MONASH UNIVERSITY
FACULTY OF BUSINESS & ECONOMICS

"TECHNICAL REGULATION AND WORK AUTONOMY: HUMAN RESOURCE MANAGEMENT IN A SPECIFIC PATHOGEN FREE ANIMAL UNIT"

Ian Roos

Working Paper 03/98
January 1998

ABSTRACT

Many workplace technologies regulate human behaviour. One such example is the technology used to ensure particulate and pathogen free environments in industries such as electronics, pharmaceutics, hospitals and the food industry. Humans are inimical to these environments and the usual management response to the risk of contamination, is to have a highly regulated workplace.

An alternative, suggested by this present study, is to have the work group accept the responsibility for maintenance of the physical environment, thus increasing autonomy. Concomitant with this is the need to address factors that produce dissatisfaction and provide staff with a sense of the value of their work.

"TECHNICAL REGULATION AND WORK AUTONOMY: HUMAN RESOURCE MANAGEMENT IN A SPECIFIC PATHOGEN FREE ANIMAL UNIT"

INTRODUCTION

Technologies in the work place can become regulating of human behaviour through a number of mechanisms. The technology may demand patterns of behaviour that reduce the scope for individual autonomy. In these situations the technology itself is regulating as it demands that workers modify their behaviour to conform to the requirements of the technology. Alternatively, managers may respond to situations created by the technology, or the problems for which the technology was developed, to increase the amount of regulation of the workplace. An example of the former would be assembly line, mass production technology, where the demands of the technology regulate patterns of work and social behaviour in the workplace. For the latter a typical example would be regulation introduced by management to reduce the occupational risk from hazards created by the technology.

The regulating effects of technology can result from both effects. One such example is the technology used to ensure particulate and pathogen free environments in a variety of industries. The technology acts to either protect personnel from hazards, contain a toxic agent or prevent contamination of a product. The nature of the technology is regulating of employees who have to be isolated from the working environment. By their physiological nature humans are inimical to the purpose of the facilities as the average person when working sheds between 1 - 15 million skin particles per minute (Cooper, 1986, Newsom, 1986) and this compromises the sterile clean room nature of such facilities. The usual management response is to have highly standardised operating procedures and a regulated workplace. Typical of these work places are specific pathogen free animal units used to produce animals that are free of pathogenic micro-organisms, for research purposes.

These units share much in common with similar clean room facilities employed in: the manufacture of micro-electronics and pharmaceuticals; sterile supply areas; anti-cancer drug handling suites; and high security containment facilities for hazardous chemical and biological agents. In all of these work environments staff are required to work behind a physical barrier with entry and exit via showers, or other decontamination methods, and hermetically sealed air locks (Institution of Mechanical Engineers, 1986). The physical environment is controlled with air pressures either higher or lower than atmospheric and the entry and exit is via graded changes in air pressure. Staff wear special clothing that isolates them from the physical environment.

Because of the nature of the technology, there is a tendency for people to be required to work individually in these facilities, or in the minimum number required for the nature of the task, for extended periods of time. This restricts the normal social behaviour that accompanies most work. (Zajonc 1965, Levine and Moreland, 1990).

When there is a failure to meet the objectives of the facility, there can be serious consequences. In the situation of a pathogen free animal house an outbreak of a pathogenic infection requires suspension of research work, slaughter of the animals, de-commissioning of the facility, fumigating the facility, restocking with new pathogen free animals and breeding of sufficient numbers, before the unit can be re-commissioned. As a result there are strong pressures for the organisation or unit to become mechanistic, with very formal procedures and work processes (Mintzberg, 1989). The physical and psychological isolation of the work can exacerbate this as it can result in a lack of critical task analysis by the employees and, to overcome this, an over-reliance on formal procedures by management (Argyle, 1972).

An alternative, suggested by this present study, is to have the work group accept the responsibility for maintenance of the physical environment, thus increasing autonomy. Concomitant with this is the need to address factors that produce dissatisfaction and provide staff with a sense of the value of their work.

THE STUDY

The Specific Pathogen Free (SPF) Animal Unit that is the basis for this study is located at an Australian Medical Research Institute. The study was instituted to address technological issues, following complaints from researchers. The main complaints were that mice were not available in the numbers required, and those that were supplied were of variable quality and often infected. It rapidly became apparent that the problems were not with the technology but with human factors related to low morale, alienation and high staff turnover.

General Description of the Facility

The unit occupies one complete floor of a building that was converted from a former warehouse into laboratories twenty years prior to this study.. It contained two distinct stock rooms operating at positive pressure each with its own shower entry, airlock exit and receiving room. The air to each of these areas is sterile filtered with independent air supplies and filter banks. The two stock rooms are connected by an experimental theatre, entered using the shower entry of one stock room and exited via the airlock of the other. These rooms are constructed on a 'room-within-a-room' principle, and this, with the pressure differentials, creates a barrier that protects the mice from contamination. The two stock rooms are serviced from a common wash room and preparation area by two steam autoclaves, and 'dunk-tank' surface sterilising facilities. Thus all supplies into the barrier are heat sterilised, or if previously packaged and sterilised, surface sterilised. The experimental theatre, for long term experiments, contains equipment that is a potential hazard to staff.

The wash room and preparation area contains a small "assembly line" washing facility for cleaning mouse cages and other equipment. There is a hoist for lifting crates of 25kg plastic coated packs of pre-sterilised mouse food into the surface sterilisation facility. Sacks of wood shavings used as bedding in the mice cages and 20 kg containers of water bottles have to be manually placed into the autoclaves. The autoclaves have two doors, an entry in the wash room and an exit behind the sterile barrier. These use high pressure steam to sterilise items going into the barrier. The 'dunk-tanks' are accessible from inside and outside the barrier and use chemicals to surface sterilise prepackaged items. A washing machine and drier for staff clothing complete the equipment in this area.

These stock rooms and the service room form a central core with a corridor on three sides. In one corner of the corridor is a small office of approximately 2.5 x 2 metres. This is the only area available in which the five staff of the unit can keep records, sit down, talk about work, and have refreshments or eat lunch.

Off this corridor are change rooms and toilets. These pre-date the rest of the facility and were incorporated into the design. There is a small store room, approximately 1.2 x 1 metre which can hold 12 bags of the wood shavings.

For security reasons the unit is isolated from the rest of the building. A key is required for the lift to stop at that floor and there is no indication from the lift, the stairwell or the building directory that the unit exists. Access is via a locked door and restricted to people issued with keys.

It is obvious that the original design involved 'shoe-horning' the facilities into the available floor space. As well the autoclaves selected, against the advice of the institution's engineers, are not capable of performing the task required. These two factors increase the workload and detract from the working conditions for the staff.

Changes to the Facility During the Study

At the commencement of the study, the unit was run down, staff morale was low and pathogenic infections were occurring in the mice. There were approximately 3,000 mice which were unhealthy and not cleaned regularly. A breeding program was supposed to be in existence but records were not kept, so the genetic composition of the mice was doubtful. Researchers were dissatisfied with the quantity and quality of the mice and research projects were compromised as a result.

At the completion of the study staff morale was high, and there were approximately 10,500 mice in the SPF facility with ample number of mice being supplied each week for research purposes. Good records were kept and the facility had been maintained for two years free from pathogenic infections.

During the study, the facility was decommissioned with maintenance work conducted prior to fumigation and re-commissioning. This provided the opportunity to paint the facility, install equipment that would facilitate work, such as suitable height shelving, and non-slip flooring in wet areas.

After fumigation new breeding colonies were established using imported breeding stock. A proper program of animal maintenance was instituted. The facility was cleaned daily. Appropriate standards were maintained and healthy mice became available for use. This, in turn, led to increased demands for mice.

The upgrading of the facility occurred with no increase in staff. Many of the physical conditions addressed, that improved the working condition of the staff, come under the classification of hygiene factors (Herzberg 1966), which unless attended to, will be major producers of dissatisfaction.

HUMAN RESOURCE ISSUES

Staffing of the Facility

At the time of the study, the facility was staffed by five people: a supervisor who was a qualified animal technician; a qualified animal technician, and three trainee animal technicians. Four of the staff were in permanent positions and one of the trainees was employed on a research grant. The supervisor was appointed at the beginning of the study and over the next six months there was a complete changeover in staff. There were no staff changes in the two years after the changes recommended by this study were implemented.

The trainee technicians were undertaking a diploma course at a technical and further education college which involved one afternoon and two evenings per week of lectures. They were given the necessary time off work.

Work Content

The unit SPF unit is isolated physically and psychologically from the other parts of the organisation. Access is restricted for security reasons to people who either work or conduct experiments in the facility. The nature of the work restricts the opportunities for normal social interchange during work. There are two distinct environments under which people work, classified by the staff as: behind the barrier; and outside the barrier.

Outside the barrier involves cleaning and washing all mouse cages, lids/food racks and drinking bottles. maintenance of associated facilities these rooms, sweeping, ordering, loading autoclaves and dunk tanks, etc. Staff are able to wear street clothes but wear separate "sneaker" style shoes that are sterilised regularly or use disposable overboots. There is the opportunity to occasionally experience daylight and to talk amongst themselves whilst working, although the background noise of the washing facility limits this.

Behind the barrier is quite different. Access involves changing out of ordinary clothes in the change rooms, walking across the corridor in a loose gown to a degowning room, showering using a bactericidal agent, moving into a dressing room, selecting a pack containing sterilised outfit and towel and another containing sterilised underwear and socks, and getting dressed. The rooms are the minimum size possible for all of these functions. Within these rooms there is an air pressure gradient.

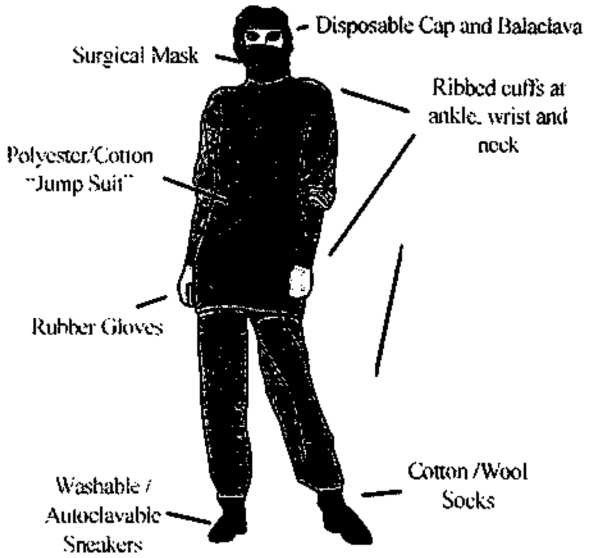
Theoretically the person working behind the barrier is totally enclosed by clothing except for a small area around the eyes as indicated in Figure 1. The clothing consists of: personal underwear in individual sizes, socks, "Jump suit" trousers and top, disposable cap and balaclava, surgical mask, cotton gloves, rubber gloves, and sterilised "sneakers". These are required to contain the particulate contamination introduced by people. A person working sheds between 1 - 15 million particles per minute, and to contain this the showering and clothing procedures need to be rigorously maintained. The difficulties that this creates for staff is a general problem for clean room facilities, and this has been noted by others. As Lambert (1986) comments,

> "Although the 'people problem' with respect to their contamination is fairly well understood, the personnel particulate barrier systems and procedures employed to contain this contamination are generally both cumbersome and irksome to the individual".

The stock rooms are completely isolated - no natural light, constant temperature and humidity, and sterile filtered air. The temperature is constant at 21°C. When autoclaves are being unloaded, the receiving rooms between the stock areas and the autoclaves are hot; when the surface sterilising tanks are unloaded there are the risks associated with toxic chemicals, plus the physical risk of wet floors.

All maintenance of mice is done behind the barrier. This involves changing boxes, providing fresh clean bedding, changing water bottles, topping up water bottles and changing food. A mouse box usually contained six mice and to change boxes, topping up water and feed takes between 40 - 60 seconds. With 2,000 boxes to be changed, the work is repetitive and constant. As well, all materials to be cleaned have to be stacked so that they can be taken out via the air lock at the end of the shift and new supplies brought in via autoclaves and surface sterilising tanks. The work is constant and there are no breaks. From behind the barrier it is not possible to visit a toilet or obtain a drink. Staff spend up to four hours at a stretch under these conditions. The stress of such work does not appear to decrease with experience.

Figure 1: Clothing Worn Behind the Barrier



The continued use of a bactericidal agent destroys skin flora so increases the risk of fungal infections and dermatitis, and there are long term risk of developing allergies to mice dander and dust.

Outside the barrier there are limited facilities for staff to relax, have a drink in comfort or to sit down between tasks.

Working Conditions

At the commencement of the study, there was considerable opposition by staff to working behind the barrier. It had been the practice for a person to be assigned to each stock room. They would work alone for two 3 - 3 1/2 hours shifts per day for 1 -2 weeks at a time. The remaining staff were exclusively involved with washing, cleaning and preparation outside the barrier. Only the supervisor was involved with the breeding program, which was regarded as the only interesting aspect of the work. No member of the animal unit staff was involved with any of the experimental research.

The working conditions, particularly the clothing provided, were another reason work behind the sterile barrier was disliked. After showering the clothing available was trousers and overjackets of coarse weave cotton, and canvas overboots, with no provision for individual size variation. The design of the clothing was such that large areas of skin could be left exposed and personal modesty could be compromised. No undergarments were provided. The canvas boots supplied gave no protection from the hard floor surface and this was exacerbated by the pellets of irradiated mouse food split on the floor during the work. These pellets are very hard and 1 - 2 cm in diameter.

Following discussion with the staff as a group, they were supplied with money to purchase their own undergarments and socks, in sufficient number to allow for a normal working week. These were washed, packaged and sterilised so that they were available within the shower entry to the barrier. Experiments were conducted with various forms of footwear, and it was found that a low cost brand of jogging shoes, or "sneakers," available from a large discount store, were washable and could be steam sterilised. These were obtained in individual sizes for use behind the barrier. Extra pairs were obtained for use outside the barrier so that staff were able to change shoes on entry to the facility. Obtaining these items was treated as an 'occasion' by the staff, who usually decided to do so as a group during a lunch time. No restriction had been put on the cost of these items, but the staff invariably purchased them from discount stores. These occasions increased the supportive nature of the staff group and were the source of much hilarity and occasional ribaldry. They also helped the staff to cope with some of the issues that arose through having a mixed gender group working under such conditions. The ability to purchase items that affected personal comfort returned a considerable sense of control to individuals in an environment where the technology was substantially controlling of their work.

Following the improved morale and improvement in the operations of the facility that resulted from these changes, attention was given to the outer clothing worn behind the barrier. Although garments designed for clean rooms were available, these were disposable and their design was not appropriate for the constant physical work required in a pathogen free animal unit. In consultation with the staff and a clothing designer, suitable outfits were designed and obtained in a range of sizes. These were made from light weight, close weave, cotton/polyester material and consisted of trousers and top with ribbing at ankles, cuffs and neck, as indicated in Figure 1, above. Because of difficulties experienced with sending these outfits and other clothing to a laundry supply company, a domestic washing machine and drier was installed in the washroom, at the suggestion of the staff. Because clothing was then washed the day it was used, the amount of clothing required was reduced, as were the costs of laundry. This in turn reduced the problem of storing soiled clothing and further increased the control of individuals over their working environment. Towels and other linen were still supplied by a linen supply company.

In the course of a normal working day staff would take up to four showers. To work behind the barrier required showering with a bactericidal agent and, following such work, staff usually had a shower before getting back into normal clothes. This increased the risk of skin damage. The study recommended that staff be able to obtain personal choice shampoos, soaps, body lotions, and handcreams in order to decrease the risk of skin damage and to improve their sense of well being. Again the purchase of these was done as a group exercise with the group maintaining pressure for individuals to choose inexpensive items. 'Pigeonholes' were placed in the shower/degowning rooms and in the staff change rooms, where 'personal use' shampoos, body lotions and handcreams could be kept.

Isolation and Environmental Deprivation

The isolation of the facility is both physical and psychological. It is physically isolated from the rest of the organisation by the security needs of the facility. However, both the floors above and below the facility contained busy laboratories, so the real sense of isolation is psychological due to three factors: the physical security of the facility; the nature of the work in the facility; and the social acceptability of the work.

The need for physical security of the facility means that there is no external indication that the unit exists or that people work there. From the stairs there is no indication other than an unlabelled door in a blank wall that there is anything on that level of the building. There are people working in the building who have no knowledge than an animal house, with people maintaining it, exists.

The nature of the work, and the work practices, mean that staff did not take tea breaks and as a result did not attend the tea room where the rest of the institute staff would meet each morning and afternoon. Non-attendance at the tea room has produced negative feelings towards animal house staff from those in other groups who have no concept of the nature of the work.

A further sense of isolation comes from the subject matter of the work, i.e. animal experimentation. This precludes the staff from discussing their work in a social context outside of the unit, unless it was to people who work in similar facilities or understood the ethical issues involved. This inhibits the stress release that comes from being able to discuss work with non-work people, and tends to restrict socialising to work colleagues or colleagues working in similar facilities.

This sense of isolation acts to increase group cohesion, which, with the social support it provides, helps staff to cope. However, it is necessary to ensure that the positive aspects of group cohesion, social support and group creativity, outweigh the negative aspects of 'group think' and group senescence (King and Anderson, 1990, Katz and Allen, 1982). This was done by addressing a number of factors such as allowing flexible working practices, an extended Friday lunchtime, multiskilling and job rotation, and group work behind the barrier.

The facility also provides a deprived working environment for staff. The only areas receiving natural lighting are the corridor and the small office. This situation is worse for staff working inside the barrier, where there is constant temperature and humidity, constant noise of air blowers, and the constant smell of mice. The work, as indicated, is repetitive and demanding, which is the situation where people gain the most benefit from the eye relaxation provided by an external view (Department of Employment and Industrial Relations, 1983). Because of the difficulty of sterilising equipment it was not possible to alleviate the environmental deprivation and provide some link with the external world by the provision of a radio. (This would have been possible if it had been designed into the facility.)

Environmental deprivation has a greater effect on individuals when tasks are complicated and demanding (Suedfeld, 1964) and deterioration of cognitive functioning is evident after 3 - 4 hours of sensory deprivation (Harrison and Newirth, 1990). This is consistent with anecdotal evidence from managers of similar facilities which suggests that problems arise if staff are required to work under such conditions for longer than 3 - 4 hours. Other studies have indicated the importance of windows in the work environment for the psychological well being of individuals(Ludlow 1976).

The recommendation how best to manage this situation was to have the work behind the barrier done as a group task, with multiskilling and job rotation occurring wherever possible. Whilst the increased number of staff entering the pathogen free area increased the risk of contamination, the increased commitment to good practices and the philosophy of pathogen free working, reduced this risk. As Lambert (1986) notes on the operation of a clean room facility:

> "The quality and standard of this facility and perhaps even more important how it is perceived by the regular users will be a major factor in establishing attitudes to the controlled environment".

Awards and Work Practices

The staff were employed under an award which specified a 38 hour week with the option of working 7 hours 36 minutes per day, or 8 hours per day with an Accrued Day Off (ADO) every four weeks. Two fifteen minute breaks and half an hour for lunch were specified.

The staff. considering the difficulties of working behind the barrier, suggested that they take no breaks but have a full hour for lunch. They have also voluntarily relinquished the ADO, and in this they took into account the difficulties of having at least done day per week in which there was one person less to cope with the tasks required. They have also established the practice of commencing early each Friday so that as a group they can take an extended lunch break that day. This did involve some of them working from 7:30 am to 12:30 or 1 p.m. without a break, in contravention of the industrial Award, but it was a system they preferred. This change explains some of the apparent anomalies in the analysis of the work diary completed as part of the study. The practice of foregoing breaks and taking a one hour lunch time result in a 35.5 hour working week excluding lunch breaks.

Work practices were also altered so that staff no longer specialised but became multiskilled. This increased task variety and improved staff motivation. In addition, all staff were given the opportunity to be involved with the research for which the mice were produced, and this was written into all job descriptions. The supervisor's job description was amended to include the authority to enforce adherence to ethical animal research practices. This increased the staff's sense of the worth of the work being undertaken, and the status of the supervisor relative to research staff.

These changes to the work practices would consistent with addressing those factors described as motivators by Herzberg (1966), that is, factors that produce satisfaction. It has already been suggested that the physical conditions addressed could be considered as hygiene factors. Whilst there have been major criticisms of Herzberg's two factor theory (Schneider and Locke, 1971, Schwab and Cummings, 1971), it does provide a useful framework to view the changes that occurred during this study.

Work Patterns

Part of the study investigated patterns of work that resulted following the above changes. With the involvement of the staff, the tasks were grouped into eleven classifications, which are given in Table 1.

Table 1 Classification of Tasks within SPF Unit

Classification	Tasks
Cleaning and Preparation	Sweeping floors, mopping floors, wiping benches, scraping and clearing mouse boxes, cleaning box washing machine, stacking linen, unloading airlocks, preparing water, etc.
Sterility control:	Loading and unloading autoclaves and dunk tanks, preparing linen packs and underclothing packs for sterilising, laundry of underclothing, preparing 70% ethanol for surface swabbing, maintenance of autoclaves.
Animal Maintenance:	Changing boxes, feeding and watering mice, renewing food in bins, filling mice orders, clearing mouse racks, checking mice. Keeping records inside barrier, e.g. cards on boxes.
Breeding and Weaning:	Setting up breeders, checking pregnant mice, weaning, keeping breeding records.
Personal Hygiene:	Showering and changing on entering and leaving the barrier.
Collecting/Delivering Outside Unit:	Collecting stores, sawdust, etc., taking out waste, etc.
Administration and Paperwork:	Ordering, supervision, record keeping, liaison with research staff, supply department and engineering.
Interruptions:	Interruptions to tasks, e.g. answering the door, telephone, etc.
Involvement with Experiments:	Setting out and sterilising equipment for use in experimental areas, observation of mice in experiments.
Quality Control:	Checking efficiency of autoclave procedures with spore strips and indicator capsules.
Education/Training	Time allowed off to attend TAFE College..

Time spent at lunch was also recorded in the work diary and noted

The staff were asked to maintain a work diary for a one week period. They co-operated in this process, to the extent of autoclaving copies of the diary record sheets so that they could complete them whilst working inside the barrier. They also understood that this exercise was not a time and motion study and that it could be used to further improve their working conditions and justify the employment of further staff as work expanded. As well as the group discussion they all received a letter specifying the nature of the study. At the end of the week the completed diaries were collected and the information collated. The results were then discussed with the staff as a group. The individual records fell within the norms of the group, as would be expected (Hackman, 1976).

Individual staff were not identified in the analysis of the diaries and are indicated in the analysis by the letters A, B, C, etc. A work diary was also kept by a research technician who conducted experiments in the Experimental Theatre and when possible assisted the SPF staff. The analysis included this time as in some instances it saved another person having to enter the barrier.

Table 2 lists the cumulative hours spent by each staff member on each task grouping during the week.

As well as classifying work according to these groupings, it is possible to classify the work as "behind the barrier" or "outside the barrier" as used by the staff when discussing their work. Figure 2 shows the number of people behind the barrier at any one time.

The work diaries reveal the practice of trying to get tasks behind the barrier conducted in the mornings. On Tuesday, Friday and Sunday they show the effects of autoclave breakdown with people having to go into the barrier a second time. The charts also show that only one person at a time can enter the barrier via the shower. On the Tuesday both showers could be used as one person went into the Experimental Theatre, via barrier 1 shower, to maintain mice in that area.

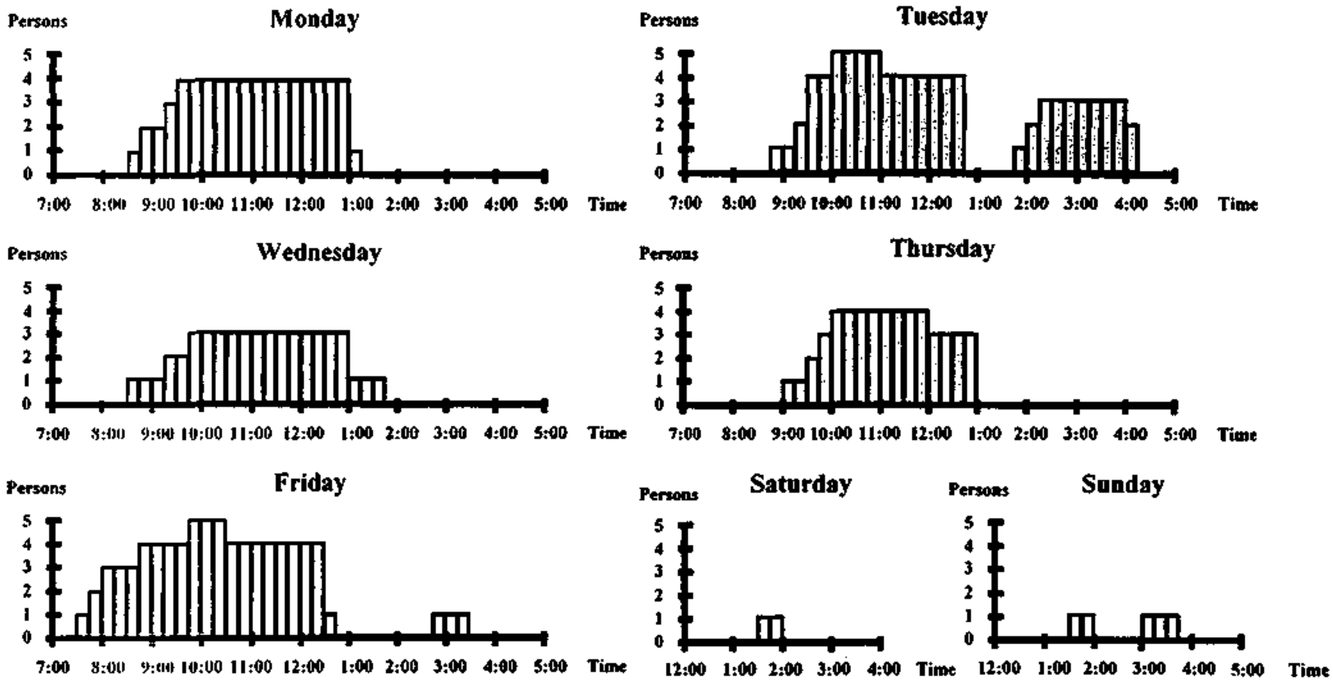
Table 2: SPF Animal Unit - Analysis of Work Diary Time Spent on Various Task Groupings

	Staff time in hours						
	A	B	C	D	E	F	Total
Cleaning and Preparation	5.75	9.50	9.25	9.25	4.25		**38.25**
Sterility Control	7.75	6.75	6.00	4.00	5.25	0.25	**28.25**
Animal Maintenance	7.50	9.00	11.00	12.75	14.25	1.75	**56.25**
Breeding and Weaning	2.75	5.75	1.50	0.75	3.75		**14.25**
Personal Hygiene	1.50	3.25	2.50	2.00	3.50	1.00	**13.75**
Collecting/Delivering Outside Unit	2.75	1.00	2.00	0.50	2.25		**8.50**
Administration and Paperwork	13.50	2.25	2.25	2.25	1.75		**22.00**
Interruptions	1.00	1.25	1.00	0.25			**3.50**
Involvement with Experiments	0.25	0.75	0.25	0.75	0.50		**2.50**
Quality Control		0.50			0.75		**1.25**
Education Training		3.00	3.00	3.00	3.00		**9.00**
Lunch Breaks	5.25	5.00	5.75	5.75	5.50		**28.00**
TOTAL TIME	**47.75**	**48.00**	**42.25**	**41.25**	**44.75**	**3.00**	**227.25**
WORKING TIME	**42.50**	**43.00**	**35.75**	**35.50**	**39.25**	**3.00**	**199.25**

Note: "F" was a research technician who during the time of the study assisted the animal technicians occasionally.

The variations of the award conditions requested by the staff are also apparent in this analysis in that everyone has in excess of five hours per week for lunch breaks, but everyone works the minimum of 35.5 hours per week. It is also apparent that even though workers B and E were rostered for weekend work (B - 3.5 hours overtime, E - 2.00 hours overtime) some workers are putting in more than their required 35.5 hours per week. The group consensus was that the time was being put in, but the two members indicated that they felt the extra time was compensating for their personal deficiencies. Similar behaviour has been reported in a study of stress amongst nursing professionals (Motowidlo, et al, 1986). So whilst considerable effort has been put into establishing group cohesiveness, and mutual support with the SPF staff, this may have had the effect of masking some stress related problems(Ganster, et al, 1986).

Figure 2: Analysis of Time Spent Behind the Barrier



Comparison with Other Institutions

Comparison with other SPF Units is difficult, due to the differing nature of the organisations to which they are attached. Comparison were able to be made with two other SPF mouse facilities, although formal studies were not conducted.

The first was a commercial, non experimental, facility, supplying SPF mice to research centres throughout Australia. It had a purpose built facility, a full time Director, Deputy Director, Supervisor and Animal Staff. The supervisor had no direct contact with the mice but managed the animal house staff. The staffing ratio was based on 1 Animal Technician per 2,500 mice, which included all maintenance, cleaning, preparing packs, etc. It did not involve the maintenance of pedigree inbred lines. Two staff were permanently assigned to this task, indicating little attempt at multiskilling.

The second facility was a large breeding and production facility for another medical research institute. It was quite different to the facility under discussion. At the time they had approximately 60,000 mice with 16 staff, plus administrative and technical staff. Staff specialised more than the commercial facility, and there was little multiskilling or job rotation. This facility had not achieved its original purposes and it was experiencing design deficiencies and staff difficulties.

The comparison with these two facilities is limited but nevertheless does suggest the value of the approach taken in the unit that is the basis of this study. Specifically, to increase the autonomy of the work group and use group processes to overcome the negative effects of the regulating technology. Following a visit to the present facility, the Director of the commercial facility affirmed the value of the changes implemented during this study.

DISCUSSION

The study into the SPF animal unit recommended changed work practices that enabled the unit to meet its objectives, i.e., the production of pathogen free mice in the numbers required. The study also investigated the outcomes of the changes. During the program there was an increase in productivity of 350% with a concomitant increase in quality. This was the result of addressing human resource issues, rather than technology, in an area where the technology controlled the nature of the work.

Herzberg's(1966) two factor theory provides a useful framework through which to view the change intervention. Whilst it is a content theory developed to explain which factors in the work environment that motivate individuals, and has been criticised for being method bound (Schneider and Locke, 1971), it does provide a rationale for the effectiveness of the changes that occurred in this unit. The poor physical facilities, the discomfort of the clothing, and the poor working conditions produced dissatisfaction but the improvements in these would not be expected to improve the motivation of the staff. However, the group cohesiveness, the mutual support, the involvement with experimental work, and the sense of control over their own work were all motivators that produced satisfaction among the staff. However, the latter could not have occurred without attention to the former. So whilst the theory is not a model of change intervention it is useful as it indicates issues that need to be addressed and the ordering of appropriate action.

Many of the satisfiers were associated with high group cohesion. The isolation of the facility and the nature of the work facilitated high group cohesion (Trist and Banforth, 1951; Brown, 1988). This high group cohesion was further reinforced by the changes to work practices and other emphases on group behaviour. Mutual support provided by the group was a major human resource tool to counter the negative effects of the technology. High group cohesion can have negative aspects associated with it as it can lead to uncritical evaluation of work and work processes, inhibit innovation, and "not invented here' syndrome(King and Anderson, 1990; Katz and Allen, 1982). These negative aspects were countered by addressing the motivating factors, as well as collaboration of the animal unit staff with research activities and increasing the sense of control by individuals over their work environment. The collaboration with experimental work increased the staff sense of the worth of their work in the animal house.

The human resource need for group work behind the barrier exacerbated the problem of contamination by people. However, group norms were able to reinforce the discipline needed to ensure that contamination control procedures were adhered to and countered the environmental deprivation and social isolation; and by the practice of ensuring a gender mix of staff behind the barrier (this aspect may warrant further investigation).

The need to address both the social systems within the workplace as well as the technical systems has long been understood in the management literature (Trist and Banforth 1951). Yet the design of clean room facilities, such as pathogen free animal houses , and the discussion of such design, still concentrates on the underlying technology (Institute of Mechanical Engineers, 1986). this is despite the fact that it is also well understood that the design should assist individuals to adhere to the necessary contamination control disciplines (Lambert, 1986) this is often overlooked. This work study has shown that although the effect of human resource changes are limited by the design deficiencies of the facility, their deleterious effects can be overcome by attention the to work group and by providing staff with as much control as possible over their working conditions. This need not compromise the necessary contamination control requirements. In addition, although the costs of the changes were not quantified, it would appear that they were minimal for the productivity and quality gains that were achieved.

The technology of clean room and containment facilities is well understand, but the effectiveness of these facilities is critically dependent on the people who are required to work in them. As this study shows attention to technology needs to be matched by attention to human factors in the design and management of such facilities. The usual approach of standardisation of work and increased regulation, to ensure compliance with the requirements of the technology, reduces staff autonomy and their sense of having some control within the workplace. An alternative approach that increases autonomy and provides the work group with some greater control over their environment, can not only ensure that the demanding requirements of the technology are maintained and even improved, as in this case, but improve staff motivation, satisfaction and productivity.

REFERENCES

Argyle, M. 1972, The Social Psychology of Work, London, Penguin, Ch 6.

Brown, R. 1988. Group Processes: Dynamics Within and Between Groups, Oxford, Basil Blackwell.

Cooper, M.G. 1986, Air-treatment Design for Clean Rooms, Clean Room Design, London, The Institution of Mechanical Engineers, 1-6.

Department of Employment and Industrial Relations, 1983. Sunlight at Work, Occupational Safety and Health Working Environment Series No. 7., Canberra, AGPS.

Ganster, D.C., Fusilier, M.R., and Mayes, B.T. 1986. Role of Social Support in the Experience of Stress at Work, Journal of Applied Psychology, 71(1):102 - 110.

Hackman, J.R. 1976, Group influences on Individuals, in Dunnette, M.D. (Ed.), Handbook of Industrial and Organisational Psychology, Chicago, Rand-McNally.

Harrison, R.H. and Newirth, J. 1990. The Effect of Sensory Deprivation and Ego Strength on a Measure of Autistic Thinking, Journal of Personality Assessment, 54(3&4):694 - 703.

Herzberg, F. 1966. Work and the Nature of Man, in Pugh, D.S.(Ed.), Organisation Theory: Selected Readings, London, Penguin, 1990, 375 - 391.

Institution of Mechanical Engineers, 1986. A Seminar on Clean Room Design, London, The Institution of Mechanical Engineers

Katz, R. and Allen, T.J., 1982. Investigating the Not Invented Here (NIH) Syndrome: A Look at the Performance, Tenure, and Communication Patterns in 50 R&D Project Groups, in Tushman, M.L. and Moore, W.L. (Eds.), Readings in the Management of Innovation, Ballinger, 1988, 293 - 309

King, N., and Anderson, N., 1990, Innovation in Working Groups in West, M.A., and Farr, J.L. (Eds.), Innovation and Creativity at Work, Chichester, John Wiley & Sons, 1990.

Lambert, R.D. 1986. Clean Rooms - a users view, Clean Room Design, London, The Institution of Mechanical Engineers, 45 - 50.

Levine, J.M. and Moreland, R.L. 1990. Progress in Small Group Research, Annual Reviews of Psychology, 41:585 - 643.

Ludlow, A.M. 1976. The Functions of Windows in Buildings, Lighting Research and Technology, 8(2):57 - 69.

Mintzberg, H. 1989. Mintzberg on Management, New York, The Free Press, Ch. 6.

Motowidlo, S.J., Packard, J.S., and Manning M.R. 1986. Occupational Stress: Its Causes and Consequences for Job Performance, Journal of Applied Psychology, 71(4):618 - 629.

Newsom, S.W.B., 1986. Microbiological Aspects of Clean Rooms, Clean Room Design, London, The Institution of Mechanical Engineers, 31 - 34.

Schnieder, J., and Locke, E.A., 1971. A Critique of Herzberg's Classification System and a Suggested Revision, Organisational Behaviour and Human Performance, 12:441 - 458.

Schwab, D.P., and Cummings, L.L., 1971. Theories of Peformance and Satisfaction: A review, Industrial Relations 9: 408 - 30.

Suedfeld, P., Vernon, J., Stubbs, J. and Karlins, M. 1964. Effect of Sensory Deprivation and Social Isolation on Performance of an Unstructured Cognitive Task, American Journal of Psychology, 73:111 - 115.

Trist, E.L., and Banforth, K.W. 1951. Some Social and Psychological Consequences of the Longwall Method of Coal Getting, Human Relations, 5:3 - 38

Zajonc, R.B. 1965. Social Facilitation, Science, 149:269 - 274

ACKNOWLEDGEMENTS

Appreciation is expressed to the staff of the Specific Pathogen Free animal unit involved in this study, and in particular to the supervisor Ms Kim Thomas. The manuscript was prepared whilst the author was on study leave in the Department of Management and Industrial Relations at the University of Melbourne. Appreciation is expressed to Professor Stephen Deery for the provision of facilities.