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COMMUNICATIONS STRESSES IN THE FUTURE URBAN ENVIRONMENT

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INTRODUCTION

A little understood feature of the Scientific Revolution is now bursting into view. It does not involve any shocking change in man's conception of himself, his origins, or his capabilities--as occurred at the time of the debates over Evolution, or at the onset of the more recent Nuclear Epoch. The new situation arises from the extraordinary efficiency of the scientific method in achieving new discriminations. The body of common knowledge that may possibly be of value in the working of human institutions is now doubling in size every twelve to fifteen years. The multiplicity of ideas and facts being produced brings about a subtle shift in the behavior of people and their organizations. The strategies for coping with communications stress are changing the structure of our habitat, particularly the human scale in our cities.

Science stimulates the ideas; science-based technology has made possible their recording, transmission, and preservation. Vast multi-media networks have been assembled in urbanized countries. The links in this cobweb of connections are thickest in the central city and are still very much entangled in the suburbs, but out in the open spaces they dwindle off to a few wires, underground cables, and radio wave channels. A city, thus, is a megastructure built to accommodate message exchange.

Illustrations of the utility of this mode of portraying the reasons for city building are easily found. For example, privacy is a concept that implies a high degree of selectivity in the receipt of messages --most often it is achieved by building walls around the activity or by putting locks on the files. Similarly, face-to-face communication with a variety of individuals can be achieved only by means of elaborate transportation systems. Once the contact has been made, it can be maintained by telephone and mail. It is not surprising, therefore, that the greatest educational institutions are found in the midst of the cities and that these institutions assign the highest priority to inculcating

competence in communication. Great institutions occupying the downtown skyscrapers are still significantly raising performance standards for their communications, so as to reduce the frequency of error and influence an ever increasing number of clients.

The rate of growth is particularly significant. Virtually every type of communication is growing more rapidly than the economy itself, so urban channels regularly record yearly gains of from 5 to 15 per cent, with the newest modes of transmission registering the more phenomenal rates. For at least two generations--the period for which at least a few statistics can be found--the cities have been escalating the pace of the message game. An increasing proportion of the participants, especially scientists, editors, politicians, and top professionals, complain about the speedup of pace. They ask whether urban society is not heading for a crackup. A typical reaction is to wonder why it is not possible to decide to stop accumulating knowledge. The bombardment with trivia that is now experienced by most educated persons could then be reduced to more tolerable levels.

THE RESOURCE SCARCITY PREDICAMENT

We cannot turn the clock back by halting the accumulation of facts without triggering a catastrophe, because the world is in the clutches of the iron Law of Diminishing Returns. Society saves itself by a series of expedients, many of which exploit the successes of communications technologists who have been dramatically reducing the incremental costs for transmitting information.

The characteristics of the predicament are now clear. We know that essential natural resources, such as fresh water, energy, and minerals, have limited supplies that can be won at a reasonable cost by using known technology. As lower grade resources are brought into use, each unit of added effort yields less of the vital commodity produced. Thus societies are forced to acquire knowledge about possible substitutes and thereafter to persuade consumers to accept them. Linen is displaced by cotton, and cotton by rayon, then by nylon, dacron, and the acrylics. Similarly, wood gives way to fieldstone, then brick, massive concrete, prestressed concrete, and pre-fab multi-material panels. Each transition

not only requires a greater input of knowledge, but uses processes that require more day-to-day communications. Nowadays this means that telecommunications channels, operating in one or another band of the electromagnetic spectrum, are drawn upon repeatedly. Many instruments send signals over such channels, independent of human intervention.

Among all the inputs into a new production scheme, telecommunications are preferred for a very good reason: they dip into the reserves of a resource still experiencing declining marginal costs. The cost of capacity to communicate, and to calculate, is much less than a decade or two ago and is expected to drop much further in the future. A body of as yet unused technical knowledge has been accumulated that promises declining costs for the communications industry for another two decades. In comparison, electrical energy production anticipates constant costs, while liquid fuels experience first slowly rising and then accelerated increases in costs.

The policy path leading to conservation over the next generation is quite clear: priority is assigned to the acquisition of relevant knowledge, education, communication of information, data processing, and computation. I have yet to find a single significant resource-conserving transition in technology that uses less communications than its predecessor. The introduced process typically uses three, ten, or even a hundred times more communication capacity.

Internationally, the flow of communications is growing in those societies with static economies, due to such substitutions, but in the countries experiencing economic growth it is accelerating. One need only glance at the statistics on the use of paper, telephones, television, schools, and computers to confirm this observation. With lasers yet to be used in a practical non-military way, there seems to be no scarcity of capacity in sight. Even a frightfully stupid allocation policy does not seem to threaten, because bootleg operations would then be so profitable they would force a removal of the most serious restrictions.

COMMUNICATIONS STRESSES

How do humans respond to the increased pace in communications? What happens when a human becomes a link in a communications network? We know from experience that at some rate of message transmission, people begin to get confused; at some higher rate of input, they break down altogether. Even at normal levels, fatigue sets in and reduces the capacity to process messages reliably.

However, one aspect stands out when observing responses in the urban environment. *The stresses are significant only for persons who have accepted responsibility.* Thus doctors worry whether the information they have not been able to acquire might save some lives or prevent disability among patients in their care. Politicians are concerned that they have not listened to all sides of an issue before reaching a decision that commits the government to action. Students are held responsible for a body of knowledge upon which they will be examined. *Each responsible social role undertakes to minimize the errors in performance.* The errors are what are expensive for society, so it is fitting that some of the cost be transmitted to persons holding responsible positions.

A few typical examples of the extraordinary effects of communications stress will illustrate the significance of this phenomenon:

1. An Environment of Rapid Economic Development.

In San Juan, Puerto Rico, rising income led to a still more rapidly increasing demand for automobiles. An irregular (15 to 25 per cent) yearly growth in licenses was experienced during the first half dozen years of the Bureau for Vehicle Licenses' existence. The volume of mail orders then began expanding so rapidly that, by the time the Bureau realized it could not fill them before the date new licenses were required by law, the deadline was missed. An investigation was undertaken. Employees were found sitting dejected amid stacks of spilling cards, apparently suffering from shock. Their morale was so low they had to be retired to the provinces for a rest cure, and were replaced by three times as many clerks and a more flexible machine. In the following year,

the Bureau almost caught up with its backlog, and thereafter functioned normally.

2. Man-Machine Interaction.

During the 1950's a large computer firm sent troubleshooters to help its customers solve their most serious programming difficulties. In the latter part of the decade these visits sometimes lengthened into months, instead of days or weeks. Because the troubleshooters could not "de-bug" the program in a reasonable amount of time, their apologies were telegraphed intermittently to headquarters. Soon, instead of postponements, they began wiring resignations; even a couple of suicides were noted. The complexity of the problems was getting beyond the capacity of the people responsible for coping with them. The principal therapy employed was the creation of a center with training programs that aided programmers to discover, before they became deeply involved, when the problem called for a larger "systems approach."

3. Growth in Reading Materials.

Three very experienced women handled the acquisitions of a large university library in the 1950's. When the veterans' bulge hit graduate schools, the demand for books expanded rapidly. The three women were overwhelmed. They decided to postpone paying bills until there was time for that routine. More than a year elapsed before the publishing companies discovered that none of them was being paid! They issued a collective ultimatum: No books until all bills are settled. At this time, the women were found at home, guilt-ridden and under medical treatment. Some ten people were sent in to do their job. When the women were able to resume work, the two who were willing to return to the university were transferred to Gifts and Exchange, to allow them to qualify for retirement, but their colleagues regarded them as "burnt out types."

Similar instances have been appearing with increasing frequency over a wide range of institutions. They occur where a high level of

education has been achieved, where growth, development, and progress are abundantly evident. Nine years ago, when I was exploring the logical correlates of communications overload, it appeared that of all the cities in the world, San Francisco would experience these problems most intensely. A linear extrapolation of the growth of information transmission in human society suggested that by the end of the century the whole adult city would be as active in sending and receiving messages as were graduate students at the time--a degree of activity believed to be near the ultimate capacity for city residents. Will large segments of San Francisco's population burn out from overload?

THE STUDY DESIGNS

Communications stress was not recognized so readily when, a decade ago, an interdisciplinary team of us in the Mental Health Research Institute at the University of Michigan were struggling to find a 'living systems' problem for joint research. Dr. James G. Miller, the director of the Institute and the conscientious member-gadfly of the group, insisted on a formulation applicable to living systems in general. This meant that physiological psychologists working with single neurons (or whole brains) should ask the same kinds of questions as did the experimental psychologists measuring individual performance and the social psychologists observing the response of a team. For such investigators, who operate outside the system and measure both inputs and outputs, the organism could be regarded as a communications channel. The term "information input overload" was the most general formulation they could achieve. For societal scientists studying large social organizations and urban populations, the perspective is changed. The investigator sees the communication process from the inside and acquires extra resources for discovering the defenses mobilized against stress that resulted from too high a rate of communication. The group as a whole emphasized health, rather than disease and its consequences; therefore it sought to discover a set of policies which could prevent injury. Obviously, the work of each participant reinforced that of the others, but it also raised many vexed questions that independent researchers would, under other circumstances, have conveniently ignored.

In this context, appropriate social organizations were sought which would be subject to equivalent stresses. Behavior in the stock exchange, at a time when speculation unexpectedly accelerates and the ticker tape repeatedly falls behind, was considered carefully. But the stock exchange can not be manipulated in the same way as a group of student volunteers following the instructions of a social psychologist. Moreover, it would be unethical to experiment with any other kind of social organization.

It was then noted that the "baby boom" reaching our university would in itself provide the subjects for an experiment in our own milieu. An increased demand for library materials was in the offing, but its dimensions and timing were much less predictable. The requests and responses would take the form of messages; energy and material inputs were virtually irrelevant. How would our library react? Because reading is the highest capacity channel for conveying information to people, and will be much more used in the cities of the future than at present, it provided an excellent analog. The behavior of the library staff and of its clients was the best predictor we had of responses in the future urban environment. Furthermore--a factor as important as any other determining our choice of subject--librarians respect scholarly investigation and maintain open organizations, in contrast to hospitals, stock exchanges, government offices, airline terminals, and corporation headquarters where, for self-protection (because staffs are subject to prosecution for negligence), scholars are kept at arms length precisely when circumstances are stressful and errors likely to be made.

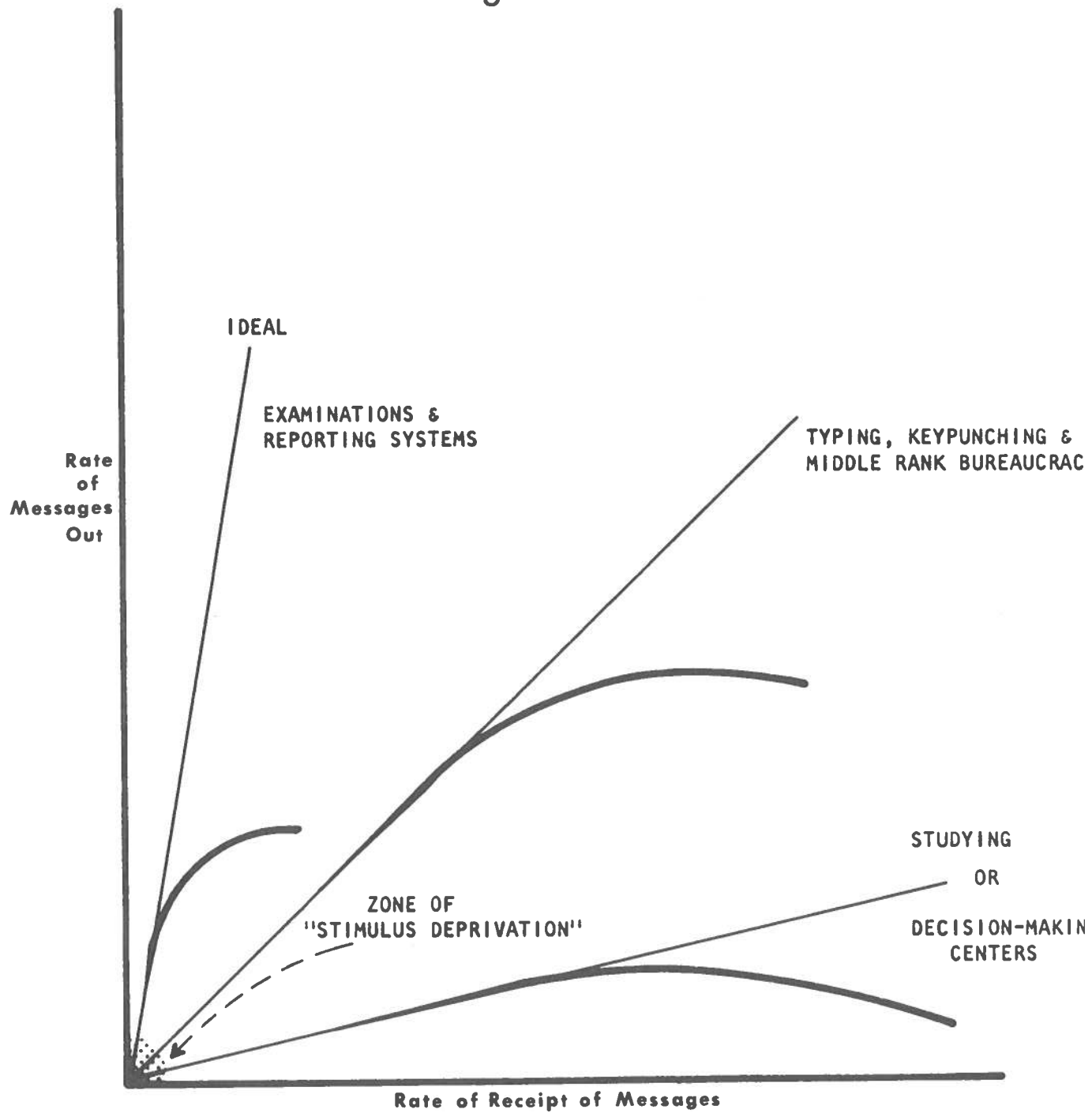
Measurements were made of all major inputs and outputs as the pressure on the library organization mounted. Where were the errors committed? Who paid the price? What action was taken to distribute the load? A specific facility was observed even more minutely as it was goaded by a population of undergraduate students to perform far beyond its design capacity. This facility became known throughout the profession for generating more intense use of printed materials than had ever before been recorded--it had passed up the New York City establishment at 42nd Street and Broadway!

The policies undertaken or seriously considered in the library study have been generalized so as to apply to a typical urban organization. Before we can describe the sequence of policies likely to be effective, however, the basic communications channel model must be presented in a way that the sources of stress can be readily identified. Figure 1 portrays various relationships of output rate to input rate, by type of activity. In some organizations a single message stimulates a burst of replies; in others, the relationship is approximately one-to-one; and in several others, information is studied or monitored so that only a few responses are transmitted. The zone of stimulus deprivation corresponds to the opposite of urban environment (e.g., Eskimos in winter, prisoners in solitary confinement, etc.) and has been the subject of much investigation. In Figure 2, the region of high stress in one-to-one interaction is identified as the gap between ideal and actual performance. When the living unit gives up hope of meeting its responsibilities, it either undergoes breakdown or it finds a set of policies that enables it to survive even if survival entails evasion of its responsibilities. The organization then performs only well enough to get by, or--to use a term invented by Herbert Simon--it "satisfices."

DEFENSES AGAINST COMMUNICATIONS STRESS

Let us imagine an organization that has been newly established to provide a service which some people think is necessary and others believe may be a convenience. The range of activities in which such an organization may engage is extremely wide. It could be a headquarters staff for a professional society, a clinic, a traffic control center, a travel reservations service, a brokerage office, a credit review service, a post office, a typing pool, or a library. All of these organizations are readily distinguished from factories and shops because information, rather than goods, is their *raison d'etre*. In all the instances listed, cyclic variations (daily, weekly, monthly, or yearly) in demand for services are found. Variations are also expected in the behavior of clients, due to local crises, rumors, fads, etc. With growing use of the service, however, each peak exceeds that of the previous round. Output records are broken regularly.

Communications Flow Alternatives In Organizations



(units are in standard messages, words, symbols, or bits of information)

Figure 1

Communication Stress in Balanced Urban Organizations

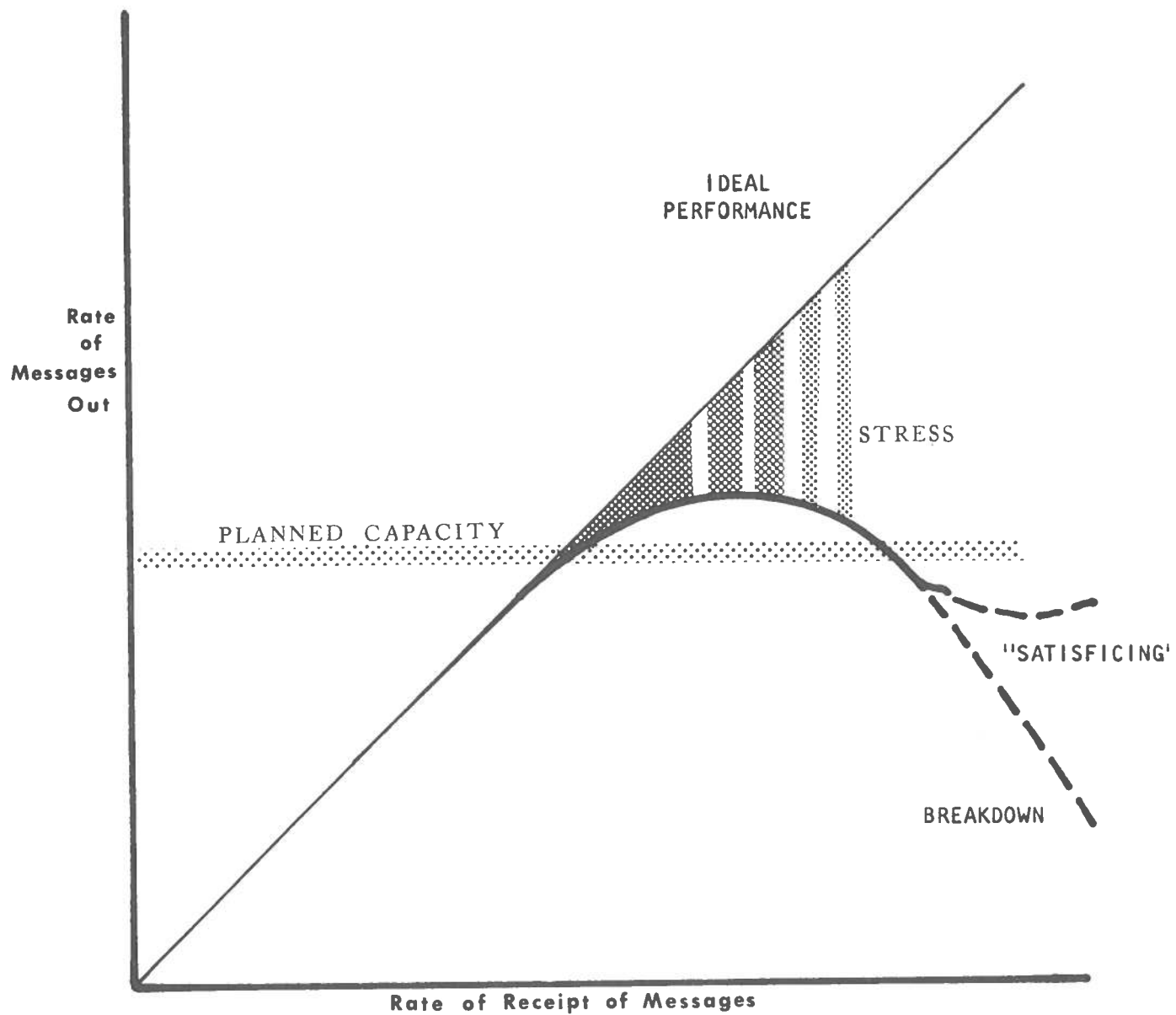


Figure 2

Note that these services are either "free"--that is, paid for indirectly and not according to the quantity or quality of service--or "delivered" at prices which the organizational supplier cannot readily increase. Price increases, therefore, cannot be used to control the visible demand.

It has already been shown that many organizations in this general category face rapidly rising rates of message transmission. What policies do such organizations fall back upon as the pace becomes more hectic? What are the internal effects of the increasing demand for services? How does the increasing load affect service to customers and clients?

As soon as one of these organizations sets up operations, it begins to handle routine incoming messages as rapidly as they are received. The processing time is short, and most departments or posts are prepared to meet work demands that arrive in ever-increasing bursts and flurries until the department's operating capacity is exceeded. Then, naturally, a new policy must be adopted:

Policy One. A Waiting Line for Inputs at Peak Periods.

The incoming requests for service are queued up in order of arrival at a receiving point for the organization. Provisions for a waiting line with a "gate" or a turnstile are needed which keep the queue outside the main body of the organization and admit messages singly, as fast as they can be processed. Then, when the flurry is over, the organization resumes "business as usual," retaining only a rule for determining when to set up a waiting line. However, if the queue continues to grow in size--if the flurry of demand lasts longer than expected--clients become impatient, adverse publicity results, and political pressures may be brought upon the organization through some larger organization of which it is a part. Then new policy measures are needed.

Policy Two. Setting Priorities in the Queue.

Messages in the "waiting line" may be rated by degree of importance. The organization considers its own scarcities (such as special skills, labor supply, space, or public relations) and tends to give

precedence to those messages that are most valuable to itself. If high quality professional persons are in charge, there is also a tendency to rate the requests for service in the queue according to the importance of the person being served, even though no extra payment is involved (the cynic will say that this is the same thing as maintaining the best public relations). In the long run these priority rules lead to savings for both customer and organization, but the organization has the initial expense of assembling data about setting priorities and instructing personnel in methods of classification. The rules worked out to expedite this policy should serve adequately until a period of steady growth in the waiting line is experienced.

Policy Three. Destruction of Lowest Priorities.

When the queue continues to build up, it becomes apparent that the lowest priorities will probably never receive attention. While they remain in line, however, they must be investigated repeatedly to see if their priority has changed. This reexamination represents wasted effort for consistently low priority items. Time and trouble are saved, therefore, when such messages are destroyed immediately upon their arrival. This is the "wastebasket policy" for incoming communications. Librarians use the term "ephemera" to categorize certain advertisements, tracts, fliers, community reports, and the like as not worth preserving. This policy reduces the backlog temporarily, but steady growth causes the higher priority material to accumulate again.

Policy Four. Adapting to Repetitive Requests.

Some transactions are far more common than others. Their processing time can be reduced by creating an assembly line and an "active file" -- spending capital to do so. The active file contains materials needed to expedite the most frequent requests. Whenever this type of system is set up, the most valued requests (i.e., the highest priority items) are usually processed simultaneously in order to reduce the likelihood of error. If the pressure from repetitive requests keeps up, the cost to the organization is rapidly repaid. Service to the public is usually improved as a result.

Policy Five. Creating Branch Facilities.

When reorganization is considered, its alternative should also be reviewed: routine services may well be shifted to points close to the addresses of the users, and only unusual requests be handled at the central facility. Thus, for example, clinics may treat perhaps 90 per cent of local needs, the remainder being referred to a central hospital with specialized equipment and practitioners. Often the organization can make deals with groups of users, who provide space, subsidies, extra capital, and other incentives in order to gain the convenience of a nearby branch. Both the users of a service and the organization providing it may be able to reduce costs through the establishment of branches.

Policy Six. Encourage Middlemen.

When waiting lines and arrearages are inevitable and growing, conditions are ripe for increased unit costs to occur. The situation provides opportunities for middlemen to develop special services for organizations, enabling the latter to "farm out" part of their work. Thus the organization may still do business at the old address, but it can handle a larger volume of requests. Middlemen are especially likely to appear if a new machine or technique can be used to expedite the combined business of several organizations. The downtown computation centers already established in most large cities serve exactly this function.

Policy Seven. Create a Mobile Reserve.

The internal backlogs of the various divisions and departments seldom remain balanced. After one or more sections has been nearly overwhelmed, thus threatening the existence of the whole organization, the management may decide to set up a "mobile reserve" force. Each member of this reserve should be sufficiently skilled to work in any one of several departments that may be under pressure. During lulls, the reserve force would work on tasks of lesser priority or deal with long-range problems. In some critical situation the reserve often becomes committed to one department and cannot easily be extricated, so that a new reserve must be

formed. A mobile reserve causes overhead costs to rise, but clients may gain because the service becomes more dependable.

Policy Eight. Set up Performance Standards.

Once the preceding policies have been suggested and considered, the risk of being swamped by too many messages is clearly evident. The thought comes naturally to mind that perhaps the job is being done too well. Many clients do not need the quality of service they are getting. Everyone makes errors; why should this organization struggle to be more perfect than the others with which it must be coordinated? A small percentage of the requests for service may be omitted from processing, or allowed to remain unattended, without scandal or attachment of blame. This thinking leads to the establishment of refined and quite explicit standards of performance which allow the service to be fitted to the need with a saving of time and an overall increase in capacity. Standardization of services requires extra expense for surveys and research. The organization gains some reduction in pressure, while the costs experienced by its public are increased to a small extent.

Policy Nine. The Search for the "Magic Formula."

When hope of using known techniques and the results of internal studies for relieving pressure have been reduced to the vanishing point, a frenzied search begins. Clutching at straws is behavior recognized almost universally. Key staff may be taken off the "firing line" to attend emergency conferences or be sent off to appeal for help from the outside. Their absence accelerates the growth of arrearages, but the organization has become quite desperate. In Europe, leaders tend to look for a new patron, inside or outside the government; in America, a solution is sought in some form of mechanization or instrumentation on the one hand, and among the private foundations on the other.

Policy Ten. Customer Self-Service.

One quite radical formula that is seldom considered seriously is the redrawing of the boundary that separates the client from the service

organization. Boundaries become sacrosanct more quickly than rules, and are often defended to the death of the organization itself. The example of self-service in marketing, however, has sometimes made this policy appear to be merely another form of technology and therefore more acceptable. It was quite a wrench for those librarians who had carefully guarded their collections of books to tell their readers to go into the stacks and find their own books!

Policy Eleven. Reduce Standards of Performance.

The pressure has by this time become intolerable. Something must give, and ordinarily the rules on standards of performance are officially relaxed or countermanded. Some slackening of performance has already occurred, but it has been winked at by foremen and supervisors because they understand the situation. The situation is tolerable, however, only as long as the highest priority requests are being met. The reduction of standards causes a striking change, even when it is recognized as being inevitable. Morale, for example (which heretofore has held up remarkably well), drops precipitately. Absenteeism, sickness rate, and labor turnover (all indicators of low morale) show sizable increases. Error frequency, which had been creeping upward slowly as the stress increased, now begins to mount rapidly. Policy that lowers performance standards causes a marked shift of costs from the organization to its clients, customers, and suppliers; such policy is undertaken only to prevent imminent breakdown.

Policy Twelve. Escape.

The policymakers and responsible personnel, if they can not reduce the pressure of increasing requests for services, usually consider quitting. The situation has become intolerable and irremediable, at least within the scope of their knowledge. A "quitting" policy may take various forms: mass resignation, a takeover by some other organization, or bankruptcy procedures. It should be pointed out that this is a surprising kind of failure, because it is brought about by burgeoning demand. Leaders are bitter because they feel that they have not been granted sufficient resources to cope with demand; they tried to deliver too much with an inflexible budget and were caught short.

Policy Thirteen. Salvage of Component Units.

The dissolution of middle-sized and larger organizations is seldom complete. There are organizational scavengers who assemble branches, departments, special units, and independent enterprises to create a new organization based upon a different formula. Often fragmentation occurs, and many of the branches find a way of surviving on their own.

Policy Fourteen. Work to Rule.

If escape is impossible because of legal, ethical, or other reasons, there is a strong tendency to cut back the work load by a rigid, ritualistic application of regulations and working rules. The organization no longer tries to meet the challenge or to correct mistakes that have been made. Errors are ignored or denied. Clients are expected to know the rules and to find substitutes on their own initiative. We have arrived at a capricious, silly, dogmatic bureaucracy that has lost most of its internal consistency. The priority assignments in particular become archaic and meaningless. The same patterns of behavior may arise as a consequence of difficulties other than those of too many messages, but the number of instances attributable to communications stress is increasing.

The policies just outlined are seldom undertaken singly. The best strategy for an organization is to reshuffle its policies each time a change seems advisable. Some of the new policies described above (and perhaps others appropriate to that special activity) are then integrated into the rules and regulations. The policies have been taken up in an order that is consonant with increasing communications load and the imminence of the threat to the organization.

THE MAGIC FORMULA MULTIPLIED

What has been outlined by the foregoing fourteen policies is a normal progression that is likely to be repeated many times. Any one of these policies will occasionally succeed well enough to deflect the sequence, thus leading to a completely different set of outcomes. The

proposal to search for a "magic formula," in the guise of a machine or a system of some kind that relieves the pressure, sometimes does connect with a relevant technological capability. The importance of this search rests in the fact that such infrequent successes are cumulative. The communications machines that can be mobilized comprise various primitive species of automata that digest data and make mechanical choices. When the machines are put on the market they solve the problems of other organizations before the stresses become truly serious. When the new equipment incorporates economical cybernetic principles and achieves relatively automatic performance, it can greatly add to the message-handling capacity of an organization.

Design engineers recognize that the problems of organizations are most readily resolved wherever organized behavior is reduced to routine. Assembly lines are good examples. The work can then be programmed, rationalized, standardized, and replicated by others. It is not surprising, therefore, that the most inhuman urban tasks--those requiring dull, repetitive work on large volumes of low priority communications--are being taken on by the newly acquired automata. They carry out the accounting calculations, connect the telephones, process checks, guide mail to its destination, and keep the files. There is a very important consequence arising from this substitution process: when machines have been fully integrated into an organization, the quality of the performance of the tasks they do invariably improves. Errors drop off by 50 to 90 per cent. Machines are much better at routine than are their human counterparts.

Recognizing the disproportionate number of routine jobs that had been created by industrial and governmental bureaucracies, and the capabilities of the automata already in existence as prototypes, social observers of the mid-1950's forecast widespread unemployment as automation of white collar work gained momentum. We now know that their projections could not have been more mistaken. The banks, telephone companies, insurance firms, and all other leaders in the automation of communications continue to hire more employees, while the poorly mechanized, low paying, dirty jobs are disappearing. The early projections were wrong because they failed to take into account the value of added information for decision making and attached too little importance to the improvement in the

quality of information processing brought about after the adoption of machines. *People were needed to fill in the gaps that could not be automated economically.*

The evolutionary pattern for future urban environment is now discernible. The long term strategy for minimizing communications stress is to continue displacing white collar workers from jobs that chain them to the hand-feeding of machines. Many new urban jobs will involve supervising work done by the office equipment. Automatic machines will increasingly serve each other, as when a computer will be allowed to direct a mechanism that dials telephone numbers and is then served by an automatic exchange that obtains for it access to another computer-directed system. Vast quantities of information may then be transmitted in a short period of time. Authorization for that operation in the non-military sector is yet to be ruled upon by the Federal Communications Commission.

The people most vulnerable to displacement are white-collar workers and middle-range executives, but they accumulate too much seniority to be lopped off the payroll. They are needed much more than before to establish contacts with the population as a whole, to refine and edit the data that are collected, and to find means of regularizing and standardizing the inputs to the automata. We can expect, therefore, that people will be ministering to the needs of other people to an ever-increasing extent. They must become new professionals, the kind that accepts the responsibility for making sure the automata deliver needed goods and services at the proper time. Such a prospect reintroduces Norbert Wiener's "human use of human beings," but with a less pessimistic note. With much more data and fewer errors in its use, the fit between a city's social services and the human needs for them will be much closer than at present, precisely because much more effort will be applied to the communications process.

To conclude, therefore, I visualize the city as becoming a place with ever-more intense communications, but the majority of the messages will be transmitted and received by automata. Communications stress may become more common, because perhaps twice the proportion of the population will occupy responsible positions a generation hence than at present. However, the disabling effects of communications overload, once the

phenomenon is diagnosed and well understood, should become relatively rare. The roles of the people on the urban communications frontier are really the same as those engaged in research and development, because much more attention will undoubtedly be spent acquiring information from the social and physical environment and reducing it to fit economically into the storage and retrieval systems. Present errors must be rooted out and future errors prevented.

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