleaning operations, landscape maintenance, snow removal, plumbing, heating, cooling, electrical and electronic repairs, etc., would also be undertaken by independent contractors just as is done now.

4.2 Recurring Costs

For each specific corporate entity, recurring costs in many categories of direct and overhead expenditure would probably be about what they are now, assuming that the physical appointments in the RNOC are more of less equivalent to what they would be in the conventional arrangement. We assume that office rental prices would remain the same as they are now, although this is perhaps subject to some debate because suburban rentals generally tend to be cheaper than the equivalent space downtown at this time. However, a rise in popularity of RNOC's would both escalate the price of RNOC space and depress the price of in-town space*.

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*cf. the discussion of § 3.1.4

Some (minor) recurring costs would have to be allocated to pay the salaries of the RNOC superintendent staff*. Also, there would be the cost of distribution of office supplies; this would probably have to be arranged by the headquarters of each individual firm because of differing policies and procedures among them, individualized stationary, letterheads, etc. So a distribution service would have to be provided, and this might very well be assumed by established parcel services like UPS, who are used to handling such jobs efficiently. There would doubtless be a market for the transfer of documents and data, to be used in emergencies when normal communications links fail. This might be the form of messenger services via radio-dispatched cars, cabs, or motorcycles.

Every parent firm would pay for dedicated office space occupied, plus a share of common area, with rents established and collected by the owners of the RNOC building. This is analogous to what is currently the practice in office buildings, except that in the RNOC even the bullpen area costs would be apportioned among all firms whose employees are occupied there. Electrical, heating and cooling charges would also be prorated on the basis of square footage of occupied floor space.

Communications would of course constitute the single largest category of recurring expenditure above and beyond the cost of running a conventionally configured office. Cost per bit transmitted is a function of the line bandwidth and the efficiency with which the line is utilized. Figure 2, taken from Reference 31, presents the tradeoff between transmission costs per page of transmitted text and the transmission bandwidth. This is assuming that only textual

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*Much of this cost, perhaps all, could probably be offset by reductions in similar activities at the headquarters offices.

material is involved and that the line is in use eight hours per day, five days per week. Costs per character drop in strict proportion to the increase in transmission rate, so it is obvious that high bandwidth lines are economically preferable. They do present a problem, however, because it is necessary to supply enough material to keep each line fully active during an eight-hour day to achieve the cost figures shown. For example, halving the usage of a line will double the cost per page.

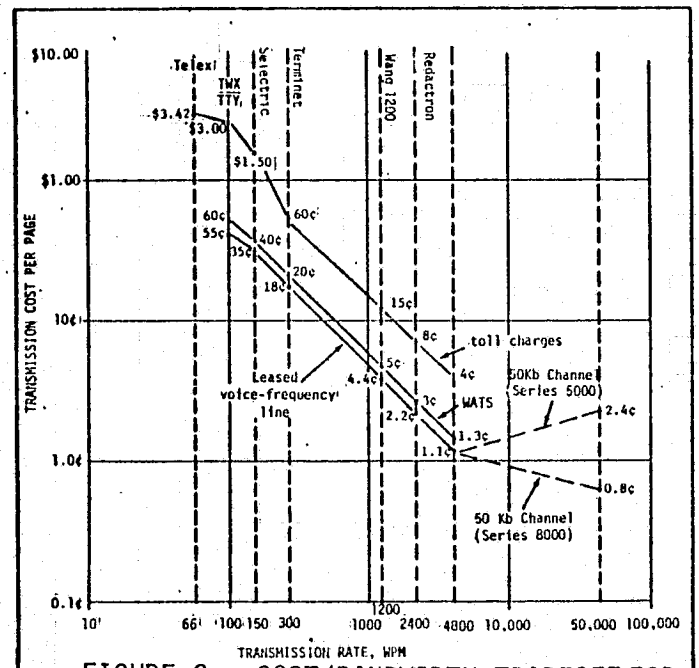


FIGURE 2. COST/BANDWIDTH TRADEOFF FOR DIGITALLY TRANSMITTED TEXT

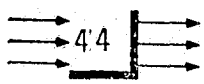
Suppose we consider as an example an RNOC typing pool, each of whose members is provided with a communicating typewriter with memory for storing text. The memory can take the form of (local or remote) magnetic tape, card, or disc. The typist performs a number of word-processing functions which include keyboarding of rough text, proofreading, text manipulation, and correction. Some of this work is repetitive and virtually automatic, e.g. typing and addressing form letters by merging an address file on one tape with a letter file on another. Assume that, averaged over all tasks, the typist can generate 60 words of text per minute, either in final form or as draft

material to be transmitted to the originator for revision or correction. This includes times out for lunch and the usual occasional breaks from work.

The most naïve approach to establishing a digital communications capability would be to install an unconditioned dial-up line at each typist's desk. The typist then calls the home office whenever text is to be transmitted. The least expensive kind of modem, a Bell 113A (or equivalent) one-way dial-up device, can transmit data at a rate of up to 300 wpm, which exceeds by a factor of five the typist's ability to generate text, under the assumption cited in the previous paragraph.

Estimating transmission costs is difficult at best because telephone rates differ substantially from one city to another, often embodying labyrinthine tariff structures that seem to defy all attempts at rational analysis. Charges are based on the number of message units involved in a call, and the number of message units in turn usually depends on the distance between stations and the number of calls made per month. In most cities at the present time, message units do not depend on call duration. However, this situation is likely to change in due course: a recent Datamation article[32] reports that the Pacific Telephone Co. is taking steps to implement the authority granted to it by the California Public Utilities Commission in July 1974 to adopt a time-rate billing system for business phones. Under this system, one message unit would be charged for each five minutes (or fraction thereof) involved in a call. At present, a message unit costs five cents.

Now in Boston, on the other hand, timed service has always been in effect, 10.3¢ being the current rate charged for each five minutes' worth of local calls made within the central exchange district. Thus, with the proliferation of data communications terminals, remote word-processing equipment and teleconference techniques, it seems certain that time-based



charge systems will sooner or later become universally applied. We shall therefore assume this to be the case and adopt a line-charge rate of 1.5¢/min. for this service. We also assume as a baseline that both ends of the line are in the same central exchange zone. The typist generates 28,800 words in a day which, at 300 wpm, will require an aggregate of 96 minutes to transmit, either piece-by-piece or all at once. Allowing for setup time and other incidentals at each end, let us say that the phone line is to be used two hours per day in all. The daily cost will then be $1.08, plus a prorated share of the basic service charge, say 60¢ per day. Modems are required at both ends of the line. These would presumably be purchased and their amortized monthly costs added to the aforementioned charges. However, it is difficult to estimate modem prices *a priori* because they are strongly dependent on the specific configuration adopted, which includes such features as line interfaces, power supplies, half or full-duplex arrangements, alternate voice, and any operational or test options that might be included. To serve as a standard, therefore, we shall apply cost figures that refer to the lease of Bell-supplied equipment, with the understanding that these are probably higher than what would be appropriate to purchased equipment, but are nevertheless self-consistent in regard to relative costs among themselves.

For the simple 300 wpm system, then, a Bell 113A modem will support one-way dial-up service at a cost of 60¢ per day at each end, i.e. $1.20 total. All-in-all, therefore, the daily transmission costs for this system will be of the order of $3.60.

Now let us consider leasing an unconditioned Bell 3002-class line on a dedicated basis rather than dial-up service. Assume a single terminal device at each end and single-line full-duplex connection over a distance of ten miles at a monthly rate of $6.50/mile. The daily charge would be $3.33, that is, about $1.50 more than for dial-up service.

Suppose, further, that Bell 202-series modems were to be interfaced at both ends, permitting transmission at 1200 wpm. The rental price for each modem (without alternate voice option) would be $1.25 per day, i.e. $2.50 per day for both units. Total daily expense for this configuration would be $6.50, almost twice what it was for the previous system, but providing four times the transmission capacity and on a dedicated basis. At a rate of 1200 wpm, the hypothetical typist's entire daily output could be transmitted in twenty-four minutes, so it would require more than fifteen typists to fully utilize the available system capacity.

As a practical matter, however, it might prove more useful to share the line capacity among several functions, e.g. voice (including teleconferencing), data, fax, slow-scan video, and so on. Another possibility worth considering is to use communicating typewriters and/or CRT terminals without local data storage. The terminals would access centrally stored data via the continuously open phone line. The price differential between a "typical" communicating terminal with and without dual magnetic cartridge is about $8,000. Amortized over seven years, this comes to about $5.00 per day, which will just about pay for the dedicated 1200 baud (1200 wpm) transmission system described above. It should even be possible to handle several devices over a single line with this kind of configuration; for each additional unit that can be handled, another $5.00 per day is saved. It might then be desirable to multiplex several units over each phone line, although the cost of multiplexors and formatters at both ends of the line would in turn reduce the savings somewhat.

In the system's ultimate form, some kind of multi-station dedicated data network would doubtless be the most efficient way to implement the RNOC concept. Packet-switched data communications combines the advantages of leased-line service

with dial-up cost. Under this approach, data messages are automatically organized into standard-length "packets"; typically of up to 1024 bits (about 128 characters) each. Each packet is assigned a destination and is transmitted to that destination via common-carrier interconnections. The customer pays a value-added service charge on only the number of packets he actually transmits. To this charge several additional items of cost must be appended, e.g. for leased-channel ports at the packet-switching service's central computer, for front-end data concentrators when multiple users are collocated, and for the usual common-carrier line lease charges cited above. The advantage to this approach derives from the fact that when the system involves more than just a handful of remote terminals the centrally switched scheme requires fewer physical transmission lines; indeed, this is the very rationale that justified the telephone network itself. Refer to Figure 3. Suppose for the sake of illustration that ten RNOC's are involved and that every RNOC contains twenty typists, each employed by one of twenty firms. The conventional approach would require a leased line between each of the twenty headquarters offices and every one of its ten RNOC typists, i.e. 200 lines. The private switching network would require only 40 lines, one from each RNOC and one from each downtown headquarters.

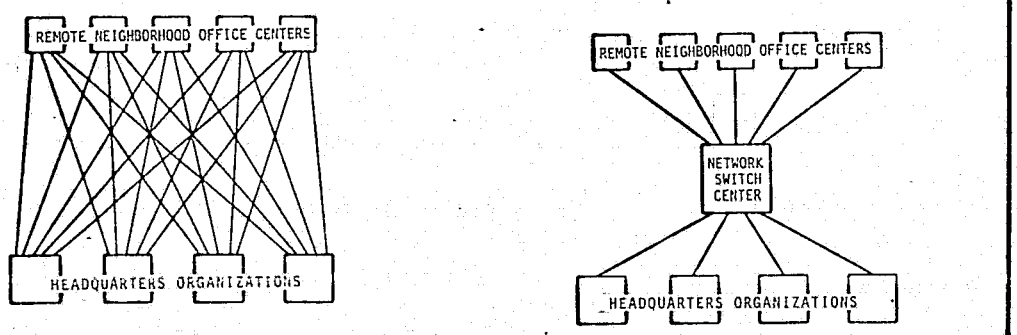


FIGURE 3. USE OF A MESSAGE SWITCHING NETWORK TO REDUCE DATA TRANSMISSION LINES

A traffic packet charge of, say, sixty cents per kilopacket* would come to eighty-six cents per day per typist, adopting the typing production rates cited above, viz. 28,800 words per day. Data concentrators become important when the number of typists at an RNOC is large enough that periods of overdemand for the communication line begin to rise. In the case discussed above, this should not occur until at least ten typists per office center contend for the same line. Twenty-four-port data concentrators, installed, might cost in the neighborhood of $15,000 each when purchased in large quantities. Amortized over five years and twenty users per RNOC, this would add less than fifty cents to the daily cost of each user. The downtown office will no doubt incur a similar charge if it communicates with multiple typists scattered throughout the city. The most expensive item of cost would be for a leased-channel port at the network terminal, viz. between $4 and $10 per day at each end, depending on the transmission bandwidth. This expense would also be shared among all of the users at each RNOC.

Another possible advantage to using a packet-switching service is that the charge between any two nodes (i.e. switching centers) is constant, irrespective of their geographical location, so typists do not have to be located in close physical proximity to the company's headquarters office. Labor charges vary from place to place, and it is conceivable that office services pools could be established in areas of cheap labor as is already the practice in many areas of manufacturing, where assembly is done wherever costs can be minimized -even abroad. Packet-switching networks of international scope are only a few years away and so for typing it might even be feasible to have original keyboarding done by foreign typists with only a rudimentary grasp of English, providing that the text editing

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*This is the Telenet rate at the time in writing. One kilopacket = 128,000 characters, or about 20,000 words of text.

is done domestically or by skilled editors resident at foreign sites; at electronic speeds of transmission, it hardly matters where these individuals are located.

4.3 Capital Expenditures

Major capital expenditures are for terminals and related equipment.* Virtually every RNOC typist will have to be provided with a suitable word-processing typewriter or CRT terminal, although at this point it is not certain whether it will have off-line magnetic memory (e.g. tape cartridge, floppy disc) or communicate over the phone line with text resident in central memory, or both. Note that a communications interface at every terminal is not at all an unavoidable requirement, for it would be perfectly adequate in many office situations to prepare tapes on non-communicating equipment, then transfer them onto a common communicating tape-read station whenever they are ready.

In the case of accountants, administrators, planners, general secretaries, and many others, it will probably not be necessary to provide each individual with a private terminal if he does not use it continuously. For these individuals, a CRT, for instance, or a high-speed printer, can serve as a shared resource, much as copying machines do now, each device or unit servicing the needs of many users who only require it sporadically.

Each word-processing terminal is apt to cost between $5,000 and $15,000, depending on whether it is equipped with local memory, or communications interface, etc.

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*Note, however, that we have chosen to account for signal conditioning, switching, and transmission hardware as recurring cost items; cf. previous discussion.

To provide one million typists* with one unit each will thus require combined financial resources of $10 billion. Among 2.7 million secretaries, 1.6 million bookkeepers, and some 1.5 million RNOC inhabitants occupied in other kinds of work, perhaps an additional $30 billion of capital outlays for digital terminals, facsimile units, audio recorder/playback devices, digital plotters, etc., might be necessary. These are staggering sums to contemplate, but one should keep in mind that the costs would be shared among the nation's entire business community.

Where will the financial backing come from that is needed to support these capital investments, and what sort of timetable can one expect for implementing the concept? As in most applications of technological advances, the conversion to telecommunicating is most likely to come about through a series of independent actions by individual business and government organizations. Hence, progress will occur gradually; and since the basic technology and hardware is available now, it will not require massive and simultaneous public approval or the mounting of programs that involve enormous development effort, as is the case, for instance, with major rapid-transit concepts. In point of fact, given the current financial climate, public support for expenditures on such a massive scale can hardly be anticipated anyhow.

Obviously, though, social and cultural benefits by themselves cannot hope to attract sufficient capital investments to make a universal telecommunications system a reality. Rather, the impetus must be spurred by hardheaded business needs, and most of all by the potential for substantial profits or savings. For just as industrial expansion encouraged the development of great power networks, transportation systems

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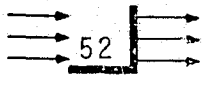
*cf. Table 1, p. 12

and worldwide communications, it is also industrial demand that must precipitate the establishment of new facilities to form the backbone of what is often romantically called the "wired nation" of the future.

Practical, dispassionate analyses, undertaken by many organizations from the separate viewpoints of their own individual needs and based on cost and benefit considerations analogous to those presented above, will be a required first step to determine whether even demonstration programs are worth undertaking. Progress will doubtless be slow in the beginning because the presence of equipment alone will not in itself guarantee a fair trial. Personnel will have to be found who are unbiased enough to judge the concept without prejudice. Even cadres of test RNOC employees who are favorably disposed towards the idea will have to be given time enough to learn to orient their habits and mental attitudes towards work-at-a-distance. Mistakes, inefficiencies, and frustrations over unanticipated situations, characteristics of all new operational environments, will perhaps be ever so much more painful here because the system is operationally quite complex and because there is a tendency to overromanticize the prospects for accomplishment while underestimating problems in executing it. "The hardware is available, so let's plug it in and start running" is an almost inescapable line of thought. "Well, what about switching from letterhead bond to second sheets, or to memorandum stationery at the headquarters end," someone will soon realize. How will this get done, and how will the responsible person even know to do it, if the text has been prepared miles away? An annoying problem, soluble in any of a number of ways, but strongly illustrative of the myriad considerations that will beset the first explorers of this new territory.

Reasoning by (weak) analogy with other fields of digital technology, it does not appear too hopeful that widespread implementation will begin to take hold until 1985 at the earliest. This assumes a minimum of five years for concept evaluation and demonstration testing, three more years for budgetary planning, funding, procurement, delivery, debugging, and acceptance by the first implementers of the concept; then perhaps two more years of successful operation and publicity before the avalanche of users can be expected to begin, if indeed there is to be one at all.

We note in passing that alphanumeric CRT terminals were first introduced commercially in the early 1960's to serve as an improved means for source data entry, but it took from five to ten years before their superiority over the ubiquitous keypunch machine could be demonstrated and accepted, orders placed, units delivered, and operators acclimated and trained. By now, of course, it is becoming more and more unusual to see keypunches used at all for inputting data.



V. DEMONSTRATION TEST PLAN

Insofar as the next step forward is concerned, it appears now that acceptance of the basic idea has progressed to the point where specific proof-of-concept tests are needed rather than further general feasibility studies. The series of tests described in the present section center around the establishment of a scattered group of suburban administrative support offices which in themselves constitute a kind of simulation of an ultimate network of fully implemented neighborhood office centers. Most of the fundamental procedural problems that would likely be experienced in the full configuration of office centers are perforce to be found in the small-scale adminsitrative support office environment as well, viz. the difficulties involved in communicating nuances of thought between people who are separated by large distances, dealing with equipment reliability problems, determining the minimal levels of ability and skills required to operate the equipment in a satisfactory manner, the need for scheduling jobs among several centers, and the complementary problem of coordinating inputs from several locations -even simply keeping track of the current status of any job- will require careful coordination of system hardware and support software with effective administrative techniques.

5.1 General Description of the Concept

The concept centers around the establishment of home-based text-typing and editorial services in which output is digitally transmitted by telephone line to the main office downtown. Besides typing, the project will later involve the introduction of remote-based stenography and drafting services. Since multiple remote sites will eventually be involved in any operational configuration,

an important series of tests is included which concerns itself with identifying and specifying procedures for coordinating a variety of services that emanate from such diverse sources.

For each series of tests, criteria have been established against which the test results are to be evaluated; these generally involve such factors as: response speed, throughput volume, ease of handling the equipment, neatness and aesthetics of the finished product, system and component reliability, schedule flexibility, typist efficiency, and the comments of job initiators on both the difficulty and the effectiveness of communicating with the typist at a distance.

5.1.1 Methodology

A stay-at-home typist* will be selected, having qualifications that are comparable to similarly employed office-based personnel. At the typist's home, word-processing devices will be provided that can communicate with the downtown office. The basic equipment supplied to the typist will be:

1) a dual-cassette communicating typewriter with modem,
2) a facsimile-type telecopier, and
3) an audio tape recorder/playback device that connects to the telephone.

At the downtown office the following equipment will be installed:

1) a communicating power typewriter (IBM 2741 or equivalent)
2) a facsimile telecopier

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* In what follows, the abbreviation SAHT will sometimes be used to denote the Stay-at-Home Typist.

A job is initiated in either of two ways, viz. (1) by transmitting a handwritten or typed rough-draft version of the document to the typist's home via facsimile or (2) by dictating the material into the typist's recorder. Dictation can be sent from any telephone: at work, on a trip, or at home. At this point, by whichever of the two means has been employed, the typist has a rough draft of the document to work with. She disconnects the telephone line and prepares a draft on her typewriter, using the cassette feature to edit her copy off-line. Upon completion, she dials the dataset number downtown and transmits the draft directly from the cassette tape. Any final touch-ups, if required, are negotiated between the initiator and the typist via the telephone, and a second (or further) version is retransmitted from the typist's home to the office.

The stay-at-home stenographer is a variant of the typing scheme described above; here the "typist" is a stenographer who records dictation in shorthand, or perhaps on a tape or belt recorder, then types the notes and retransmits the finished text downtown, often in time for distribution before the meeting ends. The stay-at-home draftsman prepares sketches and technical drawings off-line using an electronic digitizer, again with magnetic tape attachment, then transmits the digitized image downtown, where the drawing is duplicated on a pen plotter.

5.1.2 Critical Issues

The success of failure of the concept can be said to rest on the following critical issues:

.Can a level of verbal communication be maintained between typist and initiator over the remote link to an extent that will permit ideas and instructions to be exchanged clearly and fluently on a routine basis?

.Can such an arrangement be structured so that it is economically satisfactory to both employer and employee?

.Can the system be used effectively on both ends by individuals whose intelligence and training are not substantially different from other people engaged in such activities under conventional circumstances?

.Can jobs be performed in the same or less time by this method than by conventional means?

5.1.3 Financial Considerations

What must be the salary structure under which remote typists are to work, if the concept is to prove economically viable? First we shall examine the average costs per finished page for typing services performed in the conventional manner. This will serve as a yardstick against which an overall cost for the remote typist service can be established to assure operational profitability. Then the remote typist's salary can be traded off against the amortized capital costs of equipment plus recurring expenditures, all within the total dollar ceiling established above.

Up-to-date figures are available [Ref. (33)] from which typing costs in two office codes at NASA Headquarters can be derived; we shall assume these figures to be universally representative of medium-sized and large business organizations in general. For the Office of Space Applications, (Code E), twenty-nine employees* generate some

*secretary/stenographers, secretary/typists, clerk/typists, and clerk/stenos

71,000 typed pages per year; this includes letters, manuscripts, forms, statistical tables, memoranda, drafts, reports, questions, and miscellaneous matter. According to time-line analyses of work patterns conducted within Code E, an average of 1^h52^m per day is spent in typing, taking shorthand, composing and proof-reading; that is, about one-quarter of each employee's day is devoted to services that can be performed by the remote typist. Now, the average of the salaries earned by these twenty-nine Code E employees amounts to some $11,018 annually. Thus, twenty-nine individuals whose average salary is $11,018, devoting 25 percent of their working day towards producing 71,000 finished pages of typing per year, means that the average cost per finished typed page is about $1.18.

Turning now to Code AC, the Office of Center Operations, we find that sixty-nine individuals whose average annual salary is $10.752, again working about two hours per day on typing and related jobs, produce some 120,000 pages of output; this implies a cost per finished page of about $1.55.

Let us settle on $1.35 per page, which represents the mean of the two typing rates calculated above. To this is added a further $0.98, which corresponds to a 73 percent rate for overhead and benefits [Ref. (34)], this bringing the total cost per finished page to a final cost of $2.33.

In comparison, one can expect to pay upwards of $1.50 per page if the work is contracted to a commercial typing service, assuming that the typing mix is oriented primarily towards "straight" handwritten text with no unduly large volume of special formats (e.g. tables, formulas, etc.). This does not take into consideration the additional costs and delays (not to mention inconvenience) that must be suffered because the typist is not often located physically close to the job initiator.

Freelance typists, on the other hand, can be expected to charge about $1.00 per finished page. Usually working at home, often not more than part-time, they also present possible disadvantages in terms of ready availability of the typist and physical distance from the initiator.

How do these figures compare with the costs of running a network of remote typing pools? Let us impose some basic assumptions about the operation of such a service:

1. Assume that each remote typing station averages 33 pages of finished output per day. This represents the average of the 38 pages/day produced in Code E and the 27 pages/day in Code AC [Ref. (33)]. For want of better information, we will assume that a somewhat higher typing efficiency in the remote office is more or less offset by slightly longer times required for carrying on editorial discussions over the phone. (This assumption is probably conservative, penalizing the remote typist.)

2. Assume that only typewriters, telecopiers, and a recorder are used in the system configuration on which comparisons of costs for remote vs. on-site services are to be made. No CRT editing, for instance, is considered here because the baseline for comparison, i.e. on-site typing, uses typewriters only. When, in the future, cost/benefit analyses are to be performed for systems with editing CRT's, an equitable basis for comparison will have to be formulated.

3. Assume that each power typewriter at the downtown office can service four remote units. That is, average automatic playout speed downtown is taken to be 2 minutes per page, and we assume that on the average two copies of each page, one draft and one final, will have to be produced. (Time to load paper into the typewriter carriage runs about 5-10 seconds/sheet, and is disregarded here.) Then, under continuous operation, the downtown typewriter can produce 15 finished pages per hour, or 120 pages per day, which, according to the first assumption above, is about equivalent to the amount of work produced by four remote units.

4. Assume an amortization period of seven years for the typewriter, audio recorder, and telecopier units.

Purchase costs are taken to be (assumption #2) $10,000 per typewriter, $2,500 for each telecopier, and $1,000 for the audio recorder. For each station then, assigning 25 percent of the cost of the downtown typewriter/telecopier pair to it (assumption #3) the total purchase price of all equipment is $16,625. Subtract the $1,000 cost of an equivalent manual typewriter, which will not be required. Amortized over seven years (assumption #4) this comes to a yearly cost of $2,232, to which yearly rental of an unconditioned dial-up phone line will add about $300. Thus, the grand total for equipment would run in the neighborhood of $2,700 per annum.

Typing at a steady rate of 33 pages per day, each remote station would produce about 8,600 finished pages per year. The break-even point for the remote service occurs, then, when the cost per page equals the on-site cost downtown, i.e. $2.33/page or $20,038/yearly.

Subtracting the amortized equipment costs of $2,700 leaves a fund of $17,338 from which the remote typist's salary is to be drawn; the remainder can be considered profit. It is worth noting that if the average downtown salary of $11,000 cited earlier is subtracted, this still leaves a surplus of $6,338 which can be thought of as "profit".

Now let us look at the picture from the typist's point of view: The national average of daily commuting distance to work is 20 miles, round trip. [Ref. (15)]. Assume that the typist shares a ride pool with two other persons for each of the 250 working days per year, and that the overall cost of commuting by auto is 20 cents per mile, then the yearly cost of commuting by car is about $330. If the typist uses public transportation every day, at a fare of 65 cents each way, the same yearly cost of $330 is incurred. In summary, for the stay-at-home typist:

YEARLY SAVINGS TO TYPIST

.Commuting: $1.30/day x 250 days/yr.	$ 330
.Meals, coffee, etc: $1/day above home cost	250
.Clothing for work	320
.Miscellaneous	100
Total yearly saving	$1,000

The typist could actually take a $1,000 pay cut to stay at home and not really lose any money at all! Now, for those employees who would otherwise have to provide day-care for their dependents, an additional savings on the order of $2,500 per dependent could be realized. And the above rationale does not assign any monetary value to the convenience (sometimes necessity) of staying at home or, for that matter, to the time lost in commuting, or even

to the comfort of working at home. It is very easy to imagine that this convenience, time, and comfort might be worth as much as $1,000 per year to many individuals.

In summary, it is likely that, to the typist, the value of working at home would probably range from $1,000 to $4,500 per year--say $2,000 on the "average." Added to the $6,338 "profit" figure developed above, this should yield to the employer an average savings of , say, $8,000 pe year for each 8,600 pages of output which, expressed in relative terms, represents a savings of some 40 percent of present costs at NASA Headquarters.

Now, it might be argued with some justification that this apparently-substantial profit arises largely from the fact that no overhead or benefits are applied to the salaries of the remote typists. The first point to note is that even if the same 73 percent burden rate were to be applied to a "typical" remote typist's salary of $9,000, bringing the loaded cost to $15,570, the employer would still realize a profit of almost $2,000, or 10 percent of the baseline cost.

But another point should also be made: Stay-at-home personnel are very often part-time workers who, in return for earning extra money in their spare time, neither expect nor receive employee benefits. It is reasonable to estimate that some appreciable percentage of the remote typing force will fall into this category--let us say half of them. The average burden rate would then fall to about 37 percent, resulting in a loaded cost of $12,330 for the average typist. From this standpoint, the employer would realize a profit of almost $5,000, or 25 percent, of the baseline cost. The reader may make his own assumptions on what the profit margin is likely to be, although most reasonable calculations would probably lie within the 10-40 percent range established above.

5.2 Purpose

The basic purpose of the test program, then, is to study and evaluate the procedural problems involved in establishing and operating a small, dispersed group of administrative support offices, coordinated through the downtown office, which will be the principal initiating agency and sole beneficiary of the work output from these offices. Tests and their results will be viewed in the light of how their implications can be extrapolated to a large-scale network of fully staffed neighborhood office centers and a group of downtown offices.

5.2.1 Test Objectives

Specific objectives of the test program that address the purpose stated above are as follows:

5.2.1.1 To investigate the degree to which this concept can reduce the usage of paper, energy, and other resources by NASA in particular, and by the nation in general.

5.2.1.2 To investigate the degree to which the concept can reduce the labor cost of producing typed documents.

5.2.1.3 To develop techniques for applying this concept to reduce throughput times (i.e. submittal-to-completion), regardless of where the jobs might be submitted.

5.2.1.4 To apply modern electronic word-processing equipment and procedures towards enhancing the quality of the finished output. Methods will be sought for realizing improvements in:

a. neatness and aesthetics of text layout
b. reduction of spelling errors and usage of bad grammar
c. efficiency of working procedures by the typist as well as the initiator

5.2.1.5 To identify procedures required to make the service continuously available to users, at least during normal business hours, but on an around-the-clock basis if necessary.

5.2.1.6 To assess the level of skills, training, and experience required for typists to use the equipment efficiently.

5.2.1.7 To estimate the geographical extent of the sources of potential employees.

5.2.1.8 To assess the capability of state-of-the-art communications technology for making the service available on a nationwide, or even worldwide, basis.

5.2.1.9 To learn what special training, if any , the initiator should have for him to participate in the concept with any significant level of satisfaction.

5.2.1.10 To determine the degree of practical utility embodied in the remote-stenographer and remote-draftsman concepts.

5.2.1.11 To assess the transferability of the findings of this project to other NASA organizations, in particular, and other offices, government or private, in general.

5.2.1.12 To use the remote typing network established under the scope of this test program as a general test bed within which to test: (1) alternative concepts connected with remote word processing, remote administrative services and remote engineering support, and (2) the performance of competitive devices to perform similar functions in the areas cited above.

5.3 Guidelines

As stated above, the intent of this demonstration project is to permit the study and evaluation of procedural problems that would characterize an eventual operational system. The actual establishment of such a system, however, lies beyond the scope of the project, so the intended approach will be to simulate as many procedural situations as possible, to a degree of realism that will allow the evaluations to be undertaken; these tests are, moreover,

constrained under the general restriction posed by a limited base of funds for equipment and manpower. With these points in mind, the test program has been structured to embrace the following guidelines:

1. Wherever possible, use equipment that already exists in-house at NASA. Share the use of equipment if it is obtainable from other groups, unless its availability to this project is so limited as to be non-productive.

2. Rent, not buy, all required capital equipment that is not available in-house. Remote word processing is an exploding field, with new products appearing almost daily, so that by the time this project is completed much of the equipment used for it may be obsolescent. The remote typing network itself may be useful as a test bed for alternative types and brands of equipment; and for this reason alone it may not be desirable to acquire certain equipment on a permanent basis.

3. The stay-at-home typist should be chosen from a suburban community within the local dialing area of Washington, D.C., so that long-distance calls are not required for either data transmission or editorial conferences. Her home should be spacious enough to accommodate the equipment comfortably, and it should be placed far enough away from household activity areas that it is not easily jostled or tampered with.

4. It would be highly desirable if the typist is selected from a neighborhood in which there is a good supply of capable part-time typists who can serve with her as members of a local typing and editorial pool. If the typist consents to basing the typing pool in her home, she can serve also as the local coordinator for work shifts and job assignments; this additional responsibility would warrant a somewhat higher salary.

5. A phased approach: the test program should be structured so that the feasibility of the basic concept can be established (or rejected) with only a minimal expenditure of funds and manpower before any larger commitments are required to explore the more ambitious program options.

6. As much as is possible, the system should be able to accommodate any specific brand of equipment desired. Among other considerations, this means that the external data codes should be held to some widely accepted standard (e.g. ASCII or "Correspondence" code), and communications procedures adopted which are universally applicable to as wide a variety of alternative choices as possible. In this way the network can serve as a test bed for evaluating the performance of competing brands of plug-to-plug hardware, without any need for restructuring the network configuration or the communications procedures.

5.4 Brief Test Descriptions

To address the objectives cited in Section 5.2.1 fourteen tests have been designed which, for convenience, are grouped into four major subject categories: Equipment Performance Assessment, Personnel Evaluation, Advanced Concepts, and Communications Techniques. Table 3 (p.72) shows the correspondence between the eleven objectives and these fourteen tests; the tests are described briefly in the following paragraphs:

5.4.1 Equipment Performance Assessment

.SYSTEM RELIABILITY. This test is continually performed during the entire test series. It amounts primarily to keeping a log of all system and equipment malfunctions, durations of outages, and steps required to restore service. The results of this test have implications on objective 5.2.1.5, Continuous Availability of Service, and 5.2.1.12, Relative Performance of Competitive Equipment.

.SPECIAL FORMATS. This tests the ability of the system to produce documents that include formulas, tables, vuegraphs, etc. Quality of output (Objective 5.2.1.4) and Pertinency to NASA Activities (Objective 5.2.1.11) are primarily involved.

.CRT EDITING. An interactive CRT replaces the remote typewriter and is used in preparing document drafts. The fast response speed of the CRT in comparison with typewriter speed should Reduce throughput time (Objective 5.2.1.3), and its volatile display requires no paper, so helps Conserve Resources (Objective 5.2.1.1). The flexibility of this mode of editing should also improve the Quality of Output (Objective 5.2.1.4).

5.4.2 Personnel Evaluation

.TYPIST QUALIFICATION. Simply stated, this test addresses the question: How intelligent and how well trained must the remote typist be to make most efficient use od the system? (Objective 5.2.1.6), Efficient Use of System).

The general level of competence required will be used to identify how large a pool of talent is available (Objective 5.2.1.7/5.2.1.8), Widespread Availability of Help) and, therefore, indicate whether the service could be offered on a Continuous Basis, around-the-clock if needed (Objective 5.2.1.5). A low required level of skills means that less-well-trained typists can be used, which helps Reduce Labor Costs (Objective 5.2.1.2).

.TYPING POOL. Procedural requirements for maintaining a steady flow of work at the remote site will be developed. Coordination and handoff of jobs, as well as scheduling and record-keeping will be stressed. Success in this test means that more part-time help, at lower rates, can be used (Objective 5.2.1.2 Reduce Labor Cost), and a longer Continuous Availability of Service can be offered (Objective 5.2.1.5).

.MULTIPLE TYPING CENTERS. Two or more centers will be established, each at a different location. Problems in job dispatching, output coordination, and job status will be investigated. This test will involve the participation of an Operations Manager, described below. The test impacts on the questions of Continuous Availability of Service (Objective 5.2.1.5) and Widespread Availability of Help (Objective 5.2.1.7) because these activities imply coordination among many typists at widespread locations. It also impacts on Reduced Labor Cost (Objective 5.2.1.2) because help at lower rates can be sought in areas of higher unemployment.

.OPERATIONS MANAGER. Based at the downtown site, this individual will serve as job dispatcher, status monitor, and output coordinator for the project. By his actions he influences the Continuous Availability of Service (Objective 5.2.1.5) and the Widespread Availability of Help (Objective 5.2.1.7/5.2.1.8). As an advisor and system interface with job initiators, he contributes to the Ease of Initiating Jobs (Objective 5.2.1.9). Finally, as part of his coordinative function he helps make Additional Services (Objective 5.2.1.10) more readily available to users.

5.4.3. Advanced Concepts

.EDITING WITHOUT PAPER. A centrally located digital computer is introduced into the system. The text is prepared off-line on a mag tape cassetts, as before, but the digital image of the document draft is then transferred onto the computer. Editing and updating is performed interactively on the computer-based image, with typist and initiator simultaneously monitoring the text and discussing the changes over an open phone line. No paper is used until the final version is printed, so this technique should help Conserve Resources (Objective 5.2.1.1). The editing is all done interactively, so the technique should also Reduce Throughput Time (Objective 5.2.1.3) and improve the Quality of Output (Objective 5.2.1.4).

.REMOTE STENOGRAPHER. As the title implies, this is an Additional Service (Objective 5.2.1.10) that can be made available on a remote basis.

Via audio patch the stenographer can "sit in on" downtown meetings, or even teleconferences; she can take notes, record minutes and action items, and dispatch typed output to the attendees via phone line while the meeting is still in progress. This has Pertinency (Objective 5.2.1.11) to NASA activities, and the phone link makes the Widespread Availability of Help (Objectives 5.2.1.7/5.2.1.8) a strong possibility.

.REMOTE DRAFTSMAN. This individual will be equipped with a digitizer with tape cassette attachment and communications capability. Line drawings can be drawn with the digitizer or drawn separately and traced with the digitizer. The Operations Manager will be responsible for coordinating figures with text. The same Objectives apply here as in the case of the Remote Stenographer.

.REMOTE PROGRAM MANAGER. A Headquarters Program Manager will attempt to manage his program while on trips or on detached status. The remote typist will handle his typing and dictation and, as much as is possible within the limitations of the project, his digitized budgetary records will be made available via remote CRT. If successful, this test has strong Pertinency (Objective 5.2.1.11) to NASA affairs.

5.4.4 Communications Technology

.HI-DATA-RATE TRANSMISSION. A high-data rate line will be leased, to accommodate those

services that can profit by it, e.g. Remote Draftsman (Additional Services, Objective 5.2.1.10) which generates large amounts of digital data. This capability will Reduce Throughput Time (Objective 2.1.2.3).

.INTERACTIVE TV. Over line-of-sight distances TV will replace the telecopier, and also serve as an aid to conversational discussion and editing. Over these same distances, slow-scan and stop-action TV will also be tested. The use of TV may help speed the editorial process, and therefore Reduce Throughput Time (Objective 5.2.1.3) as well as make some Additional Services (Objective 5.2.1.10) more effective, e.g. Remote Draftsman.

.TRANSMISSION VIA SATELLITE. Transmission of digitized text, and probably supportive audio/video, will be undertaken via ATS or CTS synchronous satellites. If successful, this will render the service available across the nation and even around the world. Widespread Availability of Help (Objectives 5.2.1.7/ 5.2.1.8) will be assured, and areas with Reduced Labor Costs (Objective 5.2.1.2) can be utilized more heavily.

5.5 Test Hierarchy

Some tests are logical antecedents of others. This dectates that a specific sequence of events must be reflected in any rationally conceived test schedule.

Figure 4 illustrates the test hierarchy. TYPIST QUALIFICATION requires that the CRT EDITING and SPECIAL FORMATS tests be completed first, so that some measure of

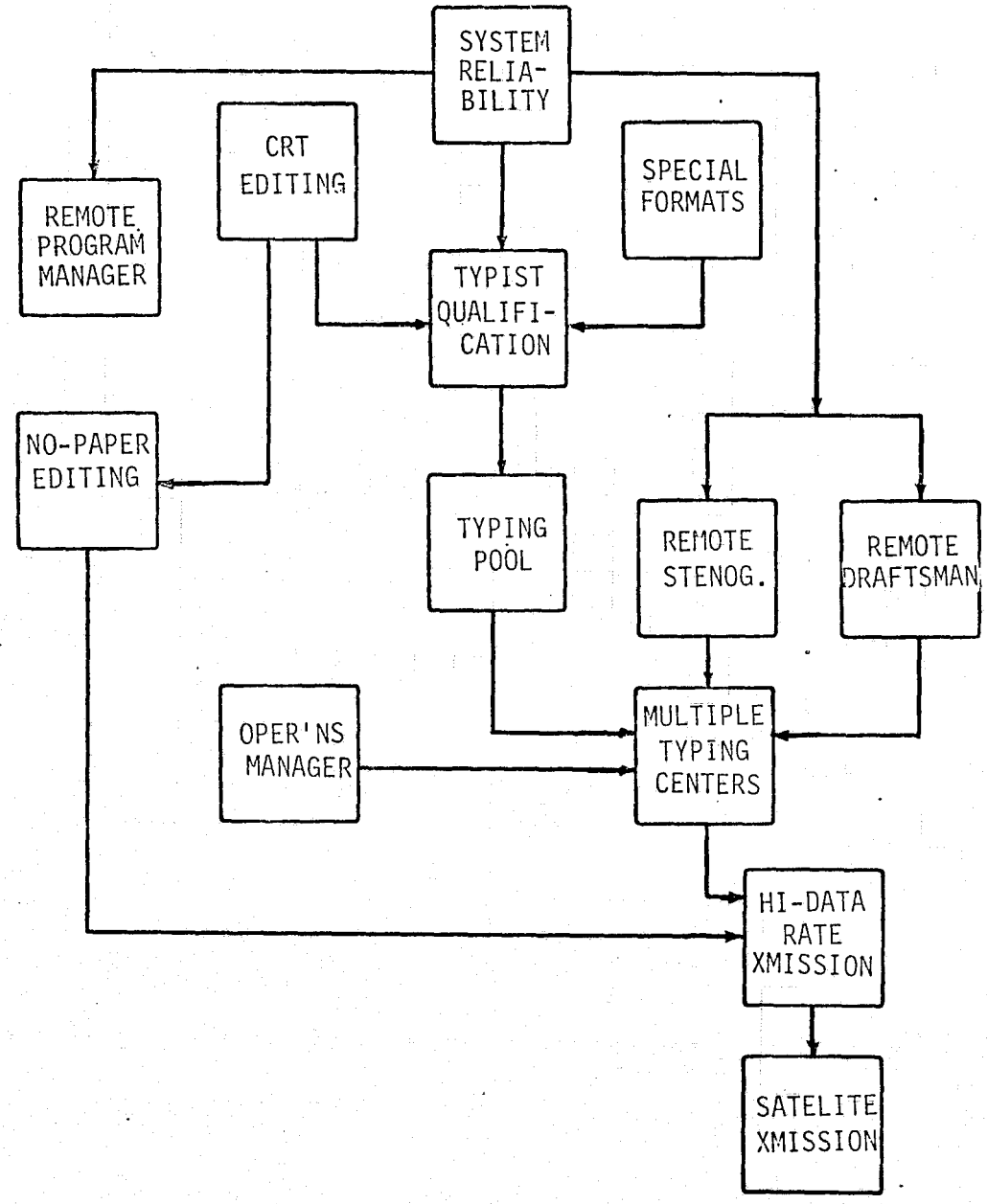

FIGURE 4. TEST PROGRAM HIERARCHY

the skills required of the typist be formulated. The SYSTEM RELIABILITY test, moreover, will yield information on any special training required for the typist to make minor equipment adjustments.

The SYSTEM RELIABILITY results will also give some indication of the procedural difficulties that might be encountered by the REMOTE STENOGRAPHER and the REMOTE DRAFTSMAN in communicating with the downtown center.

Since the NO-PAPER EDITING test is an elaboration of CRT EDITING, with the introduction of a central computer and a CRT monitor for the initiator, the latter test is a logical antecedent of the former.

The MULTIPLE CENTERS test requires the OPERATIONS MANAGER as a coordinator and is also a vehicle by which the REMOTE STENOGRAPHER and REMOTE DRAFTSMAN can be integrated into the system, assuming that they are physically removed from the TYPING POOL(S).

HIGH-DATA-RATE requires the high data rates generated by the NO-PAPER EDITING, MULTIPLE CENTERS, and REMOTE DRAFTSMAN tests for a true test of its capabilities. This test is a logical precursor to the SATELLITE TRANSMISSION test, which will require the network to be able to handle high-date-rate messages.

5.6 Test Schedule and Equipment Plan

The individual tests have been presented in Figure 4 in logical sequence; their actual time phasing, however, depends on the availability of funds, manpower, and equipment, as well as on the amount of time required to obtain useful data from one test before initiating the next. A combined schedule of tests and major supportive equipment, established in conformance with these considerations, is presented in

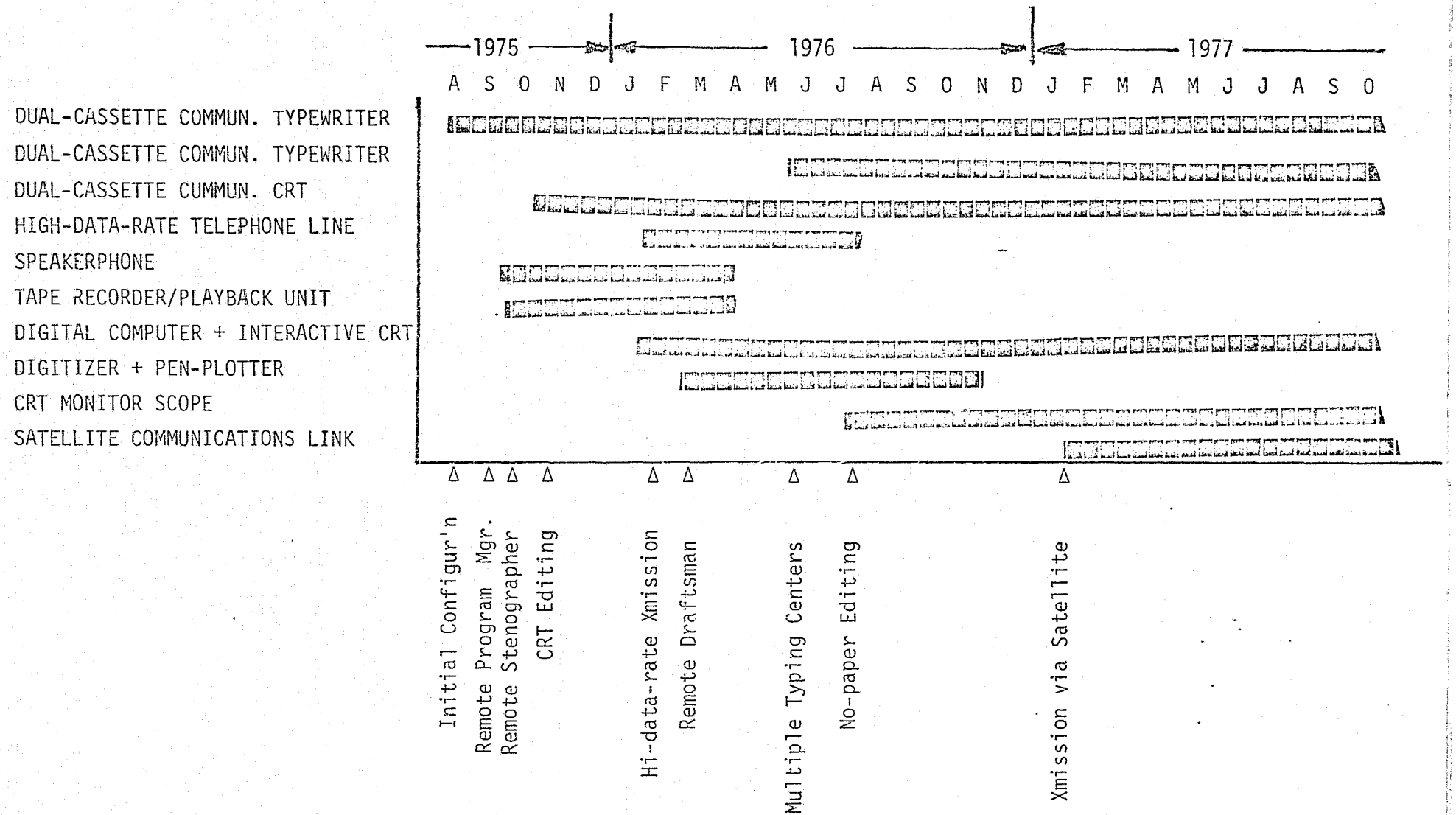

FIGURE 5. TEST SCHEDULE AND EQUIPMENT USAGE PLAN

Figure 5. The horizontal bars indicate when the various pieces of equipment will be used, and the pips at the bottom designate the start and finish of each test, as well as the occurrence of all other major milestone events.

5.7 Detailed Test Descriptions

The remainder of the present Section is devoted to detailed descriptions of the tests proposed above.

1.0 TITLE: SPECIAL FORMATS

2.0 PURPOSE: To evaluate the capabilities and limitations of the SAHT* in composing specially formatted documents.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.4 Quality of Output, 2.1.2.11 Transferability.

4.0 BRIEF DESCRIPTION: Special-format documents are those in which the text contains more than just simple alphanumeric characters, or in which the orientation of the text on the page does not conform to what is the general practice in typing simple letters, memoranda, or reports. Some specific examples of special-format text might be:

- .Mathematical or chemical formulas
- .Vuegraphs, using special type fonts (e.g. IBM "Orator")
- .Text that contains a combination of type fonts or type sizes.
- .Pages on which space is reserved for illustrations.
- .Pages typed in columnar arrangement.

A variety of special-format documents will be composed by the SAHT, under instructions from the originator downtown. The finished product will be evaluated in terms of production and compared, wherever possible, against similar documents produced in the usual manner.

5.0 PROCEDURE:

1. The originator prepares the text and plans the accompanying layout for each of a number of special-format documents.

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* Stay-At-Home Typist

2. Text and layout instructions for each are transmitted at appropriate intervals to the SAHT by fax and/or telephone recorder, as appropriate.

3. In as many cases as possible, a duplicate (identical) document should be pared by a local typist downtown according to normal procedures, and this version compared with the one created by the SAHT.

4. A variety of these transmission methods should be used. Where more than one SAHT is available, it is desirable to sometimes transmit the same document to different typists by different methods and compare the finished product in each case.

5. For each document, a log should be kept which identifies the document, cites the time at which it was submitted for typing, and the time it was completed, as well as any pertinent remarks by the typist or originator as to level of difficulty, neatness, aesthetic qualities, etc.

6.0 SPECIAL EQUIPMENT: None.

7.0 PERSONNEL: One or more SAHT's and (occasionally) a typist downtown.

8.0 DATA OUTPUT: Data will be in the form of logs cited above.

9.0 EXTENDED RESULTS: Wherever it is feasible to use her, the SAHT should involve throughput times comparable to that using the downtown typist, but neatness should be improved and final text errors reduced considerably.

10.0 REMARKS: Layouts that require non-horizontal or non-vertical orientation of the paper will be very difficult to manage using the SAHT. The main area of uncertainty is how much time must be spent between originator and typist in explaining the layout of special-purpose documents.

1.0 TITLE: TEXT EDITING USING A CRT

2.0 PURPOSE: Evaluate the interactive CRT as a possible substitute for the SAHT's typewriter in composing and editing textual material.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.1 Conserve Resources, 2.1.2.3 Reduce Throughput Time, 2.1.2.4 Quality of Output.

4.0 BRIEF DESCRIPTION: A dual-cassette, interactive CRT has certain advantages over the typewriter as a composing/editing machine. These include the ability to display corrections and realignments in the text at electronic speeds rather than electromechanical, and the elimination of the use of paper by the typist. Disadvantages include the inability to display text in any "standard" type font on the CRT screen and a lack of display capability for presenting many special-format features such as super/subscripts and mixed type fonts.

5.0 PROCEDURE: 1. Have the SAHT type the same text on a typewriter and a CRT, and evaluate her performance on both as regards throughput speed, errors, neatness, and ease of handling.

2. Have two SAHT's type the same text, one using the typewriter and the other the CRT. Comparative evaluations as above.

3. Repeat 1 and 2 for different kinds of text, including special formats of varying degrees of complexity.

6.0 SPECIAL EQUIPMENT: Interactive CRT terminal with dual-cassette attachment and communications option.

7.0 PERSONNEL: Occasional availability of a second SAHT.

8.0 DATA OUTPUT: Logs and evaluation sheets describing individual tests and responses to them, as well as data on throughput time, error rates, etc.

9.0 EXPECTED RESULTS: The CRT should prove superior to the typewriter overall, although lack of capability to display special-format characters may be a drawback, at least until the SAHT becomes accustomed to using the CRT in this mode.

10.0 REMARKS: 1. It is important to use several different SAHT's in this experiment, because different typists may accommodate to the CRT with different levels of facility. Since the purpose of the experiment is to evaluate the CRT as an editing device, this evaluation should be made using a number of subjects.

2. To fully test the CRT's usefulness, each typing test should be carried through to the end, including as many interactive editing sessions with the originator as is necessary to complete each document.

1.0 TITLE: TYPING POOL

2.0 PURPOSE: An experiment in workload scheduling for the remote typewriter and managing the several typists who use it, so that it is continuously available during at least the normal working day.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.2 Reduce Labor Cost, 2.1.2.5 Continuous Availability of Service.

4.0 BRIEF DESCRIPTION: Many individuals can serve very satisfactorily as SAHT's, except that they may be unable to contribute more than a few hours of their time per day, or per week. With proper planning and administrative controls, it should be possible to schedule the use of the system by many typists, smoothly and efficiently enough that the flow of work proceeds uninterruptedly and without any loss in overall output quality.

5.0 PROCEDURE: Arrange for several typists to man the remote facility. Work out a schedule which is acceptable to them while assuring full typing coverage at least during the normal working day.

Try a number of small jobs that can each be handled by one typist during her work shift. Also, try a number of large jobs that have to be passed from one typist to another as each one goes off duty and the next replaces her. Some of these larger jobs should be duplicated using a single typist who can stay at work long enough to complete the job.

Evaluation of the large jobs should be in terms of throughput time and initiator satisfaction for the single-typist as compared against the multiple-typist team.

Evaluation should also be made of the ability of the remote typing coordinator to keep the work moving continuously, help smooth the transfer of jobs from one typist to another, and successfully maintain a complete accounting record of the time spent and jobs handled by all of the typists.

6.0 SPECIAL EQUIPMENT: None required, except for scheduling forms and associated bookkeeping records.

7.0 PERSONNEL: Several typists whose availability covers at least a normal day, plus a coordinator.

8.0 DATA OUTPUT: The development of whatever forms and procedures are necessary to maintain proper workload balance and accounting records.

9.0 EXPECTED RESULTS: The required level of coordination to assure good-quality output should be attainable with practice and due attention to details.

10.0 REMARKS: If the demonstration is successful, it will open up possibilities for using a much wider group of potential typists than would normally be qualified if each were required to work a full day.

1.0 TITLE: MULTIPLE TYPING CENTERS

2.0 PURPOSE: To test the capability of the system to accommodate typists located at two or more physically different stations.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.5 Continuous Availability of Help, 2.1.2.7/2.1.2.8 Widespread Availability of Help.

4.0 BRIEF DESCRIPTION: Accommodating text matter that originates at multiple remote typing centers presents the downtown office terminal with several kinds of problems. These include the conflict of simultaneous transmissions, identification of the originating source, and the need to accommodate text prepared on different equipment at different sources.

5.0 PROCEDURE: 1. Devise a code that will identify such things as the originating location, typist, and the accession number of that document. This code will be typed on the document itself.

2. Typists will be instructed in procedures to follow if the downtown typewriter is temporarily unable to accept their transmissions (e.g. because a prior message is being received).

3. A standard digital communications code will be adopted among all stations in the typing network. Some existing standard codes include ASCII, EBCIDIC, and IBM Correspondence Code. These may have to be extended to accommodate special carriage control characters that are peculiar to the typewriters in use, or an entirely new code may have to be devised.

4. A SAHT Standards Manual containing instructions referred to above will be created and distributed to all SAHT's.

6.0 SPECIAL EQUIPMENT: No special equipment required.

7.0 PERSONNEL: SAHT's at two or more locations. These may be arbitrarily located--even out-of-town.

8.0 DATA OUTPUT: 1. Standards Manual

2. Logs and evaluation sheets describing individual conflict tests and responses to them, as well as data on overall time to complete transmissions under conflict situations involving the downtown typewriter.

9.0 EXPECTED RESULTS: Development of techniques to handle conflicts in message transmission.

10.0 REMARKS: Conflict resolution is primarily a problem that arises when only one typewriter and no buffer memory is available downtown. This should no longer be of concern when the downtown typewriter is interfaced with a communications processor/data concentrator and high data-rate links.

1.0 TITLE: OPERATIONS MANAGER

2.0 PURPOSE: To define the duties of, and establish operational procedures for, an Operations Manager at the downtown office center.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.5 Continuous Availability of Service, 2.1.2.7/2.1.2.8 Widespread Availability of Help, 2.1.2.9 Ease of Initiating Jobs, 2.1.2.10 Additional Services.

4.0 BRIEF DESCRIPTION: The Operations Manager occupies the central coordinative position within the SAHT typing network. As a job input dispatcher, he assigns each newly submitted job to a typist in the SAHT pool, based on his knowledge of each typist's current workload and backlog of assignments, with the object of assuring that the smoothest and most rapid flow of work be maintained between job initiators and the typing pool.

As a job output coordinator, he is responsible for assuring that (1) each page of typed output is printed on the correct paper form (e.g. official letterhead, office memorandum blank, GSA or NASA form action-assigned sheet, second-sheet blank, etc.), (2) the correct number and color assortment of carbon copies are produced when the text is typed in final form, (3) all official office editorial and production standards are adhered to per the Office Standards Manual, (4) the initiator is promptly contacted whenever his job is received back from the typist, (5) figures, tables, and illustrations prepared elsewhere are merged correctly with the typed text, and (6) the proper and up-to-date job-process records are maintained at all times.

5.0 PROCEDURE: Until more than one typing center has been established, the input dispatching function as well as output functions numbered 3, 4, and 6 in Section 4 above, will be handled by a duly assigned individual at the remote typing center; output functions 1, 2, and 5 will be the responsibility of a second individual located at the downtown site. During this initial phase of development, the emphasis will be on developing the requirements of these (and other as yet undefined) functions; when a second remote center is established, all managerial and coordinative responsibilities will be moved downtown. At that time, the Operations Manager will be provided with a computer-based dispatch console from which he can be kept current on the status of all jobs in process, the disposition of assignment queues, and the statistical records of completed tasks.

6.0 SPECIAL EQUIPMENT: For one remote center: a copy of the Standards Manual, to be located there. An individual at the remote center should have the responsibility for observing practices. Observance of correct procedures for forms and distribution downtown will be the responsibility of the initiator during this phase of operation.

For multiple remote centers: A computer driven interactive display console for the Operations Manager, with proper software backup. Also a copy of the Standards Manual at both the downtown center and each of the remote centers.

7.0 PERSONNEL: An Operations Manager downtown. During the initial phase of operation, this can be a part-time assignment for an employee regularly assigned to other tasks. When multiple remote centers are established, the position will become a full-time one.

8.0 OUTPUT: Formal specification of duties and procedures for the Operations Manager.

9.0 EXPECTED RESULTS: Procedures established during this test should permit smooth future operation of the SAHT concept. They should also point the way towards analogous but more comprehensive tasks for the general RNOC.

10.0 REMARKS: This is one of the key elements of the SAFT concept.

1.0 TITLE: EDITING WITHOUT PAPER

2.0 PURPOSE: To apply the use of current computer technology and communications links towards developing procedures by which text editing can be carried out entirely without the use of paper until the final copy is produced.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.1 Conserve Resources, 2.1.2.3 Reduce Throughput Time, 2.1.2.4 Quality of Output.

4.0 BRIEF DESCRIPTION: This technique involves the SAHT's use of an interactive CRT. At the downtown office center, the initiator likewise makes use of a CRT monitor (view only) scope. The text, stored on a digital computer, probably also located downtown. All modifications are made directly into the computer by the SAHT. The initiator and the SAHT both view CRT images of the current text configuration. Changes are negotiated over an open telephone line; and when these changes are implemented by the typist, both she and the initiator can instantaneously view the revised text. Only when both parties agree that the document is completely satisfactory will the SAHT transmit the command to initiate typing the document.

5.0 PROCEDURE: Follow the plan outlined in Section 4.0 above. It would be best for the typist's CRT to be provided with a tape-cassette option so that the preparation of text can be carried out by her off-line. Some jobs should be duplicated, using "conventional" SAHT procedures, viz. without benefit of CRT's and the computer, the typist using a typewriter instead. Comparisons of job throughput times should be made.

6.0 SPECIAL EQUIPMENT: Interactive CRT with tape-cassette attachment for the typist; CRT monitor scope downtown; digital computer.

7.0 PERSONNEL: No additional personnel required; it may prove useful to have the Operations Manager establish the interface between typist and initiator.

8.0 DATA OUTPUT: Experiment reports and evaluations regarding ease of establishing and maintaining contact between typist and initiator; throughput times.

9.0 EXPECTED RESULTS: A drastic reduction in the co sumption of paper, plus marked decrease in throughput time for any given job.

10.0 REMARKS: This will be a demanding test, at least until procedures for conducting it have been shaken down. However, it presents a significant step forward and should be perfected because of the improvements inherent in its adoption.

1.0 TITLE: REMOTE STENOGRAPHER

2.0 PURPOSE: Test the capabilities and limitations of a remotely-located stenographer.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.7/2.1.2.8 Widespread Availability of Help, 2.1.2.10 Additional Services, 2.1.2.11 Transferability.

4.0 BRIEF DESCRIPTION: A pool of remote stenographers can be established, analogous to the SAFT's and remote draftsmen. The stenographer can assist the conduct of business in several ways. One is, of course, through the direct useof the telephone to record verbally transmitted messages and documents. Another is as a recorder of minutes, action items, and memoranda that are forthcoming during meetings and conferences. In this latter application, the stenographer would be included in the meeting via telephone speaker; the meeting itself might even be conducted using the NASA telecommunications network. In many cases, minutes and other documents can be typed and retransmitted to all participants before the meeting is over.

5.0 PROCEDURE: For simple dictation, the initiator merely dials the stenographer and dictates the message. In the conference application, one of the participants is responsible for dialing her on a speakerphone.

As the meeting proceeds, the same individual cues the stenographer on what to transcribe, who is speaking at the moment, and what to do with the typed text. The stenographer may be able to type while the meeting is in progress (audio from her

can be suppressed so as not to disturb the attendees while she types). If a communicating typewriter is located near the conference room (or near any of the participants, if it is a teleconference) the typed text can be retransmitted.

During the initial phases of this test, the stenographer will be "simulated" by recording onto a tape recorder at the SAHT center, and having the SAHT type from the recorder.

6.0 SPECIAL EQUIPMENT: Speakphone in conference room; possibly a tape recorder at the SAHT center.

7.0 PERSONNEL: None during initial phases of the test, but later a trained stenographer.

8.0 DATA OUTPUT: Evaluation of the stenography turnaround time, accuracy and neatness of output, and reports on the ease of establishing and maintaining contact between stenographer and initiator.

9.0 EXPECTED RESULTS: Availability of a trained recording stenographer to any individual or any group, anywhere in the country at any time during the working day.

10.0 RESULTS:

1.0 TITLE: REMOTE DRAFTSMAN

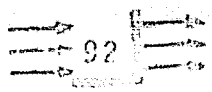
2.0 PURPOSE: To establish a remote pool of draftsmen, analogous to the typist pool, who can be used to supplement (or in some cases replace) the downtown draftsmen. Benefits and limitations of such an arrangement will be explored.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.7/2.1.2.8 Widespread Availability of Help, 2.1.2.10 Additional Services, 2.1.2.11 Transferability.

4.0 BRIEF DESCRIPTION: The draftsman will be provided with a communicating digitizer (e.g. sonic pen inductance stylus, cursor, or CRT-driven light pen, etc). He should be able to prepare line drawings either by tracing over pen-sketched figures, or by creating them on the spot. Digitizing will be performed off line, and the information stored on a cassette attachment; transmission of the digitized data will follow, and the drawing will be reproduced (suitably scaled) on a drum-type or flatbed plotter downtown.

5.0 PROCEDURE: Procedure follows that outlined above in Section 4.0. This is analogous to the remote typist concept, except that line drawings are to be produced instead of text. It is also possible to perform all editing functions in a manner similar to text editing; the concept of paperless editing extends into this sphere of activity also.

6.0 SPECIAL EQUIPMENT: Communicating digitizer with cassette attachment at the remote site. Pen-plotter at the downtown office center. For paperless editing, the use of a digital computer.



7.0 PERSONNEL: One or more draftsmen.

8.0 OUTPUT: Evaluation reports on throughput time, accuracy and quality of finished artwork, ease of communication between initiator and draftsmen.

9.0 EXPECTED RESULTS: The required level of coordination to assure good-quality output should be attainable with practice and due attention to detail. If successful, this demonstration should open up possibilities for using a wide group of off-site draftsmen.

10.0 REMARKS: The availability of text and illustrations, generated remotely and separately, created a need for someone to merge the two. This job should probably be assigned to the Operations Manager, at least on a temporary basis.

Working with digitized data, the opportunity presents itself for passing the data through a computer and mathematically scaling the figures to fit any shape and size desired on the printed page. This allows a greater degree of flexibility than simple optical (photographic) reduction or enlargement. Mathematically specified distortions are also possible, and for the most part, can be implemented quite simply (e.g. map projections).

1.0 TITLE: TEXT TRANSMISSION VIA SATELLITE

2.0 PURPOSE: Using a synchronous-satellite-based data link to replace the transmission of text via telephone line.

3.0 TEST OBJECTIVE REFERENCES: 2.1.2.2 Reduce Labor Cost, 2.1.2.7/2.1.2.8 Widespread Availability of Help.

4.0 BRIEF DESCRIPTION: A satellite in synchronous orbit, such as CTS or ATS, will be used to transmit the text in digital form. If video is available, it can be used to enhance the editing process during negotiations between typist and initiator.

5.0 PROCEDURE: Typists from one or more very remote locations should be used. Evaluation should stress the degree of reliability of the system using satellite link, and the ease with which the typist can make use of it.

6.0 SPECIAL EQUIPMENT: Transmitter and receiver to communicate with the satellite. This can probably be the same equipment already in use for similar purposes at existing ground stations. It will probably be necessary to communicate withthe ground stations via phone lines; this may tend to increase overall system complexity and reduce reliability.

7.0 PERSONNEL: No additional requirements except possibly at the satellite ground sites, depending on procedures in effect there.

8.0 DATA OUTPUT: Logs and evaluation sheets describing the tests and listing numbers of errors, number and length of system outages, and throughput times.

9.0 EXPECTED RESULTS: For digital data the satellite link should prove preferable and cheaper in transmitting messages over ranges where long-distance phone service would otherwise be required and in cases where accompanying video is used .

10.0 REMARKS: The success of this test rests on the ease with which the typist can access the satellite, and with which the satellite output can be forwarded to the downtown typewriter.

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APPENDIX A. U.S. CENSUS BUREAU OCCUPATION CLASSIFICATION SYSTEM

The system developed for the 1970 census consists of 441 specific occupation categories arranged into 12 major occupation groups. The most detailed comprise 32 occupation groups for the total employed and 22 groups for employed females. Shown below are the component categories of the 32 occupation groups

Professional, technical, and kindred workers

Engineers.—Includes aeronautical and astronautical, chemical, civil, electrical and electronic, industrial, mechanical, metallurgical and materials, mining, petroleum, and sales engineers.

Physicians, dentists, and related practitioners.—Includes chiropractors, dentists, optometrists, pharmacists, medical and osteopathic physicians, podiatrists, and veterinarians.

Health workers, except practitioners.—Includes dietitians, registered nurses, therapists, clinical laboratory technologists and technicians, dental hygienists, health record technologists and technicians, radiologic technologists and technicians, and therapy assistants.

Teachers, elementary and secondary schools.—Includes prekindergarten, kindergarten, elementary, and secondary school teachers, but excludes principals and supervisors.

Technicians, except health.—Includes agricultural, biological, chemical, electrical and electronic, and industrial engineering; mathematical, and mechanical engineering technicians; draftsmen; surveyors; airplane pilots; air traffic controllers; embalmers; flight engineers; radio operators; and tool programmers, numerical control.

Other professional workers.—Includes accountants, architects, computer programmers, computer systems analysts, farm management advisors, foresters and conservationists, home management advisors, judges, lawyers, librarians, archivists and curators, actuaries, mathematicians, statisticians, agricultural scientists, atmospherical and space scientists, biological scientists, chemists, geologists, marine scientists, physicists and astronomers, operations and systems researchers and analysts, personnel and labor relations workers, clergymen and other religious workers, economists, political scientists, psychologists, sociologists, urban and regional planners, social workers, recreation workers, teachers except elementary and secondary, vocational and educational counselors, actors, athletes, authors, dancers, designers, editors and reporters, musicians and composers, painters and sculptors, photographers, public relations men and publicity writers, radio and television announcers, and research workers not specifying subject.

Managers and administrators, except farm

Includes assessors, controllers and treasurers in local public administration; bank officers and financial managers; buyers and shippers of farm products; wholesale and retail trade buyers; credit men; funeral directors; health administrators; inspectors in public administration; building managers and superintendents; ship officers, pilots, and pursers; officials of lodges, societies, and unions; postmasters and mail superintendents; railroad conductors; restaurant, cafeteria, and bar managers; sales managers and retail trade department heads; and school administrators.

Sales workers

Includes advertising agents and salesmen; auctioneers; demonstrators; hucksters and peddlers; insurance agents, brokers, and underwriters; newsboys; real estate agents and brokers; stock and bond salesmen; sales representatives; sales clerks; and salesmen.

Clerical and kindred workers

Bookkeepers.

Secretaries, stenographers, and typists.

Other clerical workers.—Includes bank tellers; billing clerks; cashiers; clerical assistants, social welfare; bill and account collectors; counter clerks, except food; vehicle dispatchers and starters; enumerators and interviewers; clerical estimators and investigators; expediters and production controllers; file clerks; insurance adjusters, examiners and investigators; library attendants; mail carriers and mail handlers; messenger and office boys; utility meter readers; operators of: bookkeeping and billing machines, computer and peripheral equipment, key punch, tabulating machines, and other office machines; payroll and timekeeping clerks; postal clerks; proofreaders; real estate appraisers; receptionists; shipping and receiving clerks; statistical clerks; stock clerks and storekeepers; teacher aides; telegraph messengers; telegraph operators; telephone operators; ticket, station, and express agents; and weighers.

Craftsmen, foremen, and kindred workers[2]

[2]Craft apprentices are included with their craft.

Automobile mechanics, including body repairmen.

Mechanics and repairmen, except auto.—Includes mechanics and repairmen of: air conditioning, heating and refrigeration; aircraft; data processing machines; farm implements; heavy equipment; household appliances; looms; office machines; radios and televisions; and railroad cars.

Machinists.

Metal craftsmen, except mechanics and machinists.—Includes blacksmiths; boilermakers; forgemen and hammermen; heat treaters, annealers, and temperers; job and die setters, metal; millwrights; metal molders; pattern and model makers; rollers and finishers, metal; sheet metal workers and tinsmiths; shipfitters; and tool and die makers.

Carpenters.

Construction craftsmen, except carpenters.—Includes brickmasons and stonemasons; cement and concrete finishers; electricians; excavating, grading, and road machine operators; floor layers; painters, construction and maintenance; paperhangers; plasterers; plumbers and pipe fitters; roofers and slaters; structural metal craftsmen; and tile setters.

Other craftsmen.—Includes automobile accessories installers; bakers; bookbinders; cabinetmakers; carpet installers; compositors and typesetters; cranemen, derrickmen, and hoistmen; decorators and window dressers; dental laboratory technicians; electric power linemen and cablemen; electrotypers and stereotypers; engravers; photoengravers and lithographers; printing pressmen and plate printers; foremen;[3] furniture and wood finishers; furriers; glaziers; log and lumber inspectors, scalers, and graders; inspectors, n.e.c.; jewelers and watchmakers; locomotive engineers and firemen; grain, flour, and feed millers; motion picture projectionists; opticians and lens grinders and polishers; piano and organ tuners and repairmen; power station operators; shoe repairmen; sign painters and letterers; stationary engineers; stone cutters and stone carvers; tailors; telephone installers and repairmen, linemen and splicers; and upholsterers.

Operatives, except transport

Includes asbestos and insulation workers; assemblers; blasters and powdermen; bottling and canning operatives; surveying chainmen, rodmen, and axmen; manufacturing checkers, examiners, and inspectors; clothing ironers and pressers; cutting operatives, n.e.c.; dressmakers and seamstresses, except factory; earth drillers; dry wall installers and lathers; dyers; filers, polishers, sanders, and buffers; furnacemen, smeltermen, and pourers; garage workers and gas station attendants; graders and sorters, manufacturing; produce graders and packers, except factory and farm; metal heaters; laundry and dry cleaning operatives, n.e.c.; meat cutters and butchers; meat wrappers, retail trade; metal platers; milliners; mine operatives, n.e.c.; mixing operatives; oilers and greasers, except auto; packers and wrappers, n.e.c.; painters, manufactured articles; photographic process workers; drill press operatives; grinding machine operatives; lathe and milling machine operatives; punch and stamping press operatives; riveters and fasteners; sailors and deckhands; sawyers; sewers and stitchers; shoemaking machine operatives; solderers; stationary firemen; carding, lapping, and combing operatives; knitters, loopers, and toppers; spinners, twisters, and winders; weavers; welders and flame-cutters; winding operatives, n.e.c.; and miscellaneous and not specified operatives.

Transport equipment operatives

Truck drivers.

Other transport equipment operatives.—Includes boatmen and canalmen, bus drivers, urban rail transit conductors and motormen, deliverymen and routemen, fork lift and tow motor operatives, motormen, parking attendants, railroad brakemen, railroad switchmen, taxicab drivers and chauffeurs.

Laborers, except farm

Construction laborers.—Includes laborers in the construction industry and all others who specified helping construction craftsmen.

Freight, stock, and material handlers.—Includes freight and material handlers, garbage collectors, longshoremen, stevedores, and stockhandlers.

Other laborers except farm.—Includes animal caretakers, except farm; fishermen and oystermen; gardeners and groundskeepers, except farm; lumbermen, raftsmen, and woodchoppers; teamsters; vehicle washers and equipment cleaners; warehousemen, n.e.c.; and miscellaneous and not specified laborers.

Farmers and farm managers

Farm laborers and farm foremen

Includes farm foremen; farm

[3] Foremen who also report a craft occupation are classified with their craft. This category includes foremen of operatives and those who did not report their craft.

laborers, wage workers; farm laborers, unpaid family workers; and self-employed farm service laborers.

Service workers, except private household

Cleaning service workers.—Includes chambermaids and maids, cleaners and charwomen, janitors and sextons.

Food service workers.—Includes bartenders, busboys, cooks, dishwashers, food counter and fountain workers, and waiters.

Health service workers.—Includes nursing and other health aides, health trainees, orderlies and attendants; practical nurses, dental assistants, and lay midwives.

Personal service workers.—Includes airline stewardesses, recreation and amusement attendants, baggage porters, bellhops, barbers, boardinghouse and lodginghouse keepers, bootblacks, child care workers, elevator operators, hairdressers and cosmetologists, housekeepers, school monitors, recreation and amusement ushers, and welfare service aides.

Protective service workers.—Includes firemen (fire protection), guards and watchmen, policemen and detectives, crossing guards and bridge tenders, marshals and constables, sheriffs and bailiffs.

Private household workers

Includes child care workers, cooks, housekeepers, laundresses, and maids and servants.

Four occupation divisions.—The major groups are arranged in four divisions as follows:

White collar.—Professional, technical, and kindred workers; managers and administrators, except farm; sales workers; and clerical and kindred workers.

Blue collar.—Craftsmen and kindred workers; operatives, except transport; transport equipment operatives; and laborers, except farm.

Farm workers.—Farmers and farm managers, farm laborers and farm foremen.

Service workers.—Service workers including private households.

The sequence in which these four divisions appears is not intended to imply that any division has a higher social or skill level than another.

Additional information on the composition of the detailed categories is given in the publication, 1970 Census of Population Classified Index of Industries and Occupations, U.S. Government Printing Office, Washington, D.C., 1971.