

Eric I Miller

## The Ahmedabad Experiment Revisited Work Organization in an Indian Weaving Shed, 1953-1970 <sup>(1)</sup>

A. K. Rice, in *Productivity and Social Organization: The Ahmedabad Experiment* (1958), described an experimental reorganization of weaving in an Indian textile company. In the experiments, which were carried out in 1953/54 and which involved both automatic and nonautomatic looms, semi-autonomous work groups were formed with responsibility for production and routine maintenance on a group of looms. Rice's work was the first attempt to apply the concept of a socio-technical system to the design of a production process and the experimental changes resulted in substantial improvements in output, quality and work satisfaction. Rice and the author also worked with this company in implementing a set of changes in organization and management (cf. Rice, 1963). Subsequently, the experimental forms of group working were extended to other loom sheds in the company's mills.

In 1970, the author, with a colleague, undertook a follow-up study of this "group system" in four locations in the company. These included the two original sites and two other loom sheds in which this method of working had been introduced later. The study showed that the work organization and levels of performance in one of the original sites had remained virtually unchanged over the 16 years. In a newer automatic loom shed, group working had largely disappeared; regression had also occurred in both the other sheds studied. Explanations are offered for these differential outcomes and there is a discussion of resilience in systems of work organization.

The concept of the *socio-technical system* was developed at the Tavistock Institute nearly 40 years ago (Trist and Bamforth, 1950). Showing that a production system could be analyzed in terms of the symbiotic relationship of two systems, the technical and the social, the Institute began a productive search for "the 'right' organization that would satisfy both task and social needs"; somewhat later, however, it was recognized that "there are settings

(1) The original version of this paper appeared as E. Miller, "Socio-Technical Systems in Weaving, 1953-1970: A Follow-up Study," in *Human Relations*, 28:349-86, 1975. A shortened and slightly revised version was reprinted in *Organizational Democracy and Political Processes*, edited by C. Crouch and F. Heller. Chichester: John Wiley & Sons, 1983. It is the latter, with slight editorial changes, that is reproduced in this volume.

where elegant solutions of this kind cannot be found or where, if found, they introduce new and intractable constraints" (Miller and Rice, 1967:xii).

In Rice's work in 1953 at The Calico Mills, Ahmedabad, India, (2)

Attempts were made to take into account both the independent and inter-dependent properties of the social, technological and economic dimensions of existing socio-technical systems, and to establish new systems in which all dimensions were more adequately inter-related than they had previously been. (Rice, 1958:4)

In three papers (1953, 1955a, 1955b) and in the book from which the above quotation is taken (*Productivity and Social Organization: The Ahmedabad Experiment*) he describes an experimental reorganization of weaving, first in an automatic loom shed and second on nonautomatic looms. In both instances, internally led groups of workers were formed, each group being responsible for production and line maintenance on a group of looms.

The book also describes concomitant changes in management organization that the company introduced while Rice was acting as consultant during the period from 1953 to 1956. The story of management reorganization up to 1961 is continued in Rice's second book, *The Enterprise and Its Environment* (1963), which also gives updated information on the two loom shed experiments.

This work of Rice's has been widely cited. For example, it is described by Katz and Kahn (1966:455) as "by and large....an amazing success story." McGregor (1960, 1966) refers to it as a case of collaboration leading to integration; Myers (1959) as an example of involving workers in shop-floor decision making; K. Davis (1962:497) as an example of a work situation promoting group cohesiveness; and Likert (1961:38-43) as illustrating how such cohesiveness can result in better performance figures. Building directly and indirectly on Rice's early experiments and the work of Trist and his research team, autonomous group working proliferated during the 1960s and 1970s in many different countries in a wide variety of factories and offices.

For the most part, Rice's methodology has been either accepted or actively praised, for example by L.E. Davis (1967). Vroom and Maier (1961:438) are more cautious, saying that it is "difficult to draw unequivocal conclusions concerning the underlying processes." One dissenting voice is that of Roy (1969), who criticizes the methodology and suggests that in his interpretation

(2) Calico Mills" is the name by which the Ahmedabad Manufacturing and Calico Printing Company is generally known. In the rest of this paper we refer to it simply as "the company." This is to avoid confusion since one of the spinning and weaving units within the company's Textile Division carries the same name. This latter we call "Calico Mill " or "Calico." The other spinning and weaving unit with which this paper is concerned is "Jubilee Mill" or "Jubilee."

of the results he achieved Rice had greatly underestimated the extra cash incentive to the group workers.

Rice was to have revisited the company in his consultant role in 1969. Part of his task was to examine the implications for work organization of further technological change in the textile industry. This visit had to be abandoned because of an illness that led to Rice's premature death toward the end of 1969. The author, who had during 1956-58 worked for the company as an internal consultant in collaboration with Rice, went as a substitute for him for one month in July/August 1970. This seemed to be a good opportunity to review the present state of the socio-technical system that Rice had helped to introduce, to analyze changes that had occurred and to try to refine the assumptions on which the original system was designed. Permission was sought from the company to deploy a second Tavistock staff member, A.F. Shaw, in a research capacity. (3)

In addition to observation and study of performance records, individual interviews and group discussions were held with a substantial number of workers, both in the original experimental areas and in the loom sheds where forms of group working had been introduced later. (Other textile companies in Ahmedabad also adopted or adapted the Calico approach; but that experience has not been studied.) Our data spanned a period of 17 years.

## The Experiments and the Outcomes

The site of Rice's first experiment was the automatic loom shed at Jubilee Mill (here called "Jubilee Auto"), which in 1953-54 contained 288 looms. After nine months a second experiment was initiated on 120 nonautomatic Lancashire looms at Calico Mill ("Calico Exp").

Graphs showing follow-up performance figures in both experiments during the period 1954-60 are given by Rice in his second book (1963: 111-12). Higher levels of efficiency reached during the experimental phases were largely sustained and, in the case of the nonautomatic looms, even slightly improved during the subsequent six years. Similarly, the levels of damage went down and stayed down.

Comparisons of performance data need to be treated with a good deal of caution. It is virtually impossible to make precise comparisons between dif-

(3) Social Science Research Council grant covered Shaw's travel to and from India and also salary costs; while in India Shaw stayed as a guest of the company. I would like to thank both these groups for making this work possible. I am also grateful to Shaw for his preliminary analysis and interpretation of the data.

ferent types of looms weaving different types of cloth. "Before and after" comparisons on the same looms weaving similar types of cloth are more reliable. Apart from minor changes that may be made in the methods of calculating efficiency and in inspection standards, however, a reduction in loom speeds can lead to improved efficiency figures but a decline in output. Efficiency is measured in terms of the number of "picks" (weft threads) inserted during a given period (usually a shift) expressed as a percentage of the number that would have been inserted if the loom had run continuously throughout the period. Speeds were adjusted during the first experiments but, so far as could be checked, not subsequently. The performance data therefore probably do show real trends. It has also to be noted that, although fluctuations in the quality of yam can increase or decrease the work load on the looms, in the form of organization designed by the workers in consultation with Rice and agreed to by management, provision was made to increase or decrease the number of workers according to sample measurements of the number of breaks occurring in the warp and weft yam. Thus, although labor productivity would change, the broad levels of efficiency and damage should remain substantially the same. Maintenance of the looms, which also affects both efficiency and damage, is the responsibility of the group in this type of work organization. There are, however, limitations on the extent to which the work group can offset the consequences for efficiency and damage of poor quality of supplies (such as shuttles) and spare parts (see below).

In 1956-57, group working was extended to the so-called Pit Shed at Calico (Calico Pit), which had 440 nonautomatic looms. During the 1960s, Jubilee Auto was enlarged, with the addition of 128 looms of a different type, and the company installed a large new automatic loom shed at Calico with 656 looms, on which group working was also introduced (Calico Auto).

Over these 17 years, progressive changes were occurring in the company's market and sources of supplies. Since the early 1950s it had been the avowed policy of the management to raise norms of productivity and quality, and Rice's experiments themselves were designed as a means to that end. The effects of this policy were reflected in the company's record of profitability, which was surpassed by few other mills in India (Rice, 1963:108). As the company enhanced its reputation for design and quality in the Indian markets and correspondingly was able to command a progressively higher average price per yard of cloth sold, its management aspired to becoming increasingly competitive in export markets, not only within the relatively less developed countries of the Far East, the Middle East and Africa but also in the more stringent markets of the West—for example, shirting for the mass-production garment industry, which demands continuous pieces of flawless cloth.

There were two significant constraints. First, there was a limited availability of the long staple cottons required for the finest and most profitable fabrics,

since these had to be imported, mainly from Egypt, and India had maintained a tight control over imports for many years. To make full use of this raw material, high standards were demanded in spinning and weaving. Second, governmental regulations, imposed to protect the hand loom industry, prevented the installation of additional power looms. There was little scope for increasing profits through expansion and consequently greater emphasis on productivity and profit per loom. Top management pressures to maintain and improve quality and output were thus strong and persistent.

Import controls also restricted availability of loom spare parts and supplies. Domestically manufactured substitutes were often of low quality. This situation led to damage and reduced efficiency and to some deterioration in the general condition of the looms.

It is in this context that the developments in work organization have to be considered. For ease of presentation I shall depart from the chronological sequence and first discuss the experience with nonautomatic looms-Calico Exp and Calico Pit before considering the automatic loom experiment and subsequent developments. My accounts of the original experiments are inevitably abbreviated and oversimplified. Readers are referred to Rice's publications for the detailed material.

## Calico Exp

On the nonautomatic looms at Calico, the presenting problem was to improve quality. The looms were operated on two shifts; low output and high damage made three-shift working uneconomical.

In the conventional work system, each weaver operated two looms and was responsible for some ancillary activities such as collecting weft yarn and delivering woven cloth, other workers were also involved: jobbers (for loom maintenance and supervision of weavers), beam carriers, oilers. In the experimental shed set up in January 1954, small work groups were constituted to perform all the tasks of weaving and maintenance on groups of 40 looms, all of which wove the same kind of cloth continuously. Five natural grades within a work group were found: group leader, smash tender/assistant group leader, front loom worker, back loom worker and helper. These group members performed interdependent tasks and formed interdependent relationships. An aggregate of 22 workers in the conventional system was replaced by an internally structured group of 11. Minimum basic rates were raised. Bonuses were paid for both quantity and quality and, at the workers' own request, reflected group rather than individual performance.

The experimental period lasted 10 months (January-November 1954),

during which time both management and workers progressively "tested-out" each other's sincerity and willingness to cooperate. Gradually permissive and collaborative relationships were assisted by the institution of informal group meetings and of more formal conferences. In the conferences the whole executive chain responsible for production was present and, at the workers' request, all shifts attended the same conferences, some coming during their free time.

During the initial phase the quality of cloth actually declined, but then it steadily improved. By the end of the experimental period, both quality and efficiency had settled down at a significantly higher level than in other loom sheds. One factor in improved quality was a reduction in loom speeds of 11 percent. Despite efficiency increases, therefore, output per loom hour was actually reduced. On the other hand, labor productivity increased substantially and this, in conjunction with the higher average price per yard obtainable from the improved cloth, made three-shift working viable. Compared with the existing two-shift two-loom system, the experimental three-shift group system showed the following results: the mean earnings of the group were 55 percent higher; the cost per loom was 13 percent higher; the output was 21 percent higher; and the number of damages 59 percent less. These results were achieved on the most difficult sort (4) regularly woven in the mills.

Rice concluded:

The immediate practical result of the experiment has been to demonstrate that in the Calico Mills the breakdown of the "whole" task of weaving into component operations, each performed by a different worker, and the re-integration of the workers into an internally structured work-group that performs the "whole" task on a group of looms, can be accomplished in one process provided that permissive and collaborative relationships can be built up between all those concerned. ...The experimental system has established new norms of performance and earnings for nonautomatic weaving. The conclusion was reached that the acceptance of the new system and the determination to make it work were due to its providing more opportunities for effective task performance and for the building of more stable and secure small work-group relationships than those existing in the conventional system with which the traditional norms of performance and wages were associated. (1958: 166)

The 1970 version of the group system conformed closely to that described by Rice (1958). The shed contained, as in 1954, three blocks of 40 looms, operated by nine work groups over the three shifts. Within each group there were five roles. The group leader (A), the assistant group leader (B +) and the

(4) 'Sorts' or types of cloth are classified by the "count" (thickness) of yam and the number of warp and weft threads to the inch.

sweeper/general assistant (E) comprised the gating (5) and maintenance sub-group. The weaving sub-group consisted of B workers operating on the fronts of the looms, shuttling and mending the front warp, and C workers on the backs, mending the back warp and engaging in fault prevention. The size of this sub-group depended on the work load as measured by the current rate of warp and weft breakages. At the time of the follow-up study the most usual numbers were four or five Bs and four Cs, giving an overall group size of 12 to 13. The range was 10 to 15.

**Table 1** compares efficiency and damage in Calico Exp during 1969-70 with the last phase of the 1954 experimental period. On both indices, the 1969-70 performance is slightly better than that of 1954 and, indeed, for the whole period up to 1959, but not as good as that for 1959-60 (see Rice, 1963:112).

It seems safe to assume that no significant change had occurred in standards of performance over the 16-year period. Indeed, there is one quite remarkable piece of evidence indicating that they had remained unchanged. Rice noted that performance on one block of looms was consistently superior, in terms of efficiency and damage, but no reason for this could be discovered and "by the end of the experimental period there had been no conclusive explanation" (1958:114). Fifteen years later, the performance data for 1969-70 showed precisely the same pattern.

In general, not only the structure of the groups but also the method of working was hardly distinguishable from that which had been developing during 1954. During his observations, the field worker was impressed by the smooth rhythm of working. All members seemed to know exactly where and in what combination with others they could be most appropriately deployed at any given moment. Rice's description of a group culture of mutual helping between sub-groups and individuals still held true.

The fact that the group leader had a managerial as well as a maintenance role was accepted and sanctioned by group members generally. Group leaders saw the management of boundary transactions as their responsibility. They checked the group's inputs and outputs and mediated relations with the rest of the organization. Other group workers would not contact supervisors directly. Supervisors, on the other hand, felt it was their duty to approach workers directly if, for example, there were signs of slackness. Group leaders countered this by ignoring shift supervisors and the section head and going directly to the weaving master of Calico as a whole if they had problems. By doing this they were reasserting the historical privileged position of the experimental

(5) "Gating" is the installation of the beam of warp yam and threading of yam onto the loom.

**TABLE I** Calico Exp: Efficiency and Damage, 1954 and 1969-70

<i>Period</i>	<i>Index of % efficiency</i>	<i>Index of damages per 1000 yards</i>
July-Nov 1954	100.0	100.0
Jan-June 1969	101.0	79.7
July-Dec 1969	101.1	82.3
Jan-June 1970	100.3	96.9

shed, for the weaving master had himself been a shift supervisor there in 1954.

In practice, supervisors seldom exercised their "right" to intervene within the groups.

## Calico Pit

The nonautomatic looms in this shed had been converted to group working in 1956-57. In size and composition, the groups were identical to those in Calico Exp. In Calico Pit, however, there was a greater variation in deployment between one group and another. Although B workers were always held to be more skilled than C workers, the managerial view that B workers should operate at the fronts and C at the backs was not universally observed in practice. (Front work was theoretically held to be more responsible because it was from this position that the loom could be started and stopped, and also more skilled in terms of the type of mending required.) In a few groups B and C workers had the same roles but worked different numbers of looms. There were also differences between groups in the extent to which workers were rigidly allocated to a specific number of looms or allowed and encouraged to overlap with neighbors within a group. In general, there was more rigidity in Calico Pit than in Calico Exp. In one pattern observed in groups in Calico Pit, four B workers each worked front and back on six looms and four C workers each worked front and back on four looms.

In 1969-70, efficiencies in Calico Pit were 3.5 to 5 percentage points lower and damage rates 4 to 7 times higher than in Calico Exp. Performance in Calico Pit was said to have been always inferior, but in the absence of earlier records it is not possible to say whether the difference had remained stable or widened. According to managers, the only significant technical difference between the two sheds was that humidity in Calico Exp was somewhat more favorable for weaving; but this is insufficient to explain the persistent performance gap.



There were, however, notable differences in the role of the group leader and the relation of the groups to their environment. In some groups, as in Calico Exp, all official contact between group members and the rest of the mill was mediated through the group leader. In other cases group leaders seemed hardly aware of the input and output of their groups and would not be informed by group members of transactions with shift supervisors or with other sections of the weaving department.

Direct intervention by shift supervisors in the operation of the groups was much more common than in Calico Exp. Partly, as already noted, this was because Calico Exp group leaders had maintained the habit of approaching the weaving master directly if they had problems. Partly, too, it was because the supervisors felt it necessary to contact workers only when group performance was deemed to be poor and then, by their own accounts, they spent three-quarters of their time with the three or four groups that had the poorest production and quality figures. Since performance in the Calico Exp was seen as consistently satisfactory, there was no reason for supervisory intervention.

The working assumption of the supervisors in Calico Pit was that poor performance in the group was something to be remedied by intensive supervision of individuals within it; it was held to be a phenomenon for which the group, through its leader, could be held accountable and called upon to correct. Thus, the accepted mode of intervention undermined both the authority of the group leader and the possible collective responsibility of the group for its members' performance. It was certainly inconsistent with Rice's conception of the group system.

In terms of perception and attitudes there was a great deal of similarity between Calico Exp and Calico Pit. All the supervisors and group leaders and most of the workers described the group system as having two distinctive characteristics:

It required cooperation between group members.

There was a differentiation of the weaving task into work on the front and the back of the looms.

About half the workers regarded the former and half the latter as the most distinctive feature which marked off the group system from other working arrangements in weaving.

The group workers saw themselves as having higher status than those under conventional working arrangements. In Calico Exp this was linked especially with their historical success in increasing efficiency and quality compared with the previous system of working.

This feeling of higher status was evidently not linked to pay. The fact that

they earned more money was perceived rather as something that bound them to the group system and prevented them from moving elsewhere, even though some of the older workers said they felt tired and overworked. There was a commonly held belief among workers on nonautomatic looms that work in the group system was so hard as to shorten one's life. It was also said that the higher work load led to a need for better quality food, which in turn offset some of the advantages of higher wages.

The idea of cooperation among group members was highly valued. Correspondingly, the major complaints about the system were that some or all workers did not cooperate and that the team spirit that was supposed to exist was sometimes not in evidence. Workers spoke of having to "carry" fellow group members who were slow, old, lazy or troublesome. For example, one group leader spent a large part of his working day resting outside the weaving shed. Members of his group were resigned to this but not resentful. The assistant group leader on whom a larger part of the work had fallen said, "We have been together a long time-he deserves a rest." Workers were reluctant to criticize unproductive fellow group members. This was thought to be a prerogative solely of the group leader.

In spite of complaints about diminishing team spirit, group identification appeared to be quite high. Differences between groups were readily observable in style and pace of working. Physical boundaries between groups were especially noticeable during the festivities of the Hindu New Year. Some looms had been decorated with flowers, leaves, colored paper and balloons and others had either remained undecorated or had been garlanded in distinctive styles. Group identification was encouraged by publication of monthly production figures, which seemed to promote a spirit of inter-group competition. Workers frequently used the words "we" and "us" in reference to their groups. They spoke of being especially friendly with fellow group members and of sitting together with them during rest breaks.

## Jubilee Auto

The position in 1953 was that 224 (rising later to 288) automatic looms had been installed with an expectation of considerable improvements in output and quality; but actual performance was no better than with conventional looms.

Rice's analysis of the work organization showed that the weaving process had been broken down into component tasks and that the number of workers assigned to each component had been determined by work studies. The resultant pattern was of an aggregate of individuals with confused task and role relationships, ambiguities in accountability and no discernible internal group structure. Rice postulated that on automatic looms the title of "weaver" for an

occupational role was no longer appropriate: the weaver was now the loom, and all workers, including "weavers," serviced machines. The tasks performed could be differentiated into two main types: those concerned with weaving and those concerned with gating and loom maintenance. There were, in addition, only minor ancillary services. Rice then proposed the idea of a group of workers for a group of looms. The theoretical numbers required for blocks of 654 looms were calculated. Three "11 natural" grades within a work group were identified, instead of the existing nine grades. These grades were designated by letters. Workers coming into these grades would be paid a slightly higher rate than before, and it was also decided to pay piece rates on the basis of the performance of the group as a whole.

Loom shed supervisors and workers spontaneously took possession of the reorganization, the workers themselves immediately organizing four experimental internally led small groups. This was in March 1953. These groups abandoned the old titles, using only the new letter grades. After an immediate increase in efficiency at the cost of increased damage and inadequate maintenance, they settled at a new level of performance in which efficiency had risen from just over 80 percent to around 90 percent, while the percentage of damage had improved from 40 percent before reorganization to an average of roughly 20 percent.

When the form of organization was extended to the rest of the shed, and a third shift started, the efficiency was maintained for several months, but in October and November of 1953 it dropped steeply over a period of five weeks. At the same time the figures for damage rose steadily. Investigation showed that each group had to contend with variations in the sort woven; there had been insufficient spare workers; training of new and existing workers in the new methods of organization had been neglected and also diffused throughout all groups; and the basis on which the original experimental groups had been formed had not allowed sufficient time for group leaders to perform the task of leading. As a result of the difficulties caused by these factors, group members had regressed to earlier working habits more appropriate to individual than to group working.

Various corrective measures were taken, including establishment of basic rates of pay, segregation of training from production and reduction of the variety of sorts in any one group. Recovery was rapid.

It was concluded that the first spontaneous acceptance of the new system and the subsequent determination to make it work were due primarily to the workers' intuitive acceptance of it as one which would provide them with the security and protection of small group membership which they had lost by leaving their villages and their families to enter industry. At the same time the new system allowed them to perform their primary task effectively and thus provided them with an important source of satisfaction. (Rice, 1958: 110)

In 1970, Jubilee Auto contained 240 "S"-type looms dating from the 1953 experiment and 128 "K"-type looms installed in the late 1960s. They were arranged in groups of 64 or 56 and all operated in three shifts. Most groups wove two sorts of cloth which were, on the whole, finer and more expensive than those produced on the Calico nonautomatic looms.

The 1969-70 performance figures for Jubilee Auto are given in Table 2, which suggests that on the "S"-type looms efficiency was slightly lower and quality higher than in 1954-55. It also points to a short-term decline in performance, in both efficiency and quality, in the "S" groups and to an opposite trend on the "K" looms, while the weighted average figures for Jubilee Auto as a whole, especially the figures for efficiency, remained remarkably steady over the 18 months. It is possible to surmise that Jubilee Auto was engaging in an unacknowledged process of setting new performance norms for the loom shed as a whole. This would be consistent with the fact that neither in methods of working nor in modes of supervisory intervention were the "S" and "K" groups observably different in behavior. They also had similar proportions of older and newer workers. However, it must be noted that the variation of the "S" groups was within the range of variation that occurred during 1955-60 when damage figures in particular showed marked cyclical rises and falls (Rice, 1963:111, Figure 19).

The original grades of workers in the experimental groups on automatic looms were described by Rice (1958:69) as follows:

- A: Overall group leader, working head of gating and maintenance subgroup.
- B: Fully skilled member of either weaving or gating and maintenance subgroup.
- C: Not yet fully skilled member of sub-group but has acquired enough skill to help with main sub-group tasks.
- D: Full members of group mainly engaged on less skilled jobs-battery filling, oiling, etc.
- E: New unskilled entrants not yet accepted as group members.

A, B and D were the "natural" grades; C and E were transitional. Subsequently the B worker in the gating and maintenance sub-group had been reclassified as a B + with a slightly higher rate of pay. This seems to have been a carryover from the grading on nonautomatic looms. The usual complement of workers in a group in 1970 was 1 A, 1 B+, 2 B, 2 C and 1 D-a total of seven-the Bs and Cs being members of the weaving sub-group. Moreover, C, instead of being transitional had become quasi-permanent; C workers were promoted to the B grade not when they had achieved the necessary skill but when vacancies occurred-and then on the basis of seniority.

In the experimental period of 1953, the group of 64 looms had been perceived as an entity for which the group as a whole was jointly responsible

and where there had been a great deal of mutual helping among the various categories of workers for example, members of the maintenance sub-group would help members of the weaving sub-group and vice versa. In 1970, the

TABLE 2 Jubilee Auto: Efficiency and Damage, 1954-55 and 1969-70

Period	"S"-type looms		"K"-type looms		All looms	
	Index of % efficiency	Index of % damage*	Index of % efficiency	Index of % damage*	Index of % efficiency	Index of % damage*
Dec. 1954-June 1955	100.0	100.0	—	—	—	—
Jan.-June 1969	97.8	67.8	88.1	125.5	94.6	87.1
July-Dec. 1969	96.9	78.7	89.9	122.0	94.7	93.0
Jan.-June 1970	95.2	91.8	91.6	109.3	94.1	97.8

\*The damage index is calculated from the percentage of cloth classified by inspectors as below standard quality a different measurement from that on the nonautomatic looms. Note that in the efficiency index higher is better and in the damage index higher is worse compared with 1954-55.

group was typically operated in two halves, with one or two B workers and one C worker responsible for a set of 32 looms. Moreover, while supervisors and group leaders tended to regard the 32 looms as a block, for the operation of which the sub-group of two or three workers was responsible, in practice the workers themselves also tended to allocate specific looms among themselves so that each C worker, for example, might be regarded as totally responsible for 10 to 16 looms.

This situation is strikingly reminiscent of the regression during the experimental period when the B grade workers had begun to take the warp mending on 32 looms each.

As the efficiency fell they expressed resentment about the group bonus and the participation in it of other group members .... The D grade workers, whose tasks included helping B grade workers by doing simple warp mending, reverted to battery filling only, each taking 32 looms. This left them underloaded despite the general overload. (Rice, 1958:94)

Rice indicates that as a result of steps taken during the follow-up period these regressive habits were corrected and the groups reverted to their previous cooperative methods of working. The actual methods of working observed in 1970, however, closely corresponded to those that Rice had described as regressed and, if anything, sub-tasks within the group were more sharply differentiated and there was less cooperation between different categories. For example, it now appeared exceptional for a group leader to help with weaving

subtasks. Consistent with this change was the fact that group leaders were more often than not referred to by the preexperimental title of "jobber," implying a reversion to the traditional role predominantly concerned with maintenance.

While group leaders appeared, and felt themselves to be, so preoccupied by their maintenance responsibilities that they had little time left for the other activities of their role, supervisors in Jubilee Auto, especially those more recently recruited, were confused about the work system. They were told to operate "the group system," yet the nature of this system was not clearly defined to them. Their experience was of being pressed for more production, but encountering a collective resistance from the workers against any such increase. Some supervisors would respond by trying to work through the group leader. Others would go straight to individual workers. In this, too, there were echoes of the 1953 regression:

Faced with the lack of group leadership and the regression to earlier work habits the supervisors themselves tended to regress to earlier patterns of management behaviour. They by-passed the group leaders and dealt directly with workers....The intervention by the supervisors in the organizing of group tasks tended further to destroy the internally structured leadership of the groups. (Rice, 1958:94-95)

Workers were confused by the variation in supervisory styles. A typical statement was: "Each officer has his own ways; then the workers just have to follow." But some believed that at least part of the responsibility for the situation lay farther up in the hierarchy, stating that "supervisors are now under pressure from above for more production but they work less hard themselves and just put pressure on others."

Perhaps because of the combination of the arbitrariness of the supervisors and the relative impotence of the group leaders in facilitating the task, there was much greater use in Jubilee Auto of union representatives as an alternative channel of communication between group members and departmental management. It was through these representatives, for example, that complaints about shortages of supplies or about the quality of spare parts were often passed.

The Jubilee Auto supervisors also constantly intervened in the composition of groups. In the Calico nonautomatic loom shed, group membership was highly stable. In cases of absence or increased work load substitutes would be brought in from a pool. In Jubilee Auto, on the other hand, though a similar pool existed, an absence or a vacancy in one group tended to lead to a consequential series of transfers between groups based on seniority. The group, through its group leader, had no say over the qualifications of the workers allocated to it. Thus the supervisors' approach to the allocation of resources implied that the groups were no more than transient sets of interchangeable individuals.

A third of the workers interviewed in Jubilee Auto claimed to have belonged to the 1953 experimental groups. These workers and long-service supervisors spoke of a characteristic of the system being "the working together of men as in families," the group leader being like a father and the other members like sons. Post- 1953 recruits were said to have had no training for group working as such. For example, the group leader of one group had been recruited directly into that position from another mill after only one day's tests of mechanical and maintenance skills. He had received no instruction about the characteristics of the particular work system he was to operate. The same applied to supervisors. Whether or not older employees were correct in saying that an increased work load over the past three years had inhibited cooperation and mutual helping, it was observable that the more recently recruited workers seemed most confused about what the group system involved. Although they were told that cooperation was the distinctive characteristic of the system, their experience was of taking responsibility for a specific number of looms and of neither giving nor receiving very much help. The unique characteristic, as many saw it, was that in this work system a group of workers operated 64 looms in two sets of 32, whereas in other mills a similar group would operate 48 looms in two sets of 24.

Some feeling of competition among groups and internally between half-groups was fostered by the posting of daily loom efficiencies on a notice board in the loom shed. When workers spoke about availability and quality of supplies it was also in terms of supplies for their own groups or half-groups. However, there was less identification with groups and competition between them than in Calico Exp, where those interviewed spoke a great deal about "our group" , in Jubilee Auto "we" referred as often as not to all the workers in the loom shed. They spoke of their friends as coming from throughout the shed and not specifically from their own groups. This may have been linked to the fact that, because of the policy for dealing with absences and vacancies, there was greater inter-group mobility. Although promotion based on seniority was recognized as being far from ideal because of the disruption it created, it was nevertheless held by management and unions to be the fairest and least corruptible.

Despite complaints about the group system, in particular about the "exploitation" of C workers, some of whom did the same work as Bs for less money, those interviewed generally expressed contentment with their jobs within Jubilee Mill. Jobs were held to be better there than in other mills, partly because wages were higher and were paid promptly; but greater emphasis was given to the belief that the mill had a good reputation, was free from corruption and offered safe employment. Group working as such was not cited as a distinctive source of satisfaction.

## Calico Auto

The new automatic shed at the Calico Mill had been started in 1962 and at the time of the follow-up study accommodated 656 automatic looms of five different makes. These were intended to weave the finest, most expensive sorts in the company's range.

From the outset it had been planned to operate these new looms with the group system developed in Jubilee Auto. The looms were accordingly arranged in blocks of 64 or 48, and some Jubilee people were transferred to the new department. However, many new people also had to be recruited to the supervisory staff and work force. For the most part these recruits did not have prior experience of automatic looms, which were not then common in Ahmedabad, so the opportunity existed to train them in the desired methods of working.

Buildup to levels of efficiency and quality acceptable to management had been relatively slow, but by the time of the study Calico Auto was, with certain ill-defined reservations, regarded as a success. Productivity and quality were perceived as comparing favorably with those in other Indian mills, though they still fell somewhat short of the "best international standards" to which the company, in its efforts to become a major exporter of fine cloths, now aspired.

It became apparent during the research that the actual method of working in this loom shed was very different from the type of group system that management outside the loom shed believed to be in operation. Although the weaving master in charge of the department knew that he was supposed to be operating a "group system," he was also aware of strong pressure to keep up production. He felt, correctly, that he was judged primarily by his department's efficiency and quality figures which, in fact, he had been successful in improving. To do this he had used methods which he had found successful elsewhere, instituting many checks on performance and closely supervising individuals.

The supervisory staff in the department knew, or thought they knew, the way in which a "proper group system" should be operated. Like some of their counterparts in Jubilee Auto they had the mistaken belief that B and C workers were supposed to be differentiated between tasks on the front and back of the looms, and they had the added misconception that C workers were supposed to be on the front and B workers on the back-the opposite of the method of working on the nonautomatic looms where this differentiation was appropriate - The weaving master, conscious of the contradiction between senior management's view of the socio-technical system in the automatic shed and the system that was actually in operation, sought at first to hide the situation from us. During the first phase of Shaw's visits to the sheds, section heads and supervisors were ordering their men to patrol all the looms in set routes and had



differentiated B and C workers in the way just indicated. Only when individual operatives were interviewed was this revealed. They had noticed the coincidence of Shaw's visits with the "new" work system. Since this method was so far removed from current work practices and also, one surmises, from the method of working introduced in the early days of this loom shed, it is hardly surprising that the short period of a few days in which this new system was in operation was reported to have been chaotic and, at least in retrospect, a matter of some amusement.

Formally, Calico Auto had the same five grades of workers as Jubilee Auto-A, B +, B, C and D, with A, B + and D workers concerned primarily with gating and maintenance. However, these letters were seldom used; the terminology was that of other mills. A and B + were "jobber" (or "tackler") and "assistant jobber"; B and C were "weavers", D was a "helper." B and C workers were specifically assigned to a number of looms which were regarded as exclusively their responsibility. If, as was often the case, the allocation was of two Bs and two Cs to a group of 64 looms, each would be responsible for 16 looms. If, as sometimes happened, the work load required an additional C worker, he would be available to help the other "weavers" on "their" looms. The actual method of working, therefore, was little different from that in other automatic loom sheds in Ahmedabad. Managerial and supervisory staff in the department acknowledged that many, if not most, of the C workers were as competent and qualified as the B workers but saw themselves as having a limited establishment for B workers. It was small wonder, therefore, that many workers reported that the only distinctive feature of Calico's so-called group system compared with other mills' working arrangements was that some weavers (the Cs) were paid 25 rupees a month less than other weavers (the Bs) for doing the same job. This grievance was the basis for a demand from the union to do away with the C category as a permanent grade of workers throughout the group system. In this respect, the demand was consistent with Rice's original conception of the group system for automatic looms in which the C grade was, for the individual employee, essentially transitional; when the C worker obtained sufficient experience and competence he would be promoted to the B grade. The grievance, however, was somewhat less relevant to the Jubilee Auto situation and less relevant still to the Calico nonautomatic situation where there remained a genuine differentiation of task between the B front workers and the C back workers.

If in Jubilee Auto there was some ambiguity and discrepancy in supervisory behavior, in Calico Auto there was practically none. Here the principal discrepancy, as already noted, was between senior management's conception of the socio-technical system of the automatic shed and the system actually in operation. Within the department it was the individual and not the group that was the object of supervision. As in Jubilee, there were frequent moves from one group to another.

However, the philosophy of individual supervision obviously raised questions about the role of the group leader. This led to some friction between some supervisors and group leaders. Shift supervisors were often straight out of technical college, had no production experience before joining the company and their average age was about 23. Group leaders were on average some five years older and had the benefit of accumulated practical experience. In interviews, both described many of their duties in an almost identical way: to be responsible for the efficiency and quality of the group of looms and workers, to check the maintenance of the looms and to report each day on the number of looms idle and workers absent. Group leaders expressed frustration at what they regarded as the poaching of their task by supervisors and at the discrepancy between their officially stated leadership responsibilities and the only one that was exclusively theirs—the allocation of work on the looms during tea breaks. Supervisors for their part expressed annoyance at having to attend to the maintenance and tuning of looms because, they claimed, the group leaders were not doing this properly themselves. Essentially, therefore, the corollary of direct individual supervision by the supervisors was the limitation of the group leaders to their maintenance role.

Many of the workers interviewed in Calico Auto made the same point as some of those in Jubilee—that the only discriminating feature of the Calico work system was that the work load was higher than in other mills since it was usually based on 64 looms rather than 48. A few workers compared their work system with that of Calico Exp, which they saw as having the advantage of a lower work load and also cooperation between workers. Only one of those interviewed had previously worked in Calico Exp and his comment was, "I am not afraid of work but nobody helps me here."

As in Jubilee Auto, changes in work load and absenteeism led to frequent movements of manual operatives from one group to another. Identification tended to be with the automatic shed as a whole rather than with a specific work group. Operatives reported that their friends were scattered throughout the shed rather than confined to their own groups, and thus they would sometimes help friends in other groups with their work. Since by doing this they were boosting the earnings of friends at the expense of their own earnings and those of their fellow group workers, this is perhaps the clearest evidence that, although there was a singular lack of group feeling within Calico Auto, there was a felt need to engage in cooperative working arrangements.

Tension between the group leaders and shift supervisors has already been mentioned. Overall, operatives expressed considerable discontent with the work arrangement and repeatedly referred to it as a method by which management could underpay some weavers. There were reports that outside the mill supervisors had been assaulted and the weaving master threatened with physical violence.

## Discussion

Between 1953 and 1956 Rice helped to introduce and develop two types of "group system" in automatic and nonautomatic weaving. There were differences between these two systems related to the technology of the two types of looms, but the underlying concept of work organization was the same for both: a small, internally led group of workers, responsible for the whole task of weaving on a group of looms.

By 1970, the so-called group system encompassed widely different methods of working.<sup>(6)</sup> The main common thread was that the individual's pay was to some extent affected by efficiency and damage on a group of looms.

The group system in Calico Exp in 1970 differed little from Rice's description of it some 15 years before. Group identification was high; members of the group cooperated with one another in their work; the group leader exercised a boundary function; and supervisors seldom intervened with individual group members. It is notable that this was still, in 1970, called the experimental shed, which emphasizes the strong link to the past. Slightly more than half the workers had belonged to the original experimental groups and associated what they felt to be their present high status with their historical achievements at the time of the experiment. The type of cloth woven was still the same and, as we have seen, norms of performance seemed to have persisted for 14 years. It was as though the shed had been held within a kind of stasis—a monument to the original experiment.

In Calico Pit, the group system in 1970 resembled that of Calico Exp though performance was significantly inferior and there was greater variation between groups in methods of working. Certainly in some there was more of a differentiation of function between group members with correspondingly less cooperation. Compared with Calico Exp there was somewhat less group identification and a tendency for the supervisors to take over boundary control functions that in the experimental shed belonged to the group leader.

In Jubilee Auto the shift in this direction was even more pronounced. Workers in many groups were held responsible for operating a specific subset of looms; there was little mutual help; identification with the group was limited; the group leader was preoccupied with his loom maintenance activities; and to a considerable extent the shift supervisor directly controlled the activities of individual workers. Efficiency and quality, however, were fairly close to levels attained during the original experiment.

(6) It is worth noting that the term "group system" has been taken over as an English word among Gujarati- and Hindi-speaking people in the mills, as not easily translated into these languages.

Finally, in Calico Auto, except for the brief phase when the charade was put on for the benefit of the research worker, the method of working could scarcely be described as a group system at all. Group identification and internal cooperation were virtually lacking. The terminology to describe different categories of workers was much the same as in other mills. The group leader was effectively a jobber with maintenance responsibilities, though still somewhat resentful of the fact that supervisors were taking responsibility for internal management of the group and intervening with individual group members.

We therefore have to try to account for the persistence in Calico Exp of the socio-technical system developed by Rice, for the emergence of a discrepant system in Calico Auto and for the development in Calico Pit and in Jubilee Auto of systems appearing to be intermediate between these two extremes.

I have described two developments in the relation of the company to its environment that impinged on the loom sheds. First, the efforts to enter more lucrative markets led to pressure to maintain and improve output and quality; second, inability to procure spare parts and supplies of the appropriate standard increased both maintenance work load and the need for attention in weaving activities. The latter factor may have exacerbated the tendency of production incentive schemes in general, especially with three-shift working, to maximize production in the short term at the expense of maintenance of machines. Probably, therefore, the group leaders in 1970 were facing an accumulated legacy of sub-optimum loom maintenance.

The method of working had been designed so that each loom group, as a socio-technical system, had a certain amount of resilience to absorb and adjust to variations in its inputs without invoking regulatory interventions from outside. One feature was that the size of the weaving sub-group could be increased if yam inputs were substandard. Apart from that, the main source of resilience was flexibility in task allocation in place of a rigid division of labor between categories of workers and between individuals. Rice went some way toward specifying the boundary conditions within which the systems could be expected to maintain a steady state: for this, the regression of late 1953 in Jubilee Auto provided illuminating data. The resilience of the groups was evidenced in Jubilee Auto, for example, by the fact that they were able to weave varieties of cloth that had previously been found "unweavable" on the looms concerned. The early evidence supported Rice's proposition that

the performance of the primary task is supported by powerful social and psychological forces which ensure that a considerable capacity for cooperation is evoked among the members of the organization created to perform it. (Rice, 1958:33)

It suggested that the socio-technical systems that had evolved optimized task and "sentient" needs (cf. Miller and Rice, 1967, pp. xii-xv, 251-69/Vol. 1).

Rice's discussion of the regression in Jubilee implies that a reversion to a more rigid differentiation of labor could be taken as a symptom that the group as a social system had exceeded the limits of its capacity to accommodate to external change. When such symptoms are observed, the sophisticated managerial response is to seek ways of (1) reducing the sources of disturbance in terms of variability of inputs; (2) increasing the resilience of the group—in other words, to adjust the technical and/or social system in such a way that optimization between them is restored.

The corrective measures taken during the first half of 1954 in Jubilee Auto had these characteristics. The boundaries of the groups were restored and they recovered their viability and resilience. The kinds of decisions required to achieve this, however, had in some cases to be made at a fairly high managerial level. This was possible while group methods of working were still in an experimental phase and while, correspondingly, senior managers were very directly concerned in monitoring the effectiveness of the experiment. Subsequently, as group working "settled down" as an established and less controversial form of work Organization, top management involvement was gradually withdrawn.

The reorganization of management undertaken in the company between 1954 and 1960 (see Rice, 1958; 1963) involved the drawing of organizational boundaries around not merely these primary work groups but also around a series of progressively wider systems—the shift, the section, the loom shed, the mill—each of which was designed to have corresponding resilience. The role of a supervisor or manager was conceived in terms of regulating the boundary of the system for which he was responsible so as to maintain its internal resilience in the face of change; the corollary of this, of course, was that he was expected to draw the attention of his superior to sources of disturbance to which it was beyond the capacity of his own system to adjust. The position in the loom sheds in 1970 suggests that these successive boundaries had not effectively been controlled. Disturbances had been transmitted to and into the work groups themselves. The concept of boundary control, even if understood theoretically, had not been implemented in practice and, what is more, it had evidently not been considered important to ensure that supervisors understood its implications for their own jobs in relation to the groups. Consequently, by their direct internal interventions, supervisors further helped to destroy the resilience of the groups and to foster rigid differentiation of individual tasks.

One factor of possible relevance here was the progressively diminishing "bite" of the bonus system. The group worker's wage packet included three

components—a rate for the category, a dearness allowance and a bonus calculated on the first rate. Between 1953 and 1970, basic rates had increased only marginally while the dearness allowance component had trebled. Thus, for example, for a B worker in Calico Exp in 1954, with a basic rate of 115 rupees a month and a dearness allowance of 62 rupees, the average bonus of 28 percent on the basic rate was 18 percent of total earnings. By 1970, when the figures were 125 and 180 rupees respectively, the 28 percent would have yielded a net bonus of only 11 1/2 percent. This is an example of a factor that might have reduced—or more importantly have been held by supervisory staff to reduce—the capacity of groups to maintain their self-regulating capabilities. It may also be noted that the maintenance of high levels of performance in Calico Exp in spite of the fact that a reduction of effort and thus of efficiency would have led to only a marginal reduction of earnings indicated that the effects of the cash incentive may have been smaller than Roy (1969) suggests

Therefore, between 1953 and 1970 the groups were faced with a constant series of minor readjustments. Some of these were recurrent since seasonal or fashion variables required cyclical changes from one sort or one pattern of cloth to another. However, the loom sheds were also having to adjust to the Progressive attempts of the company's management to improve its overall Position vis-A-vis a changing set of competitors. Therefore, it was not simply a question of maintaining an equilibrium within a broadly static range of possible steady states but of attaining an equilibrium within a constantly altering trajectory.

We still have to explain the differences between loom sheds observed in 1970. In fact, the nature of the pressures was such that they were likely to be experienced maximally in Calico Auto and minimally in Calico Exp. Calico Auto was weaving the finest and most expensive sorts with a high fashion component (thus implying the need for cyclical adjustment), and these were also the types of cloth most influenced by the company's search for new and profitable markets. It was in this shed that marginal improvements in production and quality would produce the greatest payoff as improved profits. In Calico Exp, on the other hand, although the type of cloth woven was by no means simple—in fact there had been a deliberate decision when the experimental shed was set up to select the most difficult sort commonly woven it was a product for which there was a reliable market and in which few, if any, improvements in quality standards were required since the acceptably higher norms had been attained at the end of the experimental period in 1954. Here it had been possible to maintain a steady state. Jubilee Auto was in an intermediate position in that the fabrics woven were neither so fine nor so profitable as in Calico Auto, though at the same time there had been continuing pressure over the years to move to marginally more profitable, and correspondingly more difficult, sorts and to improve quality standards. In Calico Pit the evidence is less clear. It seems likely, however, that the process of extending the group

system to this shed may have involved too inflexible a transfer of group structure, without giving the groups enough room or help to discover their own modes of working within the appropriate culture. Some found their own resilient modes; but in other instances they failed to develop adequate boundaries within which self-regulation could occur so that supervisory intervention became integral to the regulatory function within groups.

Problems of spares and supplies impinged differentially in the same directions. Closer tolerances are required for automatic than for nonautomatic looms and for finer than for coarser cloth.

Probably an additional factor for differences among loom sheds was the surviving proportion of original group members in each of the sheds. To the extent that group members had internalized a group method of working they could be expected to be better able to maintain resilience and to resist incoming disturbances.<sup>(7)</sup> As we have seen, more than half the workers in Calico Exp come into this category, a third in Jubilee Auto and a negligible number in Calico Auto. Thus, direct intervention by supervisors with individual workers, which would be regarded as abnormal in, for example, Calico Exp would be accepted as normal and natural by those who had experienced more conventional modes of work organization and supervision elsewhere.

This also suggests that the need for individual recognition by one's superiors, which is quite strong in the Indian culture, was not really provided for within Rice's concept of group organization. The individual was to derive satisfaction primarily from the respect of his colleagues within the group. It would seem that this need could remain submerged so long as the group as a whole could be perceived externally as being sufficiently successful—though our observations in 1970 suggest that the role of the group leader, even in Calico Exp, had been made more into that of a superior or boss and less of a *primus inter pares* than Rice had originally envisaged. One would therefore postulate that the diminishing experience of success, accompanied by a withdrawal of group leaders from the leadership aspects of their roles into a greater preoccupation with maintenance, would lead to the reactivation of the need for recognition from outside the group. This would increase individual workers' readiness to accept direct supervisory intervention from outside and correspondingly move the mode of intra-group relations away from cooperation.

Although Myers (1959) noted that Rice's innovations reflected a democratic, participative philosophy which was at variance with the paternalistic, authoritarian philosophy generally prevalent in Indian management, and Rice himself stressed the importance of developing "permissive and collaborative

7 In a British food factory I have seen group workers explicitly instructing a new supervisor on appropriate behavior.

relationships" which brought workers, supervisors and managers together in problem-solving approaches, both these comments are more apposite to the process of introducing the experimental changes than to the nature of the ongoing socio-technical systems that emerged. The "permissive" element in these systems was the investment of authority and discretion within the group. Their built-in capability for self-regulation made them resilient over time within certain boundaries of stability.

Rice's application of systemic concepts to organization had been much influenced by the biologist von Bertalanffy (1950), who introduced the idea of a quasi-stationary equilibrium in an open system. Understanding of ecological systems has developed considerably in the last 20 years, and it is now well known that intervention in such systems needs to be circumspect if unanticipated side effects are to be avoided. Thus, direct attempts to raise crop yields by applying pesticides and/or fertilizers will probably produce short-term benefits, but consequential changes in the wider ecological system are problematic and may in the longer term cancel any gains and even lead to regression to lower productivity than had prevailed in the first instance. Loss of variability and a contraction of the boundaries of stability mean a loss in the system's capacity for self-regulation. The goal of maximizing productivity in ecological systems has therefore become suspect-unless a very long time scale is projected. Indeed, modern ecologists are suggesting that the appropriate "conceptual framework for man's intervention into ecological systems ...changes the emphasis from maximizing the probability of success to minimizing the chance of disaster" (Holling and Goldberg, 1971:226). Nowadays some planners are learning this lesson as these authors and others (for example, Friend and Jessop, 1969) have indicated.

The analogy with industrial production systems is suggestive, even compelling. Single-minded pursuit of efficiency goals nevertheless dies hard in industry. (Here I am using "efficiency" in its more ordinary sense.) Rice's approach, insofar as he was building a new resilience into the experimental socio-technical systems, was entirely consistent with the goal of "minimizing the chance of disaster"; but in the prevailing industrial ethos it would have been difficult for him to claim this as his intention and still more difficult for others to perceive it. Paradoxically, because the prior pursuit of efficiency goals had resulted in a relatively unproductive work organization, Rice's efforts led to improved performance in the short term and could thus be interpreted as being in harmony with efficiency goals-for example, Likert (1961) saw Rice's experiments as confirming that group cohesiveness leads to higher performance. It is much more plausible to suggest that the effect on performance of introducing a socio-technical system designed for long-term viability will depend on whether preexisting levels of performance were high or low. Similarly, it can be postulated that performance of a system designed for minimizing disaster can almost always be improved by intervention designed to maxi-



mize efficiency. What is problematic is the length of time over which the improvement can be sustained. The most probable outcomes are a decline in performance, a multiplication of regulatory interventions, or both, and eventual loss of resilience. If this is so, then the most remarkable outcome of Rice's experiments is that the "group system" survived so completely in Calico Exp and, albeit to a lesser extent, in Jubilee Auto, during a period of considerable change and in a managerial environment in which efficiency goals largely prevailed.

This suggests that the goal of designing systems to minimize the chances of disaster may be more appropriate to industrial organization than is generally recognized. However much one may endorse the values attached to "participation," "permissive and collaborative relationships," "industrial democracy" and similar terms, they are too readily reducible to management styles and to modes of conducting interpersonal relationships. They do not call into question the task of management or the prevailing assumption that managing is the prerogative of people who carry the title and status of "manager." Rice's group members demonstrated that they could manage themselves. His achievement was in drawing the boundaries of the production system in such a way as to allow this to happen. The role that we conventionally think of as managerial then becomes a boundary function (cf. Miller and Rice, 1967/VOI. 1). The task can be defined as: to provide the boundary conditions within which members of the organization manage their roles and relationships in such a way as to produce effective task performance (Miller, 1977). Likert was right in connecting group cohesiveness to task performance; whether the chosen task is one that the company would wish to see performed is another matter. Although now, 35 years after Rice's first experiment, the term "socio-technical system" is widely used, it is a pity that the concept of boundary management remains so little appreciated.

## References

- Davis, K. 1962. *Human Relations at Work* (2nd edition). New York: McGraw-Hill.
- Davis, L.E. 1967. "Job Design and Productivity." In *Studies in Personnel and Industrial Psychology*, edited by E.A. Fleishman. Homewood, Ill.: Dorsey.
- Friend, J.K. and W.N. Jessop. 1969. *Local Government and Strategic Choice: An Operational Research Approach to the Processes of Public Planning*. London: Tavistock Publications.
- Holling, C.S. and M.A. Goldberg. 1971. "Ecology and Planning." *Journal of the American Institute of Planners*, 37:221-30.
- Katz, D. and R. L. Kahn. 1966. *The Social Psychology of Organizations*. New York: Wiley.
- Likert, R. 1961. *New Patterns of Management*. New York: McGraw-Hill.
- McGregor, D. 1960. *The Human Side of Enterprise*. New York: McGraw-Hill.

- \_\_\_\_\_. 1966. "Why Not Exploit Behavioral Science?" In *Leadership and Motivation*, edited by W.G. Bennis and E.H. Schein. Cambridge, Mass.: MIT Press,
- Miller, E.J. 1975. "Socio-Technical Systems in Weaving, 1953-1970: A Follow-Up Study." *Human Relations*, 28:349-86.
- \_\_\_\_\_. 1977. "Organizational Development and Industrial Democracy: A Current Case-Study." In *Organizational Development in the UK and USA: A Joint Evaluation*, edited by C.L. Cooper. London: Macmillan.
- Miller, E.J. and A. K. Rice. 1967. *Systems of Organization: Task and Sentient Systems and Their Boundary Control*. London: Tavistock Publications. Portions also in Vol.I, "Task and Sentient Systems and Their Boundary Controls," pp. 259-83.
- Myers, C.A. 1959. "Management in India." In *Management in the Industrial World: An International Analysis*, edited by F. Harbison and C.A. Myers. New York: McGraw-Hill.
- Rice, A.K. 1953. "Productivity and Social Organization in an Indian Weaving Shed: An Examination of the Socio-Technical System of an Experimental Automatic Loomshed." *Human Relations*, 6:297-329. Condensed, Vol, II, "Productivity and Social Organization: An Indian Automated Weaving Shed," pp. 106-29.
- \_\_\_\_\_. 1955a. "The Experimental Reorganization of Non-Automatic Weaving in an Indian Mill: A Further Study of Productivity and Social Organization." *Human Relations*, 8:199-249.
- \_\_\_\_\_. 1955b. "Productivity and Social Organization in an Indian Weaving Mill 11: A follow-Up Study of the Experimental Reorganization of Automatic Weaving." *Human Relations*, 8:399-428.
- \_\_\_\_\_. 1958. *Productivity and Social Organization: The Ahmedabad Experiment: Technical Innovation, Work Organization, and Management*. London: Tavistock Publications. Re-issued 1987, New York: Garland.
- \_\_\_\_\_. 1963. *The Enterprise and Its Environment: A System Theory of Management Organization*. London: Tavistock Publications.
- Roy, S.K. 1969. "A Re-examination of the Methodology of A.K. Rice's Textile Mill Work Reorganization." *Indian Journal of Industrial Relations*, 5:170-91.
- Trist, E.L. and K.W. Bamforth. 1951. "Some Social and Psychological Consequences of the Longwall Method of Coal-getting." *Human Relations*, 4:3-38.
- von Bertalanffy, L. 1950. "The Theory of Open Systems in Physics and Biology." *Science*, 3:23-29.
- Vroom, V.H. and N.R.F. Maier. 1961. "Industrial Social Psychology." *Annual Review of Psychology*, 12:413-46.