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by

Nobuo Takahashi
University of Tokyo

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NOBUO TAKAHASHI

Faculty of Economics

University of Tokyo

Hongo, Bunkyo-ku, Tokyo 113, JAPAN

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Abstract

Many Japanese firms had found out the multi-office systems in which linking pin members were physically shared between the headquarters office in a metropolis and the branch office located in a local city. The system costs are theoretically decisive of the multi-office design, and the infrastructure in Japan's high-tech society greatly reduces the system cost of multi-office design by comparison and makes it possible to choose the multi-office system.

INTRODUCTION

To better understand Japan's changing local social system and the influence of technological advances, an empirical survey was conducted in the Hokkaido (the northernmost island of Japanese archipelago) and Tohoku (the north of the Honshu island) Areas in Japan. Interviews at firms, local government, national government agencies, think tanks, etc. in Sendai City in Tohoku Area particularly in 1991, and in Sapporo in Hokkaido 1992 indicated a transition toward a local social system as which is explained in the following findings (Takahashi, 1992).

Finding 1. Considering all of the social and resource costs, greater urbanization of local cities is a logical one. For example, even in rural areas, business can be done by going by car from a nearby city to an agricultural area where there is the principal place of work. This makes it possible for those working in the agricultural profession to live in a big city. Further, in industrialized countries especially where there is greater farming technology, i.e., improved machinery, this phenomenon has changed traditional industries and liberated farmers. Consequently many believe that with urbanization, social capital costs may be greatly reduced.

Finding 2. The Intelligent Cosmos concept of Tohoku Area has been described as "Liberated Settling Down-Area of Exchange", because people and firms with different schedules are "straddled" between multiple cities, (of course, these cities also include the Tokyo Metropolitan Area). In other words, people and firms can stochastically exist in multiple cities. Moreover, this trend is significant for local cities in that individuals and time can be shared throughout several cities while still maintaining the popular level constant. Therefore, "settling down" has not necessarily occurred.

The development of the regional social system mentioned above originates in the same way as a technologically advanced society. The rapid transportation systems, the

Bullet Train (Shinkansen) and the highway network, as well as an advanced communication system make it possible to diversify the patterns and ways of living. The new lifestyles are as follows (The 2010 Regional Living Vision Research Association, 1991).

(a) Country Life Type: Those residing in the Tokyo Metropolitan Area may go with their family members to a resort area or second home on weekends and on extended holidays.
(b) Business Camp Type: While having their primary place of residence in a local city, they spend their weekdays in a second home near their jobs in the center of a metropolis.
(c) Long Distance Commute Type: Commuting from a local city is the choice of those unable to own their own place of residence in the center of a metropolis. This type is already prevalent in the Tokyo Metropolitan Area.
(d) Home-Work Type: This type describes the very short commute into the work place, i.e. from satellite or resort offices located in a resort area of a local city.

Among them, the Country Life and the Business Camp Types are most appropriately referred to as "multi-habitations".

The diverse patterns of establishing a local place of residence are not limited to the Tokyo Metropolitan Area-local cities case, as was already established in Finding 1 and illustrated on the right side of Figure 1. It also refers to the commute which is becoming more popular these days between a local city and the work place located in agriculture or fishing villages. Those who desire the conveniences of running water and sewage facilities, proper medical care and educational facilities, as well as the smooth succession of their agriculture or fishing trades to their sons and daughters live in local cities and more readily commute to the "work places" (farms or ports) by car.

According to the survey's preliminary findings, the new image of the local society is shown in Figure 1 or the proliferation of this pattern of commuting to and from the primary locality residence to the work place. However, people's living patterns are not the only means of diversification, indeed attention must be paid to the fact that firms themselves are also relocating. Though not considered seriously until recently, while living patterns must evidently diversify, so must the work place patterns (Takahashi, Ouchi and Hayasaka, 1992).

Company A which has its headquarters in Tokyo is a representative example. It is major manufacturer of electric, home appliances and until recently, all of its factories were independently developing identical sorts of computer software. However, to improve its management, the development activities were concentrated in a subsidiary, Company B, located nearby Sendai Station of Japanese Railways (JR) in Sendai City in Tohoku Area. Indeed recruiting the necessary software personnel had become so difficult in Tokyo that they decided to add the Sendai office. While close contact with the Tokyo headquarters is of course necessary, thanks to the Bullet Train, engineers and administrators can do their jobs such as attending meetings and appointments by coming to Tokyo for the day. JR's Sendai Station lies 351.8 km northeast of JR's Tokyo Station by the Tohoku Bullet Train, but the express takes only 104 minutes, which is not much different from a commute within the Tokyo Metropolitan Area. Although in terms of cost, the commute between the two is a burden, the unit price of office space around Sendai Station is approximately one-third of what it is in Tokyo, therefore in comparison, transportation costs become trivial.

In this paper, individuals can conceivably divide their time between multiple cities and multiple offices; this is why the concept of a *multi-office system* should be examined. Tokyo Metropolitan Area firms can no longer find all the necessary human resources in the localities. Moreover it has become difficult to find a sufficient number of diverse, high quality individuals even in the local cities. Because of the change in the distribution of human resources, highly skilled, quality human resources should not be kept in one work place, offices should instead share them. This can be accomplished by a multi-office system which has developed thanks to the rapid transportation and advanced information and communication systems, a phenomenon which is already becoming widespread.

THE MULTI-OFFICE SYSTEM

To illustrate the persons who frequently commute between the Tokyo headquarters and the Sendai subsidiary to attend meetings and appointments, Likert's (1961) "linking pin" is useful. The Likert type of linking pin is illustrated in the pyramid organization as indicated in Figure 1 (A). The pyramid organization epitomizes the principle of unity of command which may be described as: "the more completely an individual has a reporting relationship to a single superior, the less the problem of conflict in instructions and the greater the feeling of personal responsibility for results" (Koontz, O'Donnell and Weihrich, 1980, p.427).

However, Company B's localized organization mentioned above is in reality closer to the type in Figure 1 (B). The human resources on hand were divided into various divisions which formally followed the principle of unity of command but had greater flexibility; simultaneously it was possible to delegate tasks to the multiple divisions. In much the same way, the concept of a matrix organization developed in the American aerospace industry in the 1960s (Kingdon, 1973; Davis and Lawrence, 1977; Janger, 1979). Davis and Lawrence (1977) defined the matrix organization as an organization which adopted a multiple command system and abandoned the principle of unity of command. Takahashi (1986) focused on the organizational structure of large Japanese firms (*N*=299) listed on the securities exchanges and reported: 63.6% of the total firms take the pyramid organizations, and the amazing fact is that 36.4% of total firms take the matrix organizations, contradicting the principle of unity of command in classical management theory.

The matrix organization is the multi-boss system where there are members having several superiors. Our attention is now focused on another step in advance: Regardless of whether there is a single place of residence or not, the organization design is called the *multi-office system* if office managers physically share the members between several offices. In the case of Company A, there exists a multi-office type of linking pin, called the *linking pin member*. In Figure 1(B), the linking pin member has two offices. Company A's linking pin members are living and working principally in the local city, while commuting into Tokyo several times a week for necessary meetings and appointments.

To discuss the advantages and disadvantages of the multi-office system, we consider an organization design problem of multi-office, called the *multi-office design problem*. The notion of organization design was first developed in the field of contingency theory. Lawrence and Lorsch (1967) researched the relationships between the management patterns of organizations and the uncertainty of their environment, as well as past studies with similar aims, and called them "contingency theory." But the discussion of contingency theory is mostly based on the empirical researches. Most of the propositions are drawn as only inferences from the results of them. Therefore Hax and Majluf (1981) pointed out that a useful normative approach to organization design had little literature ever published. While it is possible to think of the matrix organization as a formalized mixed strategy for human resources (Takahashi, 1987; 1988), it is equally plausible that the multi-office be considered as a similar model for human resource strategy.

We formulate a multi-office design problem under uncertainty on the basic bureaucratic model of Galbraith (1973). The concept of the multi-office system corresponds closely with the concept of the mixed strategy in the game and decision theory context. We derive some managerial implications of decision theory and prove a proposition that the system costs are decisive of the multi-office design problem regardless of whether uncertainty is high or low. Thus, we can conclude that the effect of uncertainty is negligible in selection of the multi-office design though the contingency theory lays too much stress on the uncertainty of environment. Therefore, we examine the system costs of multi-office system and ordinary "single-office" system, then the primary reasons that the multi-office system is becoming widespread is made clear in terms of system costs: The infrastructure in Japan's high-tech society greatly reduces the system cost of multi-office design by comparison and makes it possible to choose the multi-office design. The multi-office system can be also a solution to the Japanese mismatch problem of human resources in progress.

THE MULTI-OFFICE DESIGN PROBLEM

Programs

Galbraith (1973) studied organization design from the viewpoint of information processing in the organizations under uncertainty. He conceived of organizations as information processing networks and showed the basic bureaucratic model having three mechanisms, i.e., programs, hierarchy, and goal setting, which were provided to handle complexity and great information loads.

Programs teach the members the job-related situations with which they will be faced and the activities appropriate to these situations. In other words, the program is analyzed into the following two steps (March and Simon, 1958): (1) the *evoking step* as including the conditions that the activities are to be evoked, and involving observations of some activity or some part of the environment, and (2) the *executing step* as describing the contents of activities to be executed, and involving the roster of kinds of activities, i.e., the whole set of job specifications, formulas, blueprints of standard products, standard operating procedures, etc.

Let a denote the activity described in the executing step of the program to be executed by a member. The same activity can result in different outcomes depending on the state of environment θ not controlled by the members of the organization. Thus the loss function associated with the activity a is denoted by $L(\theta,a)$. In the evoking step, a member takes an observation X on the job-related situation in the organization which is the random variable whose distribution depends on the true state of environment. Now, let S denote the sample space of X and let A denote the set of all possible activities. Any function $d(x)$ that maps S into A is called a *program*, which represents a schedule contingent on the job-related situation. A program d designates an activity a as one can be executed by the member when he or she receives the observation x.

Hierarchy and Goal Setting

In general, the scheduling problem of members' activities is a very complex combinatorial problem (Galbraith, 1973). Even for few members and simple cases, the organization has too many possible programs to trace them all and choose the optimal one within limited time and resources and "bounded rationality" (Simon, 1976). To simplify the scheduling problem, we introduce hierarchical structure and goal setting into our organization model (Galbraith, 1973). We consider the hierarchical structure composed of three layers: (1) a top leader; (2) m office managers; (3) k linking pin members. Then the organization undertakes the following three-phase U-turn management process: For each linking pin member, (*Phase 1*) the top leader is to set goals on the performance of his or her program, (*Phase 2*) every office manager is to search and choose a program to be executed by the linking pin member that satisfies the goals and to recommend it to the top leader, and (*Phase 3*) the top leader is to choose a program (or a mixture of programs) from among such satisfactory programs.

The U-turn management process is characterized as a combination of top down management process (Phase 1) and bottom up management process (Phase 2). MITI (1984) researched the management process of large Japanese firms (N=532) listed on the securities exchanges, and reported that 77.7% of the investigated Japanese firms use this "U-turn" management process whereas 13.3% use "top down" management process and 9.0% use "bottom up" management process.

Phase 1 is characterized by Galbraith (1973) as the process to set goals. The goals on performance (e.g., the defective rate of parts, a completion date, man-hours to be used) describe minimally satisfactory programs of each unit organization to cover the primary interdependencies within the meaning that each linking pin member does not need to coordinate its activity with the others' if it meets or exceeds all these goals.

In this paper, the organization is assumed to be short-run adaptive in the sense of March and Simon (1958), namely, in Phase 2 every linking pin member is assumed to have at least a satisfactory program without developing, elaborating and revising activities.

A Multi-Office System and a "Single-Office" System

In the multi-office system, the linking pin member is to implement programs chosen by two or more office managers in their offices. The top leader can order the linking pin member to distribute his or her effort among the several office managers' program. To represent such a distribution, a *mixed program* is defined as any probability distribution f on $D=\{d_1,\ldots,d_m\}$ in Phase 3, where d_j denotes the satisfactory program chosen by office manager j, $j=1,\ldots,m$. The space of all mixed programs is denoted by F. The mixed program, $f=(f_1,\ldots,f_m)$, is a mixture of elements of D and mixes $d_1,\ldots,d_m$ in the proportions $f_1,\ldots,f_m$ with $f_j \geq 0$ ($j=1,\ldots,m$) and $\Sigma_j f_j=1$, and then the linking pin member spends $100f_j$% of his or her business hours in the office of manager j in the long enough term.

Any probability distribution f giving probability one to a single point d_j for some j is called a *pure program*. We identify a point $d_j \in D$ with the probability distribution $f \in F$ degenerate at the point d_j, then the space D of pure programs is considered as a subset of the space F of mixed programs, that is, $D \subset F$. Now, an ordinary "single-office" system is formally defined as follows: An organization design is called a *single-office system* if every linking pin member implements a pure program in D. An organization design is, of course, called a *multi-office system* if some linking pin member implements a mixed program in *F-D*. Let the system cost required in a single-office system to execute any activity be C_1, and the system cost required in a multi-office system to execute any mixture of activities be C_2. The *system cost* consists most of labor costs, office space costs, transportation costs (including the wages attached to the transportation time that should be spent on a more important activity), communication costs, etc.

Now, let $G(\theta, f)$ denote the expected loss when θ is the true state of environment and f is the program, that is,

$$G(\theta, f) = \sum_j f_j E\{L(\theta, d_j(X))|\theta\}.$$

From the above discussion, in Phase 3, the top leader is confronted with the problem to choose the optimal mixed program f^* on the basis of the *risk function* (or simply the *risk*) defined as

$$R(\theta, f) = \begin{cases} R_1(\theta, f) = G(\theta, f) + C_1 & if \quad f \in D \\ R_2(\theta, f) = G(\theta, f) + C_2 & if \quad f \in F - D \end{cases}$$

where $R_1(\theta, f)$ is the risk if he takes a single-office system and $R_2(\theta, f)$ is the risk if he takes a multi-office system. By definition, if $f^* \in D$, then a single-office system is appropriate, whereas if $f^* \in F\text{-}D$, then a multi-office system is appropriate. Hence, this paper adopts "ceteris paribus" approach to Phase 3 of our three-phase U-turn management process, and our attention is directed to obtain the optimal program f^*.

Multi-Office Design under Uncertainty

The true state of environment is generally not known to the organization in advance, that is, uncertainty exists about the state of environment θ. In accordance with March and Simon (1958), the existing categories of "uncertainty" for the top leader are three: (a) Certainty: The top leader completely and accurately knows the true state of environment. (b) Risk: The top leader has knowledge of a subjective probability distribution $w=(w(\theta_1),\ldots,w(\theta_s))$ on the set of all possible states of environment $\Omega=\{\theta_1,\ldots,\theta_s\}$, called a prior distribution with the interpretation that according to his belief θ_j occurs with probability $w(\theta_j)$ for $j=1,\ldots,s$. (c) Strictly uncertainty: The top leader knows the set of possible states of environment, but he cannot assign definite probabilities to the occurrence of particular states of environment. He knows only Ω.

The case of certainty is a special case of risk, where the subjective probability distribution is $w=(0,\ldots,0,1,0,\ldots,0)$ with probability 1 assigned to the true state of environment. Therefore, in the cases of certainty and risk, the optimal program is one to minimize the Bayes risk, $r(w,f)$, for the given prior distribution w, defined by

$$r(w,f)=E\{R(\Theta,f)\}=\sum_j w(\theta_j)R(\theta_j,f)$$

where Θ is a random variable over Ω having distribution w. Thus the following Bayes program is optimal: A program f^* is said to be a *Bayes program* with respect to the prior distribution w if

$$r(w,f^*)=\inf_{f\in F} r(w,f)=\min\left\{\inf_{f\in D} r_1(w,f);\ \inf_{f\in F-D} r_2(w,f)\right\}$$

where

$$r_i=E\{R_i(\Theta,f)\}=E\{G(\Theta,f)\}+C_i,\qquad i=1,2.$$

We note that there exists an $f^0\in D$ such that

$$E\{G(\Theta,f^0)\}=\inf_{f\in F} E\{G(\Theta,f)\}$$

(see Blackwell and Girshick, 1954, Lemma 5.2.1). Then we obtain

$$\inf_{f\in D} E\{G(\Theta,f)\}=\inf_{f\in F-D} E\{G(\Theta,f)\}$$

since $E\{G(\Theta,f)\}$ is a continuous function of $f\in F$, and D is a finite set. Therefore,

$$r(w,f^*) = \begin{cases} \inf_{f \in D} r_1(w,f) & if \quad C_1 \le C_2 \\ \inf_{f \in F-D} r_2(w,f) & if \quad C_1 \ge C_2 \end{cases}$$

Thus, if $C_1 \ge C_2$, then $f^* \in F\text{-}D$ and the multi-office system should be taken.

In the case of strictly uncertainty, the best known method which does not require the specification of a prior distribution w is the minimax rule (March and Simon, 1958; DeGroot, 1970): Consider the worst risk that could happen for each state of environment and then select the program whose worst risk is less than or equal to the worst risk attached to other programs. We consider the minimax program as optimal in the case of strictly uncertainty since the minimax rule widely spreads in the game and decision theory context and a minimax program actually exists (Ferguson, 1967, Theorem 2.9.1). A program f^* is said to be a *minimax program* if

$$\sup_{\theta} R(\theta, f^*) = \inf_{f \in F} \sup_{\theta} R(\theta, f) = \min\left\{\inf_{f \in D} \sup_{\theta} R_1(\theta, f);\ \inf_{f \in F-D} \sup_{\theta} R_2(\theta, f)\right\}$$

Since $D \in F$ and D is a finite set, we obtain

$$\inf_{f \in D} \sup_{\theta} G(\theta, f) \ge \inf_{f \in F-D} \sup_{\theta} G(\theta, f).$$

Therefore, if $C_1 \ge C_2$, then $f^* \in F\text{-}D$ and the multi-office system should be taken.

From the above discussion, we have the following proposition.

Proposition. Regardless of uncertainty, the multi-office system should be taken under the condition that $C_1 \ge C_2$.

Although the contingency theory lays too much stress on uncertainty, this proposition states that the system costs are decisive of the multi-office design problem and that the effect of uncertainty can be negligible under the condition that $C_1 \ge C_2$. Therefore, it is sufficient to discuss the advantages and disadvantages of the multi-office system that the system costs, C_1 and C_2 are examined in the following sections.

DECREASING C_2 IN TECHNOLOGICALLY ADVANCED SOCIETY

As mentioned in the example of Companies A and B, the companies which come to Sendai share the following characteristics:

(a) They are no longer able to sweep all the necessary, high quality human resources into the Tokyo Metropolitan Area.
(b) Sendai is on the Bullet Train Line which may be used for day trips from the Tokyo Metropolitan Area.
(c) These transportation costs may be offset by Sendai's inexpensive office space.

Characteristics (a) and (b) respectively describe the system costs C_1 and C_2, and (c) describes both of them. Characteristic (a) describes the firms' primary reason for the push from Tokyo to a local center or a local area in the vicinity. For this reason, Company A had already set up a factory near Sendai City in the 1950s and begun the local development of its manufacturing subsidiaries. In this section, we first examine characteristic (b). (a) and (c) will be examined in the next section.

For the multi-office system, since movement between offices is required, it is clear that the transportation time and costs are not negligible. But the principal factor for these system costs can be greatly reduced by the high speed transportation and high level communication systems. Now we illustrate that a commute between Sendai and Tokyo is not much different from a commute within the Tokyo Metropolitan Area. The commute from JR's Hachioji Station to JR's Tokyo Station within the Tokyo Metropolitan Area is 47.4 km, while the one using the Tohoku Bullet Train from JR's Sendai Station to JR's Tokyo Station is 351.8 km, just 7.42 times as far. Within Sendai City, the distance to the work place is only a few kilometers, therefore, the average commuting distance in Sendai in addition to one trip per week into Tokyo with a night's stay near the work place in a second home or in a hotel, is about the same as one week of daily commuting to and from Hachioji. In terms of time savings, the former's shortest one-way commute is 51 minutes, while the latter is 104 minutes, making it a clear advantage for the latter.

The Tohoku Bullet Train Line which runs through Sendai is the reason why firms have established themselves in the vicinity of Sendai, however the airport and air lines have had similar effects. In Japan, it was thought by local governments that without an airport, high technology industries such as IC manufacturing would not come to the area. It was also assumed that because IC products are generally lightweight with high unit prices, they should be transported by air. However, in reality IC products differ from perishables, as the degree of "freshness" is of no importance; they are transported by truck to reduce costs. Airplanes are used for the transportation of people. For the factories or manufacturing firms established in the local areas, sending people into the Tokyo headquarters for appointments and company meetings is frequent, necessitating the movement of these human resources. Therefore, having an airport in proximity is in this sense necessary.

In 1985, the Sapporo Technopolis was constructed in Sapporo City on the island of Hokkaido as a center for the information processing industry. However, it is said that 60% of their work is from contracts by firms in Tokyo; moreover, the short 90 minute commute from the Tokyo-Haneda to the Sapporo-Chitose Airports which is located nearby the technopolis gives it its real appeal.

A survey conducted by the Hokkaido Bureau of International Trade and Industry of this facility indicated that the Sapporo Metropolitan Area sales for fiscal year 1990 made up 87.5% of Hokkaido's total sales. The sales ratio within Hokkaido was 52%, but the information processing services accounted for 87% of the sales to local governments located in Hokkaido itself. Conversely, the sales of 66% of the software industry, and

70% of the system house industry were made outside Hokkaido. In other words, jobs from firms outside Hokkaido were the central focus. In addition, attention must be paid to recruitment: in this area the percentage of mid-career recruits was high making up 39.9% of the total. According to the survey results, the total ratio of "mid-career recruits from outside Hokkaido" occupied: 9.0% in 1988; 9.9% in 1989; 12.1% in 1990, demonstrating the certainty of the rise.

Hence the airport and the Bullet Train Lines have similar effects in that they both transfer human resources from Tokyo to localities. This is also valid for the local cities of the Tohoku Region far away from the Bullet Train Lines. Indeed, before to the extension of the Bullet Train into Sendai, some Tokyo-based companies with subsidiaries in Sendai had to use Sendai and Tokyo-Haneda Airports regardless of cost. Thus the infrastructure in Japan's high-tech society makes it possible to choose the multi-office.

INCREASING C_1 IN IMMOBILITY SOCIETY

The primary reason for the difficulty in sweeping all the necessary high quality human resources into the Tokyo Metropolitan Area is that: Those who do not wish to leave the local areas, as well as those who consent to employment in the Tokyo Metropolitan Area only on the premise of being able to return to the localities later are becoming more common. Japan's mobile society is putting down roots.

According to Schein (1978), "career anchors" guide and give a sense of stability to individuals throughout their careers. Through his interview surveys of 44 male alumni with MBAs from the Massachusetts Institute of Technology (MIT), the people can be grouped according to their career anchors as follows: (a) Technical/Functional Competence, (b) Managerial Competence, (c) Security and Stability, (d) Creativity, and (e) Autonomy and Independence. Among the MBA graduates of MIT, some belonged to the (c) group, which valued the career anchor of geographical stability such as a fixed place of residence, family security and community belonging.

In Japan, those with (a) and (b) career anchors would likely move from the localities to the attractive large enterprises in the Tokyo Metropolitan Area. Nonetheless, the supply of people with (a) and (b) career anchors has almost entirely been exhausted. The reason is the importance of geographical stability in today's localities and settling down decreases mobility.

Furthermore attracting high quality human resources to the Tokyo Metropolitan Area would be more difficult and costly by the following reasons:

1. Soaring land prices in the Tokyo Metropolitan Area have made it more difficult to purchase a home. Even if employees are allotted company-owned housing under the terms of employment, these homes must be returned after retirement.
2. An additional consequence of the soaring property prices is that living expenses, central to which are housing costs, have also risen. Given this drop in the standard of living, the Tokyo Metropolitan Area is losing its appeal.
3. This is particularly true when it comes to attracting human resources who compare it with places such as Sendai located in local centers which can also guarantee many of the high standards of big cities such as the proper educational and living environments.
4. In addition to the decrease in the number of children per family, those from localities are finding it difficult to leave their parents' side as well as the localities themselves when they seek employment in the Tokyo Metropolitan Area.

Among the four, reasons 1 and 2 arise as part of the soaring land prices, however reasons 3 and 4 have nothing to do with property prices. And while some form of future government policy or measure will force land prices in the Tokyo Metropolitan Area to eventually drop, nothing will actually change the situation for the reasons 3 and 4.

The decreasing mobility of human resources and soaring land prices in the Tokyo Metropolitan Area increase the system cost C_1. On the other hand, the infrastructure in

Japan's technologically advanced society greatly reduces the system cost C_2. Therefore, at least in the vicinity of Sendai City, the system cost C_2 is regarded as less than or equal to C_1. Then from our proposition, the effect of uncertainty can be negligible and we can conclude that the multi-office system is becoming widespread near Sendai.

THE DISTRIBUTION AND "MISMATCH" OF HUMAN RESOURCES

Thus far, we have implicitly assumed that linking pin members are living and working principally in the local city, while commuting into Tokyo several times a week for necessary meetings and appointments. But the mismatch problems of human resources are magnifying the importance of another type of multi-office system in the near future.

Companies which are setting up their factories in the Tohoku Area expect to find competent and low-cost production workers in particular. However, in reality, the mere acquisition of production workers for this labor-intensive and low-cost production is just one side of the question. It is equally essential to be assured of an adequate technical staff in order to adjust to the diversification and transformation of operations in the near future. Companies confront problems in their efforts to localize.

To illustrate them, a manufacturing subsidiary of a major precision machine enterprise, Company C is a symbolic example. This company was set up near Sendai City in 1973; its reasons for selecting to operate in the Tohoku region were the Tokyo Metropolitan Area-centered development of the headquarter's factory and its facility in obtaining high quality human resources. Because it is a process-assembly type manufacturer, it is labor intensive particularly in terms of blue-collar workers. The advantage of the Tohoku region is not only the generally lower salaries of young male and female high school graduates but also the possibility of finding higher quality human resources than in the Tokyo Metropolitan Area at the same wage rate.

Nonetheless, female high school graduates in the Tohoku Region have different working patterns. In the Tokyo Metropolitan Area where the number of nuclear families is increasing, women marry and leave their jobs to have children. On the other hand, in the local farming areas, they already have a home, live either with or in proximity of their parents, home, and have a place to leave their children. Their salaries are higher than the other local industries, and therefore even after marriage and the birth of their children they continue working much longer. In other words, these woman were undoubtedly highly capable and inexpensive labor when first hired, but become increasingly expensive due to the Japanese seniority system of gradually increasing wages over time. For the labor intensive-low cost industries this is a dilemma. When labor costs increase, the only choice is to compete in high value-added products; however a competent technical staff including university and technical college graduates as well as high school graduates is also needed. These companies moving outside Tokyo which have intended to adjust to the distribution of blue-collar workers are also adjusting to another distribution of technical staff. Companies such as Company C which are setting up in the Tohoku region expect to find competent, low-cost workers. However, in reality, the mere acquisition of blue-collar workers for this labor-intensive and low-cost production is just one side of the question; it is equally essential to assure that there is an adequate technical staff which can adjust to the diversification and transformation of operations.

The data collected in late February 1990, by the Tohoku Regional Development Research Center may be used to clarify the actual state of affairs and the shortage of personnel in the manufacturing sector in the seven Tohoku prefectures (see supplementary data for methodology). As shown in Table 1, the labor shortage for the entire process assembly industry's factories was at a high 92.2%. Independently of the scale of employees and the period during which the factory was set up, Table 1 shows a tremendous labor shortage. The results of the survey reflected the favorable economic conditions which Japan experienced at that time. However, the apparent uniformity disappears when viewed closely.

Table 2 shows the percentage ratios for the shortage of personnel by profession. According to the table, the shortage of the blue-collar workers was 78.8% or approximately 80%. A similar ratio was calculated for the technical staff which reached the high level of 72.5%. By contrast, office workers only accounted for a 37.0% shortage. Therefore, blue-collar workers and technicians were the central focus in particular: the unskilled accounted for a high 53.0%; electric and electronic technicians for 54.0%; machine technicians for 42.2%; and information processing technicians for 26.2%.

Next, the reasons for the shortage and the relationship with the types of professions were explored. In 1990, the primary reasons why the 389 companies surveyed needed greater numbers of employees were: "expansion" (165 companies or 42.4%); "product diversification" (163 companies or 41.9%); "operational diversification" (58 companies or 14.9%); "restructuring", i.e., the current products were to be abandoned and new ones developed (2 companies or 0.5%); "supplement to retiree vacancies" (172 companies or 44.2%). The responses were multiple, and Table 3 supplies the correlation coefficients for determining the reasons for the shortage profession. In factories where the reasons were expansion or supplement to retiree vacancies, i.e., quantitative changes in the operations and employee scale, the shortage of blue-collar worker was strongly perceived. Factories which were pursuing qualitative changes in their operations such as product diversification, tended to perceive a great shortage of technical staff members. Close observation of the occupation types of those who specified "expansion" of operations, indicated a labor shortage most acutely perceived in the lack of unskilled workers and machine technicians used in process supervision and who were directly involved in the factory expansion. Consequently, factories which indicated "supplement to retiree vacancies" as their reason for the shortage, felt the need for a greater number of employees for office work and unskilled manufacturing. While these factories adjusted to quantitative changes, those which mentioned "product diversification" must face qualitative changes. Those producers of high value-added products were in need of electric and electronics technicians as well as work supervisors; and those who cited "operational diversification" as their reason were creating new operations which required research specialists and those related professionals. In sum, the reasons for the shortage were closely related to the occupational category.

Finally, independently of the factory's scale and the period during which it was established, uniform levels of employee shortages were found; nonetheless, the reasons for the shortage were not identical. Favorable economic conditions leading to the subsequent expansion of operations and mid-career retirement brought about a shortage. In other words, external factors caused the shortage, especially in the manufacturing sites where blue-collar workers are largely unskilled. However various types of aggressive management such as product and operational diversification, also lead to a parallel shortage of technicians. Research specialists important for producing creative operations as well as high value-added features, and essential to the technical industries as in electric and electronics industry were also in high demand. Therefore, grasping the difference between the two shortages, the general one and the shortage of technicians is important. What is problematic is that while the Tohoku region is plentiful in capable, inexpensive blue-collar workers, it is not certain that it can provide an adequate supply of technicians.

The distribution of blue-collar workers will remain concentrated in the localities, and technicians in the Tokyo Metropolitan Area and the central local cities. For example, since Company C decided to set up in Sendai City which has universities and technical colleges with departments of science and engineering, it is fortunate to have a constant source of technical staff. However, for others, the situation is generally more difficult. As was explained above, the transportation system is often used by technicians and managers commuting to and from the Tokyo Metropolitan Area.

A SOLUTION TO THE JAPANESE MISMATCH PROBLEM

As mentioned in Table 3, aggressive management such as product and operational diversification lead to a shortage of technicians, but it is not certain that the Tohoku Area can provide an adequate supply of technicians. Hence, as was explained above, the transportation system can be often used by technicians commuting to and from the Tokyo Metropolitan Area. In this case, linking pin technicians are living and working principally in the Tokyo Metropolitan Area, while commuting into the local city several times a week for necessary meetings and appointments. Thus, the development of the multi-office system can be also a solution to the Japanese mismatch problem of human resources:

1. Factories and manufacturers are moving toward greater localization expecting to find high quality production workers. However, there is a "mismatch" between the distributions of production workers and technicians, which must be remedied.
2. The highly trained technicians are especially scarce even in Tokyo. Without sharing these important human resources through the multi-office system, factories in any part of Japan cannot work to their fullest and cannot climb up the technology ladder.

These problems did not occur at migration's peak when people were attracted to Tokyo for both economic and psychological reasons. However, it has become necessary for companies to incorporate the personnel with the geographic stability career anchor. It is impossible to centralize the various types of human resources in an area to unify their distributions. Under such circumstances, it becomes a fair working solution of the mismatch problem to unify the distributions of people by "straddling" them between multiple offices, i.e., by allowing mixed strategies. In game theory, equilibrium is not necessarily achieved by the pure strategy, but it is achieved by the mixed strategy. With such a mixed strategy, today's advanced technology society can achieve equilibrium by individuals who choose to "straddle" themselves between multiple offices.

APPENDIX: METHODOLOGY

The survey was conducted in the seven Tohoku prefectures (Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima, Niigata). From the 2,500 factories in MITI's *Complete Survey of Japan's Factories 1988*, all of those with over 100 employees as well as one-fourth of those with less than 100 employees were selected by random sampling. Questionnaires were sent by mail in late February 1990, and about 40%, or 917 companies responded. With the type of selection procedure used in this survey, there was a definite bias towards relatively large factories. Moreover, it should be noted that in reality almost 90% of the factories located in the Tohoku region have less than 100 employees, but the factories with under 100 persons occupied under just 40% of those surveyed. In this paper, the 422 factories, or 46.0% were assembly-processing types, and the analysis pertaining to the shortage of regular employees was limited to them. The so-called assembly processing factories refer to the following types of industries: metal goods manufacturing, general machine products, electric machines and appliances, shipping machine tools and the precision instruments industries. A correlation is not statistically significant (Cramer's V=0.089; χ^2=6.493) in the cross tabulation of Table 1 between the scale of employees and the period during which the factory was set up. Furthermore, Table 1 also indicates the proportions of the factories answering a shortage of employees, but the two-way variance analysis did not produce any statistically significant results. Among the 422 factories surveyed, the number of factories indicating a shortage was limited to 389. For further details concerning the survey see: *Tohoku ni okeru Kogyo Haichi no Henka to Jinzaijukyu Kozo* (*The Allocation of Factories in the Tohoku Region: the Changes and the Structure of the Supply and Demand of Human Resources*) published by the Tohoku Regional Developmental Research Center, July 1990.

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Table 1. Labor Intensive/Low Cost Factory Distribution and the Shortage of Employees.

The number of regular workers	The period during which the factory was set up -1969	1970-1979	1980-1989	Total
1-99	43(97.7)	63(93.7)	55(92.7)	161(94.4)
100-199	48(91.7)	46(89.1)	34(88.2)	128(89.8)
200-	42(88.1)	50(92.0)	28(96.4)	120(91.7)
Total	133(92.5)	159(91.8)	117(92.3)	409(92.2)

In parentheses is the percentage of factories which indicated a current labor shortage.

Table 2. The Human Resource Shortage over the Past Year by Profession (Multiple Answer).

Shortage of Employees by Profession	
Blue-collar worker*	306(78.7)
Skilled worker	127(32.6)
Unskilled worker	206(53.0)
Other	39(10.0)
Office worker*	144(37.0)
Manager	26(6.7)
Supervisor	47(12.1)
Operative worker	49(12.6)
Planning and marketing	23(5.9)
Sales	44(11.3)
Other	13(8.5)
Technical staff*	282(72.5)
Researcher	33(8.5)
Information processing	102(26.2)
Agriculture and food	1(0.3)
Refining of metals	10(2.6)
Mechanics	164(42.2)
Electronics	210(54.0)
Chemicals	20(5.1)
Sanitary engineer	28(7.2)
Other	19(4.9)
Total	389(100.0)

* The number of factories indicating a shortage in at least one of the professional types in each of blue-collar worker; office worker; technical staff.

Table 3. The Shortage of Employees by Profession and the Reasons for it: Correlation Coefficients of 2×2 Cross Tabulation (N=389).

Shortage of Employees by Profession	Reason				
	Expansion	Product diversification	Operational diversification	Restructuring	Supplement to retiree vacancies
Blue-collar worker	0.142**	-0.041	0.007	0.037	0.198***
Skilled worker	0.046	0.042	0.047	0.027	-0.013
Unskilled worker	0.132**	-0.003	-0.025	-0.004	0.207***
Other	0.025	-0.023	-0.068	-0.024	0.013
Office worker	-0.022	0.072	0.053	0.019	0.079
Manager	-0.001	0.002	0.032	-0.019	-0.010
Supervisor	0.049	0.101*	0.022	-0.027	-0.012
Operative worker	0.035	-0.024	-0.050	-0.027	0.239***
Planning and marketing	0.005	0.074	0.048	0.134**	-0.004
Sales	-0.060	0.075	0.078	-0.026	0.074
Other	0.043	0.103*	0.002	-0.013	-0.079
Technical staff	0.039	0.150**	0.112*	0.044	-0.031
Researcher	0.037	0.059	0.132**	-0.022	-0.067
Information processing	0.068	0.086+	0.095+	0.039	-0.142**
Agriculture and food	-0.044	0.060	-0.021	-0.004	-0.045
Refining of metals	0.091+	-0.105*	0.023	-0.012	0.019
Mechanics	0.120*	-0.018	0.081	0.011	-0.005
Electronics	0.072	0.167***	0.097+	-0.006	-0.061
Chemicals	0.059	0.038	0.099+	-0.017	-0.114*
Sanitary engineer	0.023	0.005	0.023	0.119*	0.032
Other	-0.074	-0.023	-0.028	-0.016	0.086+

(+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$)

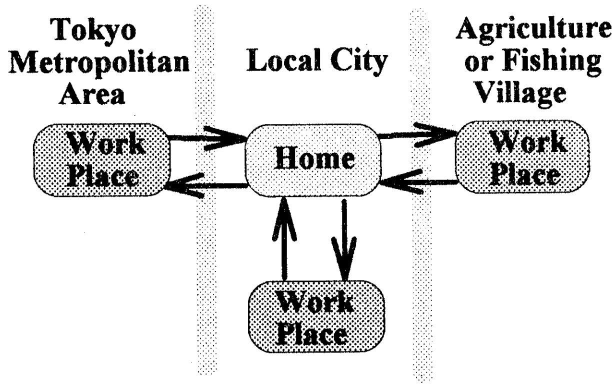

Figure 1. Local City as Primary Place of Residence.

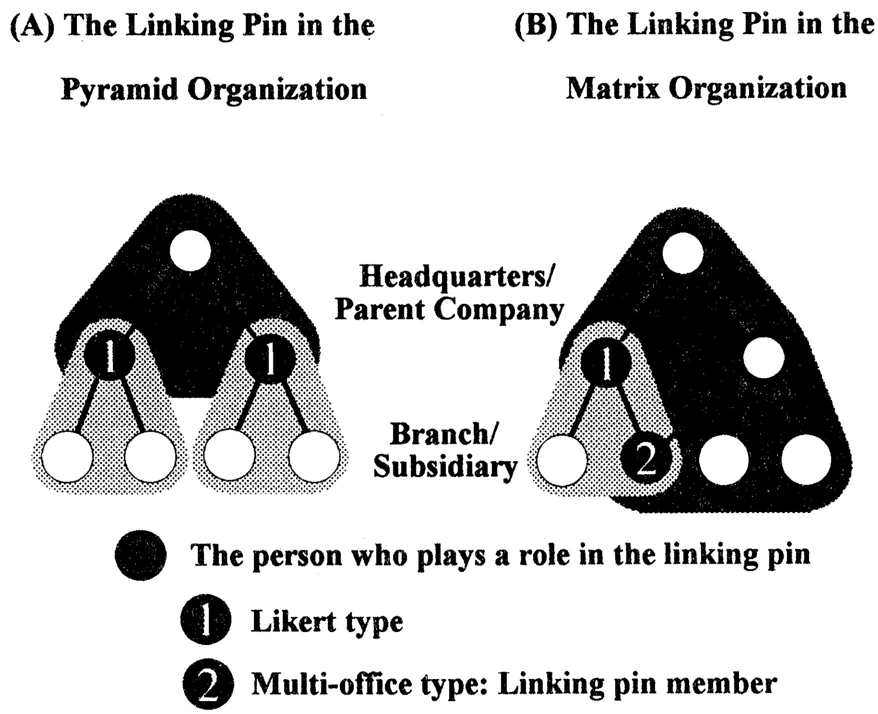

Figure 1. Organization Structures and Linking Pins.