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The Norskhydro Fertilizer Plant[1]

The initiative for this experiment arose from the Norskhydro Company. This is one of Norway's largest companies, with over 1,000 employees in the four production complexes it directly manages at widely separated sites around the country. As a science-based industry--electrochemical and petrochemical--it has long prided itself on being a progressive influence on the Norwegian scene. A new president was appointed at the beginning of 1967. He quickly started discussions with the Heroya Workers Union (HAF) at the main complex, with a view to thrashing out a new approach to productivity. The sort of thinking that was brought into these discussions can be illustrated by a statement from the president in 1968:

> A tremendous and worldwide increase in knowledge has created a new foundation for the use of knowledge and ability in solving the problems of society and production. Many people say that modern development in technology puts man out of function. This is not true. The individual will not lose his importance. In industry the requirements of individuals increase. They must increase their competence and initiative, and the value of machinery, raw materials and processes which the individual person is given responsibility for, is steadily increasing. More than ever before, the crucial matter

[1]This chapter is based mainly on unpublished follow-up reports by Jon Gulowsen.

> behind the progress in society, in industry and for the individual person is to make proper use of man's abilities and initiative.

On the same occasion two of the leading shop stewards, Tor Halvorsen and Arne Johnny Nansen, wrote on behalf of their Union (HAF):

> The idea of participation represents nothing new in HAF. For a long time we have understood that we must participate in order to obtain great results within industry. The best results are never reached after a one-sided evaluation. Today all positive forces must be released in a constructive participation. Today only the best results are good enough.

Independently of, but parallel to, these discussions the management and shop stewards met representatives from the Hunsfoss plant in a national labor-management seminar and discussed in concrete terms the experiences from that experiment. With the agreement of the Joint Research Committee, the management decided that the company would start up its own experimental studies and itself finance whatever assistance it needed from the research team.

As the first experimental site, the company chose a new fertilizer plant being constructed at Heroya. This offered the very great advantage of not having to first overcome an established management system and old customs and practices. It had the further advantage that the existing fertilizer plant, which was alongside it, would provide some basis for comparing performance. The overall purposes of the experiment were to be the same as for the earlier experiments. Increased productivity was not expressed as an aim in itself, but it was stated that the project could not be accepted if it ran contrary to the normal long-term development of productivity.

The Action Committee

From the start it was clear that the experiment should proceed via the active collaboration of management and the local union. A declaration of the project was drawn up and signed by both these parties. An important clause in the bulletin they issued gave protection to the experimental area:

> If it is convenient or necessary to change the organisation, the division of functions or the payment system from the usual pattern within the company, this may be done within the experimental area provided such changes are granted to have no immediate consequences outside the experimental area.

Of course, the agreement did not allow a completely free hand. The overriding constraint was that the experiment should come up with forms of participation that would be economically viable in fertilizer production <u>and</u> that would act as a demonstration model for the rest of the company. Getting an experimental success by extending special advantages to the workers in the experiment was thus not an acceptable solution.

To carry through the agreement, an Action Committee was decided upon. Drawing upon the experiences of the earlier experiments, it was felt that such a special body would be needed to help the change process and to cope with the temporary load on communication channels that the experiment would create. The specific needs that were identified were:

- contact with the local management and authority within the area
- contact with the workers to secure their confidence
- drawing upon technical competence in the fertilizer production
- contact with the personnel department in order to secure information from within the company as well as to make a future diffusion easier
- contact with the research workers

To meet these needs the following people were appointed to the action committee:

- the head of the fertilizer department (chairman)
- one representative from the local trade union
- a charge-hand from the old factory
- a representative from central management
- a representative from the local personnel department
- a representative from the Work Research Institute

The last mentioned provided the ongoing link to the resources of the research team.

In the event, the Action Committee was not the prime source of the new job design, but it did carry out most of the preliminary reality testing of the ideas. In all its other functions, the committee proved invaluable. Two of its members were continuously present in the fertilizer plants. They maintained effective two-way communication so that many of the misunderstandings and difficulties that plagued some of the earlier experiments were dealt with before they started trouble. They not only kept the committee aware of the atmosphere in the plants but were able to feed in ideas, observations and suggestions from the operators and supervisors.

The Action Committee launched the project by organizing a meeting, which was attended by nearly 100 percent of all employees in the old fertilizer plant (recruitment for the new plant had not yet begun). At this meeting committee members outlined the objectives of the experiment and the ideas behind it. The interest displayed and the quality of the discussion directly reflected the high morale of the plant. As the men themselves were anxious to point out, there had been important steps toward participative management in the preceding year. So they felt they knew what the experiment was driving at, and, from their own experience, they knew that this was a way to get a good cooperative atmosphere and better production.

Following the mass meeting, the Action Committee moved to protect the experiment from outside influences that would have reduced the range of experimental choice. With the support of the operators, they prevailed upon the plant manager to postpone, and eventually cancel, a manpower study that an external consulting firm was supposed to carry out and also to postpone the introduction of UMS (a standard time system for planning and paying maintenance work).

As the experiment took shape, the Action Committee became increasingly immersed in the urgent task of recruitment, training and the wage system. We will return to this after dealing with the critical phase the emergence of a design for operating the new fertilizer plant.

Design Proposals

Although the new plant had a vastly improved layout and included some important technical innovations, both plants were largely automatic, heavily instrumented and equipped with centralized controls. The sheer volume of dry and liquid materials being transported through the many stages of production meant a high but variable load of maintenance work and constant monitoring at many points.

The operators have little manual work but must move across large areas, that can include many physical levels. At intervals they visit one of the control rooms which are natural centers of communication. It is characteristic of this kind of process technology that work is fairly relaxed when production is high and stable. The workers are only kept busy performing a limited number of routine tasks. However, things become very hectic when production starts to go out of control.

To an outsider, the dimensions of the factory are very impressive. One can go through large parts of the factory without meeting anyone. Process flow, layout and the information system create divisions in the factories. Each of the units has a separate control room and is manned with up to five operators. Both factories have their own small mechanical workshops which can handle the majority of the day-to-day maintenance tasks.

The old factory consisted of two geographically separated areas, and the workers were divided into two sub-groups. Each of these sub-groups was supervised by a charge-hand who acted as a troubleshooter. The charge-hands reported to the shift foreman.

Most of the maintenance was done by a local maintenance group which reported to the department management. However, breakdowns on night shifts were handled by a shift pool of maintenance workers. These people did not report to the department management. A low-status group of day workers did the necessary cleaning and laboring.

At an early stage in the construction of the new factory, in fact many months before the new approach was started, an experienced production engineer had designed the organization and manning scales for operating the plant. His ideas were based on the traditional methods of work organization and on the technological specifications of the new factory. Although his ideas were never put into practice, we will examine his model since it shows the way many engineers in that and many other companies thought, and still think, about work organization.

The engineer's original model included the following proposals. Every shift should be under the supervision of a foreman who would be in charge of the whole factory. Technical specifications suggested that the factory could logically be divided into three areas; therefore, the shift group should also be divided into three corresponding sub-groups, each of them under the supervision of a charge-hand. The operators within each group would be allocated three different grades of skills, with the charge-hands on the highest level. Two highly skilled operators would be in charge of the central control room. A special day force, reporting to a day foreman, would be responsible for cleaning, laboring and transport activities. Maintenance would be organized as in the old factory.

When the participation experiment commenced in March 1967, the total research group, with Professor Louis Davis (on sabbatical at the Tavistock Institute), visited the old factory and studied the plans for the new one. This group interviewed many of the people in the department, collected data and made a socio-technical analysis. A meeting between representatives from management, supervisors, the workers in the department and the social scientists produced another organizational model that was suitable for both factories.

This model was based on, among other things, an analysis of the maintenance data from the old factory. These data suggested that various kinds of repair work were significant parts of the daily work load throughout the factory. In fact, it proved to be difficult to separate maintenance from normal process operations. Since the new factory appeared to be divided into a number of separate geographical units, it was suggested that each shift should consist of sub-groups structured in the following way.

Each sub-group should include at least one worker who possessed versatile maintenance skills. The idea was that each sub-group should possess the skills and the working capacity necessary to tackle most of the production variances that occurred in their area. The model did not include charge-hands. The basic idea of the model was to provide conditions for increased self-sufficiency and autonomy at group level and better opportunities for learning and work satisfaction for individual group members. The different implications of the two approaches can be readily seen in the manning table given in Table 1.

This reduction of 40 percent needs to be closely examined, as it highlights the differences in organizational principles. The reduction had nothing to do with lowering the targets for level of plant efficiency nor with burdening the workers; the management would not allow the first, and the unions would certainly not allow the latter. The reduction stems from a difference in principle. In the first design, an overriding principle was that every necessary task had to be identified as the responsibility of a particular individual. The individual was then pinned to the geographical area where "his or her tasks" were located. Each person's own

Table 1

Manning Levels for the New Plant (1967)

	Initial proposal based on Classic scientific management principles	Subsequent proposal based on Semi-autonomous groups
Plant manager	1	1
Production assistants (clerks)	2	2
Superintendent	1	1
Day foreman	1	0
Shift foreman	4	4
Maintenance foreman	1	1
Shift charge-hands	12	0
Shift-operators (12 X 4)	48	40
Maintenance workers	12	8
Day laborers	12	0
TOTAL	**94**	**57**

specified work load had to be so gauged that coping with normal peak load could be expected. In this plant it was easy to calculate, from the performance data of the old plant, that most of the operators would have nothing to do but watch a great deal of the time, even though their neighbors might be experiencing a temporary overload. The shift charge-hands provided a floating reserve of multiskilled workers. They and the foremen could temporarily reallocate duties to help with crises, but even this was limited by the fact that individuals tended to know only their own jobs. The next level of backup was provided by the maintenance staff and the day laboring gang. These people took the load of these kinds of tasks off the operators and theoretically allowed for maximum utilization of operators on operating tasks.

We started, as in earlier experiments, from the principle that groups take responsibility for as many of the necessary tasks in their area as possible. It would be up to the group to deploy and re-deploy themselves so as to cope with variations in task loads and to ensure adequate monitoring over the processes still running in control. To operate effectively in this way, the members of the group would need to be multiskilled to the point where they could at least lend a hand with any of the tasks coming up in their area (as were the charge-hands in the previous design). Because of the sheer physical size of the plant, it was recognized that a shift would normally operate as three small sub-groups. It seemed that a shift crew of 10 would be sufficiently flexible to cope with the operating tasks, with many of the less skilled maintenance tasks and with all of the cleaning and moving tasks. The management and union representatives accepted the desirability of the shift crew coping with these other tasks. Too much downtime was due to waiting for maintenance or to someone failing to use a spanner before trouble actually occurred. Similarly, spillage was not unrelated to the operators' carefulness and alertness. However, both parties felt it would be prudent to set shift stafing at 11. They also felt that it might be difficult to recruit two skilled maintenance workers per shift to work in the teams as operator-maintenance workers. (They were right. The plant finished up with only one per shift.)

It was expected with the new system that the shift foreman would for the most part be acting-in for the manager and superintendent, not acting as a supervisor. And, of course, there would not be a set of charge-hands to organize.

One final feature of the design should be noted. Everyone on a shift could expect to be skilled up to the level of control room operation. An understanding of automated process plant operation requires a close and up-to-date view of things from the center and from the floor level. Under the classic one worker/one job approach, control room operators tend to be wedded to their "white collar job" and its attendant status.

Thus, instead of the traditional status differences among unskilled day laborers, ordinary operators, control room operators and charge-hands there would, in our design, be only differences in currently proven competence. Achievement of higher competence was expected to be largely up to the individual. There would be no waiting until a vacancy occurred at the next level and, even then, having no prior chance to prove fitness to compete for the vacancy.

Developments in the Design

Two months after the meeting that considered these alternative designs one of the engineers in the division brought forward "new" proposals based on discussions within the local management group. These were:

- Process workers would each be responsible for cleaning in their own work area.
- There should be no low-skilled daytime groups in the factory.
- Each shift should have a charge-hand in addition to the foreman. This charge-hand should have some competence in instrumentation as well as being capable of acting as a troubleshooter for the whole factory.

These proposals accepted the suggestion that a day cleaning squad be avoided. In other ways, it was a rearguard action. The reversion to individual/task area responsibility and to charge-hands would have eliminated the notion of semiautonomous groups. The "job enlargement" entailed in doing one's own cleaning would probably not have been seen by the union as "job enrichment."

The Action Committee gradually came to their own conclusions regarding the design of the organization. There should be no charge-hands or low status day workers in the factory. Shift operators should be urged to work in pairs or in larger groups within their own group territory. The shifts should, if possible, be staffed with some maintenance people. (The number of maintenance people who applied for jobs in the factory was limited. Thus each shift, which numbered about 12 operators, had only one or two maintenance workers when the factory started up.)

Using these ideas as their point of departure, the different shift groups subsequently developed their own ways of working the new organizational patterns. The major differences were in the degree of multiskilling they were prepared to accept and the size of geographical areas they were prepared to man. The older workers showed less interest in increasing their skills and, not unnaturally, more interest in minimizing walking and climbing stairs.

Prior to the shift groups doing anything, or even existing, the Action Committee had a lot to do themselves, and a lot to work out with others, so that the proposals for semiautonomous group manning could become operational.

Wage System and Bonus

It was obvious that the new manning proposals offered considerable economic advantages to the company, provided they worked. It was equally obvious that some new wage system would be needed to bring advantages to the operators and to go on doing so in the likely event of the new system continuing to create further advantages for the company.

Previous experiments gave some leads to the Action Committee, but they were not seen as providing any model that could simply be copied. Before the committee could move, an overall site productivity agreement was finally settled in April 1967. This agreement offered all the workers on the site, including the old fertilizer plant, an opportunity to earn more. It included a manpower analysis which was to be taken care of by a consultant firm, and the introduction of piece rates for maintenance work according to a so-called Universal Maintenance System (UMS).

At a plenary meeting, the workers in the fertilizer factory questioned the applicability of this productivity agreement to the project area. They saw the principles as irreconcilable because the manpower analysis started from the principle of one person/one job with unshared responsibility. They also questioned the competence of outside specialists.

With this background, the workers suggested that their own manpower analysis should be taken care of by the Action Committee. This was done in cooperation with the local management. The proposal, which suggested a reduction in the manning of the old plant from 72 to 60 workers, was unanimously accepted. Later the maintenance group was reduced from 12 to eight people.

The old fertilizer plant, after this event, followed more or less the same pattern as was developed by the new plant when it gradually started to operate on the new basis during the early autumn of 1967.

Next the Action Committee, aided by the local management, worked out a bonus scheme for all operators in the old fertilizer plant. This bonus was based on the following criteria:

- Production volume of acceptable quality.
- Control over raw materials lost, particularly nitrogen.
- Other costs which could be influenced by the workers.
- Total number of man-hours for production, including service workers' time.

The central idea behind the bonus scheme was to pay the workers according to factors which they themselves could influence; factors which at the same time were important for the factory. Since the bonus included all workers in the factory, it was expected to stimulate cooperation. The payment and the working conditions for each individual depended upon the joint effort of the whole factory staff: operators, maintenance, clerks and supervisors. The bonus scheme represented the first step toward a new wage system for the new factory. It soon became clear that more drastic changes would become necessary.

The traditional wage system put people in a position where it was not in their interest to help each other, and hence it acted against cooperation and mutual aid in the work situation. It did less than nothing to encourage a way of work that could provide opportunities for learning from each other, for sufficient variation, for the development of work groups and for operators to get to know the whole process. In other words, chances for satisfaction of the psychological job requirements were small.

In order to improve the chances for satisfactory psychological work conditions, the Action Committee devised a new wage system. In close cooperation with the local shop stewards, it was decided that each worker should be paid according to proven competence. Both theoretical knowledge and practical experience from production could contribute to higher wages. By learning all the jobs in the factory, the process operators could advance from wage class no. 2 to class no. 6 and then get the same wages as skilled maintenance workers. The wage system presupposed that the workers were given the chance to rotate through all jobs in the factory.

It was hoped that this would reward the workers for learning from their work and, step by step, developing more flexible interdependent work patterns. It was agreed that the local shop steward and the general foreman should be responsible for the evaluation of the competence of the workers. This wage system was a major innovation. For management, it was a challenge. Would lower manning rates and better performance offset the added costs of training and paying extra for having a reserve of competence on the job?

Recruitment to the New Factory

The workers who became superfluous--through their own rationalization--in the old factory were guaranteed jobs in the new plant. But it was necessary to recruit more people. A lot of discussion took place about how the vacant positions should be advertised. It was agreed that any such advertisement should create only those expectations that were in line with the intended design of work. The final advertisement was as follows:

> We need workers to take care of process and maintenance in the new fertilizer factory

> (process workers, maintenance workers, plumbers and instrument makers). The company is going to try to develop new kinds of cooperation to the benefit of employees as well as the company itself. Therefore, we want to get into contact with employees who are interested to:
>
> learn and develop themselves further through the work
>
> take responsibility
>
> become active members of a work group
>
> participate in the training of others
>
> participate in developing jobs and ways of co-operation which create conditions for personal development through the work.
>
> It may be necessary to alter many of the usual norms within the organization, such as formal organization and contents of the different jobs. At the moment, it seems likely that work groups with optimal competence within maintenance and process control will have to be formed.

No financial incentive was mentioned. The advertisement generated more than enough applications. Selection was based on interviews by a representative from the personnel department, the general foreman of the factory and the trade union representative in the Action Committee. Concerning wages, the operators were assured that they would not lose anything compared to their old level while they were training until the new factory was started. No other guarantees were given.

This procedure differed significantly from established routines in the personnel department of the company. The 20 workers who were selected according to the procedure that has just been described made up the first group to join the staff for the new factory. The majority of the remaining part of the staff came from the old factory and joined somewhat later. This group had not been through special selection.

Training

Traditionally, process operators in Norskhydro, as in most other companies, have received little systematic training and education. They have generally had to prepare themselves for the performance of relatively simple routine tasks by working together with a more experienced worker. The narrow specialized jobs gave little opportunity to understand the process as a whole and did little to stimulate further learning. Only half of the 20 new men had even this much experience of process work. So the Action Committee immediately took the initiative to set up a training scheme. A course of 200 hours of theoretical training was started in cooperation with the company school and the local shop stewards. Practical experience and training went on in the old factory and later in the new factory as equipment was being installed. Due to lack of time to commissioning date, only the first group went though the whole training program. The rest of the workers, all experienced, were given a shorter theoretical training program lasting 40 hours.

The character of the training was dictated by the desire to staff the factory with multiskilled operators having a broad knowledge in process maintenance work. They were therefore provided with learning opportunities in chemistry, process knowledge, instrumentation and maintenance work. The interest in the training program was great, and the operators constantly probed the connection between the theory and their future work. Supervisors and technicians on the factory staff participated in the course both as teachers and as students.

The training scheme, which was built up for the workers in the fertilizer department, represented a "new deal" in the training policy within the company. Previously, the company school had mainly been occupied with training craftsmen in craft skills: plumbers, welders, mechanics, etc. The majority of those trainees were under 20.

The new training scheme was a first step toward creating in the company the status of a "skilled process worker." The need for adult training was stressed, and new organizational and pedagogic principles were applied: "The school must go into the factory; the factory must become the school." In particular, it was believed that education for working as semiautonomous groups should be based on semiautonomous learning groups. As the pressure for multiskilling built up on the site as a whole, there were signs of the education being routinized. We are not in a position to judge whether the principle was ever firmly established in the company school or, if established, whether the observed tendencies remained central.

The Operation of the New Principles in the New Plant

The critical test of the new principles of organization was in this case quite simple. What was judged to be a good design by traditional "scientific management" principles stated that about 94 people were needed for the plant to be efficiently operated. The alterative design, based on self-managing multiskilled shift teams, predicted that 56 people could operate the plant with at least equal efficiency and with greater satisfaction to the people concerned. The modified design went into operation with 60 people, one extra operator per shift. The difference in staffing levels was still so great (60 to 94) that there could be no rational doubt that different principles were at stake. Differences in technology, personnel, etc., were nowhere near comparable in the magnitude of their possible effects on work satisfaction or efficiency.

Two questions arise:

Did the much lower manning level with semiautonomous groups manage to achieve the level of efficiency that would be expected with a traditional design?

Did the workers benefit accordingly from the system (or was the per capita improvement in efficiency taken from their hides)?

Let us reply very briefly to the first question, turn to the second question, and then return to the first.

The new mode of operation was obviously economically viable by management's standards. They encouraged the old fertilizer plant to move over to the same principles of operator self-management and encouraged their other plants on the site to move in the same direction. Although this has been achieved only to a limited extent, it is explicit company policy to push in this direction. Over seven years of operation (1967-74), there has been no question of going back to the old principles of organization. This managerial attitude was not due to Norskhydro having money to throw away, to sustained union pressure or to public opinion. We will return to the question of what evidence could have been so convincing to management.

The most obvious and most easily measured advantages to the workers were those flowing from being multiskilled, being able to increase their skills and being able to use and be paid for these additional skills. Less easy to measure were the advantages of the workers being able to make so many of the decisions about the deployment of their capabilities. Even less obvious were the advantages that accrue from disappearance of the "donkey jobs" of day laboring and the erosion of the "labor aristocracy" of control room operators and charge-hands (as welcomed and further pushed for by the paper machine operators at Hunsfoss).

The plant was commissioned in 1967. By late summer 1969, the average operator was being paid extra for competence in 5.4 out of the 8 possible task skills in the plant. One shift lagged noticeably behind in multiskilling and rotation of jobs, and they were also noticeably dependent on their shift foreman. These were older workers, and this seemed to be their preferred style. In the overall pattern this was not disruptive. Observations made at this stage also showed that the average operator was involved in two to four different task areas during a shift. In the traditional system, the operator was only rarely involved in more than one area and then had to be paid as if it were overtime. Multiskilling was obviously the new norm. Even the "laggard shift" had an average of more than three skills. Flexibility in the use of these skills was markedly higher than in the old system and indicative of the new style of working.

A measure of the attitude of operators was taken after they had had some months of working the new system (Table 2). Because of the work pressures in the factory, only 33 of the 52 operators and maintenance workers could be taken off the job to be interviewed at the start and only 22 in December 1972. Some of these respondents had worked in other equally traditional jobs but not in fertilizer production, and others were in the maintenance section which was only marginally affected. The differences are striking enough to offset the inadequacies of the data.

Table 2

Changes in Attitudes of Workers Between Previous Jobs and December 1967 in the New Plant

		Yes	No
Do you have adequate responsibility for determining your work?	Old job	14	19
	New plant	24	1
Are there good chances to learn on the job?	Old job	10	21
	New plant	25	1
Is there adequate variety in the job?	Old job	16	17
	New plant	22	4
Does the job give you a sense of security?	Old job	13	20
	New plant	22	8
Do you feel satisfied with the job?	Old job	18	13
	New plant	26	0

Of critical significance is the fact that all but one worker on the new plant said that they could now determine how they did their jobs. As social scientists, we did not think it necessary to run statistical tests of significance over these figures; they were very obviously highly significant. After day-to-day experience of the new form of organization for more than four months, the workers thought they had more control, better chances to learn, more optimal variety, more satisfaction and more security.

Our systematic observations on the new plant continued through 1972. Some changes were occurring. The younger people with the higher levels of competence were expressing some dissatisfaction with lack of further challenge and applying (successfully) for new jobs in other parts of the company. The labor market, particularly within their own company, was becoming very rosy. Thus, while labor turnover was practically nil during the first two years, it now resembles the turnover for operators in the other chemical plants on the site.

It is sometimes asked whether the effects we are describing here could not have been achieved just by making the same changes in wages and bonuses. This seems an appropriate point at which to confront such queries. Quite simply, what good would it have done the new plant to have paid for a high level of skill if this were used only within one individual's area of responsibility? What good would a group bonus have done if the workers did not have the rights and responsibility of self-management? We suggest that self-management of the work groups is the key, not the lock to be turned by forms of monetary reward. This is rather obvious when we consider older forms of group working, where money rewards sustained brutalized forms of subcontracting within which employees had even fewer rights for self-determination and less legal protection against exploitation.

Self-management was not complete and was never intended to be so. However, there was no felt need nor any expressed desire for the return of charge-hands. In fact, when one foreman retired, no one was formally appointed to replace him--one operator was informally asked whether he would look after the things the foreman used to do (answering the outside phone, etc.). Observation of a typical shift cycle confirmed the "decentering" of the foreman on all but the one shift mentioned above (Table 3).

Table 3

Persons Consulted by Operators about problems

	Foreman	Other Operators	Both
Shift 3	7	2	0
Shifts 1,2,3	8	11	4

Returning now to the company's apparent satisfaction with semiautonomous group working, the most obvious fact is that the plant worked. It did not collapse from undermanning, and it did not have to be kept on its feet by special support systems. The evidence allows us to go beyond this simple statement of the key fact. The plant did not only work, it worked better than could have been expected on the traditional system of manning.

The bonus scheme was based on savings in inputs as well as increase in outputs. Adequate records of these were not brought into being until 1969, the need for such data not having been recognized. In the two years 1969-70, the bonus increased about 50 percent.

Production data for each of the three main lines exist from commissioning time. They show increases between 50 and 100 percent despite the low manning levels. The downtime percentage for the plant's operation was probably the most critical indicator. Downtime was the most costly experience the plant could have. It was expected from experience of this type of plant that downtime would vary between 10 and 30 percent (usually more than 20 percent). In the new plant with the new form of organization, the downtime has been kept within 5 and 10 percent, much less than half. This was achieved by the increased concern of the operators, not by increased effort.

With the savings on inputs, these reductions in downtime (with such low manning levels) might well explain the continued managerial interest.

Diffusion of Project Results at Corporate Level

Diffusion must be seen in the specific context agreed upon at the time the project was launched. It was Norskhydro, in collaboration with its related unions, which took the responsibility for the project and for evaluating the results. The Joint National Research Committee agreed to the project plans in general and to the involvement of the research group.

When the new fertilizer plant had been in operation for a few months, the Action Committee presented a progress report to a joint meeting of company and union representatives. A decision was quickly made to start preparations for similar projects in other plants. Six months later the company magazine published the results from the fertilizer project and stated that the new principles of work organization would constitute a shift in company policy. It soon became clear that this was easier said than done. One was obviously not dealing with an experiment and a simple transfer of results but with all the complexities of changing the largest private industrial organization in Norway.

This occurred at a time when Norskhydro and its unions faced two serious challenges, which diverted most of their resources away from the Industrial Democracy project. First, Norskhydro became a major partner in the North Sea Oil activities. Secondly, there was a national struggle over membership in the European Economic Community with a referendum deciding that Norway was not going to join. This caused considerable reorientation within the company, and its major union was divided politically to the extent that it could not mobilize its members in anything but traditional bargaining issues.

In view of these limitations, it is perhaps understandable that diffusion from the fertilizer project has been slow. One project in the carbide plant was just getting off the ground, after considerable resistance from the supervisor, when market conditions caused the plant to close down. An extensive project started in the magnesium plant, which has included major technological improvements and retraining activities. Projects in a large mechanical workshop and in the transportation sector were hung up on primitive bargaining over a new structure.

In 1970 a new wage agreement, based on the model from the fertilizer project, was signed for the whole company, granting all workers the right to get training on the job and in special courses integrated in a guaranteed promotion ladder. A special incentive system (UMS) for maintenance workers, causing a split between process operators and special tradesmen, was gradually abolished. A two-year program was set up to retain 350 foremen for alternative supervisory roles. Most of them had had no formal education beyond the age of 15, and their average age was now above 50. ln 1973 and 1974, a series of middle management seminars have been run to initiate small organization redesign projects. Still, no further real breakthroughs have occurred at the productive level to match the policy declarations of the company in 1968. Some of the reasons for this can perhaps best be understood if we explore on a more general level the trade union and management involvements in projects of this nature.

Other reasons might have to be sought at the level of the research team. At Hunsfoss, after a very different start-up at the chemical pulp plant, the machine operators on the paper machines took things very much into their own hands. They first worked out what they needed to do and then checked it out with the researchers and with the operators at Porsgrun fertilizer plants. At the Hemya complex, despite the very successful start-up of the fertilizer plants, we implanted a resident expert, which tended to stifle local initiative. The carbide plant experiment stopped because the market for carbide closed down. The magnesium plant experiment developed very slowly in the face of a massive technological redesign. The unions in the central workshops and in transportation would not consider redesign of jobs until they had settled outstanding scores with management, by arbitration.

We should perhaps at this stage have implemented the lessons of the Hunsfoss paper mills, namely; namely, we should have pulled out the resident expert and provided advice on call.