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THE HUMAN SIDE OF OFFICE AUTOMATION

The terms *ergonomics, quality of working life,* and *human factors* are beginning to appear in connection with office automation. There is growing concern among office workers, labor unions, and even some governments that automated office systems are not yet being designed with people's needs in mind. Regardless of management's intent with such systems, these people see office automation as a continuation of factory automation and assembly lines. In this report we look at two people-related aspects of office automation—the physical office environment and work redesign.

Barclays Bank is Britain's largest international bank, with total assets of $80 billion. It is one of the top ten banks in the World Banking League. Its headquarters are in London, England, and it operates through nearly 3,000 branches in the U.K. The Barclays Group includes Barclays Bank International, which has offices and subsidiaries in more than 75 countries around the world, including Europe, North America, Africa, and Australia. The group also includes various investment companies and merchant banks, and employs over 70,000 people in the U.K. alone.

In 1974, the British Parliament passed the Health and Safety at Work Act. This Act requires that employers meet certain new standards for the health and safety of employees while at work. Following the passage of this Act, Barclays Bank appointed a health and safety controller to look after the interests of its employees. His job involves setting policies and co-ordinating the interests of different parties, but does not entail enforcing the Act's provisions within the bank. Thomas Stewart, of Butler Cox & Partners Ltd., visited Barclays Bank and talked with the health and safety controller for us.

A major concern at the bank over the last few years has been the impact of computer terminals on the office staff and their working environment. Toward this end, the bank has developed guidelines for the selection and installation of many types of office equipment.

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Specifically, in these guidelines the bank has identified the requirements for visual display units (VDUs in Europe, CRTs in the U.S.) in word processors and banking terminals.

CRT guidelines. Their CRT guidelines have been drawn from various published sources and adapted to the bank's requirements by the health and safety controller. The responsibility for providing the equipment, work-stations, and working environment resides with the management services department and the property division.

The guidelines cover operator health, equipment selection, environment, and operator training. The guidelines are deliberately broad and do not form a precise specification. Instead, they indicate desirable characteristics and leave open exactly how these will be achieved.

For example, the guidelines state that the CRT user is "to be provided with a clear, stable image on the screen." It is the responsibility of management services to ensure that this requirement is true for the terminals they purchase.

A few of the guidelines are specific. One such guideline is that the keyboard not be attached directly to the display unit, but instead be attached by a flexible cable. This is so that operators can adjust the keyboard to suit their working style.

The environmental guidelines, which relate to the office environment where the terminals are to be used, are also broadly stated. For example, one requirement is that "lighting should be shielded so as to prevent reflection on the screen."

These guidelines were only recently collected together into a formal document. Previously, specific projects were handled as the requirements arose. One of the major problems with that approach was that the environmental considerations tended to follow the technical developments. This led to excessive time pressure and often meant that certain options had been precluded by earlier technical decisions. The guidelines have been introduced to ensure that environmental issues are considered right at the start.

Inherent environmental problems. Many of the bank's 3000 branches in the U.K. are located in prime downtown locations. And frequently the buildings they occupy are of historical interest, and are thus protected from being altered in any major way by local regulations. This can make the installation of all kinds of equipment a difficult task.

In addition, U.K. banking laws state that bank branches cannot readily be closed for alteration or conversion. For instance, when decimal currency was first introduced, the two-day closure of the banks had to be approved by an Act of Parliament. Thus, most installations of new office automation systems have had to take place with 'business as usual.' Apart from the physical problems of moving equipment through small doorways and up old- fashioned stairways, the major installation problems associated with on-line terminals have been concerned with power supplies and lighting.

Although the equipment is supposed to require normal office power, in old buildings, the operation of elevators and other equipment frequently causes spikes and surges in the electrical current. These spikes and surges can cause terminals to disconnect themselves from the system or distort data. Clean power, independent of such interference, has therefore become an important consideration in installing new office automation systems in the bank.

Lighting is also a major problem because the new equipment tends to be located where previous equipment was placed. When a number of new terminals are introduced, then the environmental considerations described in the guidelines are generally considered properly. However, when only one terminal is installed in (say) the back office of a small branch, there is a real danger that the environment will not receive adequate attention by the installation staff. Since the health and safety controller cannot reasonably supervise the installation of every terminal, the responsibility for following the guidelines often resides with the local manager. So making bank managers aware of the environmental guidelines is another important part of the health and safety controller's job.

A special furniture problem. One major system being installed will use on-line accounting terminals installed in branch offices. During the planning for this system, the bank explored various types of furniture on the market and concluded that none of the desks designed for use with CRT terminals suited their needs.

The terminals selected by the bank have thin, detachable keyboards which can be located on a conventional desk surface, if desired. However, the screens are small (9 inches diagonal), which means they must have a closer viewing distance than would larger screens. But they also need to be moved out of the way at times, to clear the desk-top for other types of work.

The main problems with adjustable desks on the market, the bank felt, were that they were too complex and impractical to use, for most employees. No one would want to spend many minutes adjusting a desk in order to turn to a new work activity.

Since the bank could not find a suitable desk on the marketplace for these terminals, they designed their own desk. The desk is conventional except that it includes an ingenious small platform for the display screen which sits slightly above the desktop and can be swung out of the way or moved to adjust viewing distance. The users also have easily adjustable chairs. The bank believes these more limited, but easier to adjust, desks and chairs are a more realistic approach to their furniture problem.

Based on his experience with such environmental factors in office automation systems, the health and safety controller had several recommendations for others implementing such systems. He recommends getting the correct office environment determined and in place before installing any system. This requires putting more effort into the design stage, but the benefits are time savings after implementation and greater acceptance of the system by the employees.

He also recommends involving the users in using pilot systems, and even in testing equipment mock-ups, to familiarize them with the new equipment and to obtain their ideas and comments to assist in the design process. He suggests monitoring early experiences closely, and keeping both formal and informal communication lines open to all employees involved with the implementation. When employees do not feel free to comment about the changes, small problems often become big problems. And human factors and environmental problems often fall into this category, he pointed out.

The changing office environment

Environmental design is beginning to be recognized as a major factor in successful word processing and office automation installations. Lighting, static electricity, noise, and work-station design are major determinants of 'the office environment.' And these factors may determine how successful and comfortable an office automation system is.

The design of office systems should not be left entirely to computer experts, for they are generally concerned only with the capabilities and needs of the machines. The human factors are equally, if not more, important. Thus, we will discuss several office environment factors which promote (or inhibit) successfully combining people and machines in an office setting. Our main reference for this discussion is a book, entitled *Human Factors in Office Automation*, by Wilbert Galitz (Reference 1). We begin with lighting, which is perhaps the most important, yet most subtle, factor.

Office lighting and its importance

Photo-biologists study light's effect on living creatures. Within the earth's life-support system, light from the sun, or full-spectrum light, is essential. Substitution of artificial light in an office environment certainly is workable; however, the wrong kind of light can cause fatigue, stress, impaired visual acuity, and decreased worker productivity.

As Galitz points out, natural outdoor light has a color rendering index (CRI) of 100. The most effective artificial light for daily work is obtained when using full-spectrum florescent bulbs with a CRI of 91. Standard, cool-white light only rates 68, and other florescents only rate 56. Performance testing under full-spectrum lighting at Cornell University showed marked increases in visual response and decreased overall fatigue, compared to performance under regular florescent light.

Determining the best quality light to use is an easy task; determining the best *quantity* is difficult. Recommendations for levels of illumination (measured in 'lux') become complex when several visual tasks, each requiring different illumination, need to be performed in the same work area. Most conventional office work involving paper, such as reading documents, typing, and writing, requires a minimum illumination of 500 lux. But variables, such as employee age and the ever-present problem of glare, belies these guidelines. And in the automated office setting, where CRT screens are the norm, the problem of glare is heightened considerably.

Galitz notes that persons over the age of 50 require one and one-half times the illumination of those under 40; and when older than 60, illumination needs are double those of under-40. What results is a range of 500 to 1000 lux needed for 'conventional' office tasks. However, experts strongly recommend that offices with CRTs have a 3:1 luminance contrast between the office light and the CRTs luminance, to reduce glare and eye-strain. Since most CRTs emit 50 to 100 lux, achieving the 3:1 balance requires extra measures—less lighting for the CRT and more light for the other work areas.

Experts therefore recommend using indirect or recessed light for background illumination for work with CRTs, preferably 150 to 300 lux. Extra light can then be added in areas where there will be concentrated viewing. This additional light source, often called task/ambient lighting, should be screened from the field of vision of other CRT operators. If ceiling height is less than nine feet (thus making indirect lighting difficult), special light fixtures can be added to existing lights to ease the lighting problem.

Glare is a critical factor in office lighting. If artificial or natural light falls upon a CRT screen, it will reflect into the user's eyes. Also, glare levels increase faster than illumination levels; for example, doubling the illumination level results in more than tripling the risk of glare, making the 3:1 ratio even more difficult to attain. Manufacturers of terminals have responded to these conditions. CRTs are now being produced with features such as matte finishes on keyboards and keycaps to deflect light, low or no-glare coatings on screens, and amber phosphors for display characters.

But office space designers can also help. Neither terminals nor operators should be placed facing a window that is not properly shaded with blinds, drapes, or louvers. Terminals should be placed with consideration for overhead lighting fixtures, and hoods should be installed over screens to combat glare from unavoidable overluminance. Several low-intensity lights should be used instead of a few high-intensity fixtures. Lighting should be out of the line of sight of the CRT operators, including the sides and rear.

Static electricity in the office

Electro-static discharge, commonly called static electricity, is what you feel when you touch a metal object, often a doorknob, after walking across a carpet on a low-humidity day. Its effect on people is bothersome; its effect on electronic components can be disastrous. The problems of static electricity have long been known in computer centers—printers have stopped, video displays have displayed 'garbage' characters, and terminals have been detached from on-line, for instance.

Static build-up in the office environment is rarely as hazardous to people as in assembly plants, where workers handle ungrounded metal components. Most office machinery is shielded and grounded to resist shocks of several thousands of volts. A shock travelling through a console or keyboard will thus usually only affect (often deleting) data in a computer's memory—resulting in a 'soft failure' rather than a 'hard failure' of a damaged piece of equipment. But even soft failures can be a major problem.

One way to reduce the static problem is to use an anti-static spray, applied to the floor and carpets to prevent static build-up. (A speaker at a recent conference said that fabric softeners, such as Downy, when mixed with water and used as a spray, do just as well as the more expensive anti-static sprays.) Another approach is to use a humidifier to increase the room humidity. The moisture in the carpeting helps dissipate the static build-up.

Still another way to retard electro-static discharge is with special carpeting. Anti-static carpeting was first developed for use by the airlines. These carpets do not completely resolve the static problem however, for they limit charges to the 5,000 to 6,000 volt range—tolerable by humans (because such a tiny amount of current flows) but still able to cause soft failures on many machines. For additional protection, equipment should sit directly upon mats impregnated with carbon, so that the charges can be conducted away from the operator and equipment to a harmless ground.

If sprays, increased humidity, special carpeting, or mats do not eliminate static electricity problems, Stamps (Reference 2a) recommends trying some alternate approaches—change the traffic patterns to lessen traffic around computer components, or discourage the use of polyester clothing. Wearing blue jeans in the computer room, for example, causes less static build-up than wearing man-made fibers.

Handling the increased noise problem

Acoustics in offices should keep sound and noise levels within a range that is comfortable for office workers. Such levels should allow for good hearing, adequate privacy, and elimination of distractions. A primary consideration when designing or re-designing offices to introduce office automation equipment is the elimination of unwanted sound. Machines, especially those that are close to one's work area, can create a disturbing amount of noise. This is especially true of their electro-mechanical parts, such as fans and printing mechanisms.

Galitz points out that most sound waves radiate spherically, hitting various objects such as walls, ceilings, office equipment, furniture, and people. These waves may be absorbed or reflected, depending upon the surfaces they encounter. Sound-absorbent materials on ceilings and walls are imperative, and should be at least one-half inch thick, with a porous surface and a high absorption co-efficient. For walls, the most important area to cover is from desk-top height to six feet above the floor. Acoustical baffles can be used on ceilings where installing sound-absorbent material is not feasible.

The large, flat lenses covering many ceiling light fixtures are major sound reflectors. These can be fitted with louvered or 'egg-crate' shields to minimize noise reflection (and reduce glare). If windows are slightly angled outward at the top, the sound energy will be reflected toward a (hopefully) absorbent ceiling. Also, vertical venetian blinds, sound-absorbent louvers, or net draperies can help reduce window sound reflections.

Sound-masking systems, such as music or nature sounds, can eliminate the effects of sporadic noise. When optimally adjusted, people are usually unaware of the new sound and claim that the office seems quieter.

Some sounds, like the human voice, are directional. When people speak, the sound waves travel mainly in front. Good office design involves channelling sound in directions that cause the least disturbance. Barriers are excellent for blocking sound transmission and preventing visual distractions. They should be at least five feet high, preferably six, and mounted flush to the floor. Desks should be located so that employees are not in voice sound-paths, although the ability to hear co-workers' conversations at adjacent work areas is not as important as whether the conversation is intelligible or not, notes Galitz.

Work-station design

In designing offices to accomodate work-stations and other new office equipment, proper work area design depends upon the flexibility of the equipment's components to adjust to physical requirements, and the arrangement of these same components for optimum use. Of primary importance in office automation is the comfort of the employee using the equipment. CRT screens with a tilt/rotate base are the most desirable, Galitz states. These enable operators to change the position of the screen to accomodate their individual needs, or to respond to different light sources throughout the day.

Placement of a terminal should be determined by whether keying is a primary or secondary task. If primary, the terminal should be directly in front of the user; secondary use allows the terminal to be placed to one side. Work-stations should be equipped with a copy holder that can be placed near the CRT in order to minimize visual searching.

Detachable keyboards, connected by coiled cables, allow greater freedom of choice in placement of the unit. This is especially advantageous when screens must be placed on existing desks—which may be at the correct height for writing but can give users backaches when typing. Movement of the keyboard may be necessary for easy access to source documents or execution of other tasks. Movable keyboards also allow personalized desk arrangements, which vary for left-handers and right-handers.

Keyboards with a pitch of eleven degrees or less are the easiest to operate. Galitz points out that some research has revealed that the lower the keyboard to the position of the elbows, the flatter it should be. One European manufacturer recently developed a keyboard with a variable pitch between five and twelve degrees. Excessive keyboard height can lead to fatigue due to the operator's need to keep hands in an elevated position. Ideally, the working height should be adjustable within a range of 23 to 30 inches from the floor. If a fixed height is necessary, 26 1/2 to 27 inches from floor to table or desk-top is a good height for typing, while 29 inches is better for writing.

The proper display height for the screen is a function of eye position. Normally, a person's line of sight is about ten degrees below the horizon. The primary display area should be within a thirty degree cone from this position. And view distance controls this guideline. Terminals are designed to be viewed from 14 to 25 inches away. Proximity to the terminal will determine the thirty degree arc.

It is necessary to recognize that the norm for eye correction is not the norm for operating a CRT. Reading eye-glasses are designed normally for a 10 to 12 inch viewing distance, and thus will not bring the CRT screen into proper focus. Operators should use corrective lenses designed for the CRT viewing distance, to reduce fatigue.

Legibility on CRT screens has become more important due to their use in word processing. Word processing requires a screen that is sharp, clear, and readable, because the operator uses the screen for extensive editing. Flat screens are now available and they may become more widely used because they eliminate visible flicker and provide low-distortion displays. Also, although the following combination sounds strange, orange phosphor characters on an amber (light brown) background have been shown to be easier on the eyes and more readable.

A well-designed chair is one of the most important parts of the total employee's 'work-station.' It should be adjustable in height, and have an adjustable backrest so that the user's middle back area has adequate support. If a full backrest is part of the chair's design, only the mid-back portion should contact the person during normal sitting. Also suggested are rests for forearms and wrists while keying. Such rests can be obtained by selecting chairs with armrests (preferably removable) and/or arranging for a ledge at the bottom of the keyboard for placement of the wrists. These features, along with five-star bases on the chairs, self-locking casters, pneumatic height adjustments, cloth-padded seats, and the ability to adjust while sitting, comprise 'the optimum chair.'

Health hazards in the office

The U.S. National Institute for Occupational Safety and Health, NIOSH, has been evaluating the CRT since 1975, primarily for radiation hazards. It's 1981 published findings (Reference 3) dismissed radiation as a concern. But it did link regular use of the CRT to eye-strain, headaches, nausea, lower and upper back pain, and stress.

Health hazards resulting from machine-paced work have been recognized since the advent of the assembly line. But what was uncovered by NIOSH was that stress-causing factors from working with machines accumulate and combine. For example, NIOSH found that low levels of indoor air pollutants may not be noticed by most workers in one office; but in another more crowded and noisier office, the additional psychological stress of this same level of pollutants may be enough to cause widespread illness.

Prolonged viewing of CRTs poses additional problems that must also be addressed. For example, continuous concentration on a CRT screen can inhibit an individual's ability to instantly focus near to far, and vice versa. NIOSH found that four hours of un-interrupted CRT work can subsequently impair eye focusing for up to thirty minutes. This can pose a hazard for those driving home from work. NIOSH recommends that 15-minute rest breaks be taken after two hours of continuous CRT work for operators under moderate visual demands or workload. And they recommend 15-minute rest breaks after one hour for operators under high visual demands and/or repetitive tasks.

Francke and Kaplan, in Reference 2b, suggest even more time away from the terminal, because they point out that the American Optometric Association found a 20% increase in eye-strain among CRT workers. So they recommend regular eye examinations, as well as more frequent and longer rest periods than NIOSH recommends. It also helps eye-focus problems if work areas are arranged so that CRT operators can look up and out across the room occasionally.

The above discussion makes it quite obvious that there is more to office automation that just setting a work-station on someone's desk. It behooves employers to provide proper illumination, reduced noise levels, glare resistant surfaces, well-designed work-stations, and comfortable climate controls.

Designing jobs around people

Besides the physical working environment, the social working environment is an important component of life in an office. And when companies computerize jobs, they often disrupt the social relations—by making people work at terminals all day long. This need not be the case, if jobs are designed around people rather than around machines.

So now we look at jobs, and what can be done to preserve the quality of working life when work is computerized. Consider the experience of one insurance company.

An insurance company

Several years ago an insurance company (which has requested anonymity) decided to experiment with a work design approach in four departments, in order to find out whether the approach could help them increase productivity and reduce absenteeism. The approach that was to be used is known as the socio-technical systems (STS) approach.

The STS approach separates the current working relations among the employees in a work group (the 'socio' portion) from the requirements of the work being done (the 'technical' portion). These technical requirements are particularly important for the "key variances from standard or normal" which occur (such as an insurance application that is received incompletely filled out). The work group's methods of handling these variances are the focus of STS studies. Generally it is these key variances and how they are handled between people within the group or with outsiders that are the major causes of employee stress—which in turn lead to absenteeism, sickness, and so on.

With these numerous job variables defined, the work is then re-defined so that the key variances can be handled by the work group itself with the least amount of inter-personal stress and supervisor intervention. As a result, STS often recommends forming work groups that are responsible for entire work processes. A major problem is that these groups' autonomy generally requires new types of supervisory skills, and thus management may be very reluctant to implement the suggested changes.

At this insurance company, two departments in particular were interested in re-defining jobs that dealt with computers. We hasten to add that these jobs were not paced by the computer; the employees used the computer as a tool. In cases where the work is paced by the computer, more severe human reactions occur, as we discuss later.

In one department, the employees filled in the forms concerning commission payments to agents—for changes to existing policies, new policies, and lapsed policies. At the time, the department was getting ready to computerize the process so that the clerks would be filling in computer input forms.

The department manager wanted to avoid the very specialized and fragmented jobs that are so often created for this type of work, so he organized an STS team, consisting of himself, one subordinate, a systems and procedures staff person, and an STS consultant.

By studying the manual work processes, the STS team was able to identify several key variances. One was that the work had a great variety of tasks—some were simple, some were complex. Second, the workload fluctuated greatly; therefore, with specialized jobs, some employees were over-burdened while others had little to do. So certain employees were often asked to work overtime or to work on someone else's work (generally the most dull and boring portions). In response to this situation, the under-burdened employees worked slowly so as not be be given other people's work.

When these problem areas had been identified, and the current (inadequate) methods of handling them had been studied, the STS team then drew up recommended job design changes. They recommended that teams of self-managed, multi-skilled employees be created. Each employee would be trained to handle anywhere from a few tasks (say, the entry level people) to all of the tasks (say, the more senior people). An employee's position would be dependent upon his or her demonstrated skill and breadth of knowledge. And job content would vary, with the group distributing its work itself.

The STS team's design was accepted and put into practice. After several months, the department's work was re-evaluated and the following points came to light. The multi-skilled team approach eliminated the problem of over-burdened and under-burdened employees. Hard-to-fill vacancies were handled more easily; in the past, the supervisor, who was the only person who previously knew all of the tasks, would have had to take over the work. Also, the groups' flexibility helped during the conversion to the computerized system. Overtime was spread among more people, so morale rose. Employees received more on-the-job training, so they assumed more responsibility and became more promotable. And finally, job satisfaction improved—fewer requests for job transfers were made.

In a second department, a similar STS study was initiated and another STS team was formed. In this office, they receive requests for insurance payments and must determine the correct payments to be authorized. Generally these requests come from the company agents who sell and continue to service the policies. The detailed policy files are kept in physical files in another department. Individual claim information, however is kept on a computer. The authorizers use an in-house APL-based time-sharing system for calculating the complex payments.

The key variances uncovered in this department by the STS team were, first, that agents would often request rush routing of a claim through the office—a sometimes too demanding task. Second, the calculations were, in some cases, very complex. Third, the workload varied considerably from day to day. And, fourth, the physical files were not always available, because they were kept in the records maintenance department.

In general the employees felt they had good working relations with each other in the department, but they had strained relations with the agents and the records maintenance people. Also, the employees felt they were not receiving adequate training and so they were not often promoted.

This second STS design team also proposed several changes. One was that the physical files be moved into their department, because they were the main users of those files. Second, they recommended that the department manager and his superior act as buffers for the rush requests. Third, the section supervisor should handle the day-to-day contacts with other company employees and perform more on-the-job training. And fourth, groups of authorizers (with differing skill levels) should be organized to co-ordinate their own work, set their own goals, and handle their own problems (as much as possible).

In this case, the most serious key variances involved relations with employees in other departments—the agents and the records maintenance people. Management had initially assumed that re-design would impact *only* the target department, and they were not willing to implement changes that affected others, so the recommendations were not approved.

This example points up the problem of job redesign—it must deal with the human side of office work and it must be acceptable to management. When a design team recommends changing supervisors' roles and crossing departmental boundaries, the recommendations may not be implemented.

Job design problems

When one thinks of office automation, one might visualize office workers busily working at CRTs and keyboards, with each employee and the computer being a 'team.' But people generally want to work with other people, not mainly with a computer. And they want to be treated as people, not as cogs in a wheel. If office automation job design does not take these fundamental facts into account, problems arise.

Just what are some of the job design problems associated with office automation? Here is what our research uncovered.

In a study done by Working Women, a national association of office workers in the U.S. (Reference 4), the women employees they polled stated that what they liked about their jobs were: social contacts with others, a variety of tasks, advancement opportunities, learning new skills, and gaining knowledge about their industry. What they did not like about their jobs were: the low pay they often received, the prospect of no advancement, and the lack of respect they received from their supervisors.

In addition, the women mentioned several trends in offices about which they were most unhappy. These trends related to computerization of some of their work. One complaint was the fragmentation of their jobs into series of specialized tasks, each performed by a different employee. This, in turn, has led to fewer career paths. Centralization, such as the creation of word processing centers, also disturbed them, as did computer-based speed-up and monitoring of work. And lastly, although the computers allowed them to increase their productivity, their pay increases did not keep pace with their increased productivity. So they felt they were being penalized for being more productive while their companies were being rewarded.

In short, they did not see office automation trends benefitting them; rather, they saw office automation worsening their situation. They were being given more of the same boring work, less variety, fewer social contacts, and lower relative pay.

Many of these office workers felt work was becoming more stressful for them. Gregory (Reference 5), at the 1981 AFIPS Office Automation Conference, described more of the findings of the Working Women study. She noted that the five major sources of stress were: lack of promotion opportunities, low pay, monotonous work, lack of input into decisions about one's own job, and unsupportive supervisors.

Also, as Gregory notes, for work to be satisfying, office workers need to have some control over their own work pace, their work content, and their performance.

Similar ideas are described by Zuboff of M.I.T. (Reference 6), who notes that companies have paid little attention to the social and psychological changes that computerization often brings. Employees may see the computer as substituting automated decision rules for individual judgment. Thus a decision may no longer be a decision made by an office worker, it may become an output of the computer. Employees may not want the computer to encroach upon their judgment, their freedom, or the 'art' of their work, she says.

If a system is designed that does supplant these aspects of the job, such a system can lead to morale and motivation problems, with the computer viewed as the enemy, according to Zuboff.

Also, it was expected that employees who used their own CRT work-stations would feel more professional. Such was not the case, Zuboff reported. Instead, they complain of feeling *isolated* from their co-workers. Since they no longer deal with people to get answers to many of their questions, they have fewer chances for social contacts.

Some employees report that the computer makes them feel isolated from their *work*, since there is nothing that they produce which they can touch or see. A pile of account folders that have been processed looks like a lot of work; a screenful of account numbers does not. While they agree that they are doing the same amount (or even more) work, it does not *feel* the same. Their jobs are 'thinner' and less satisfying, she says.

Further, when employees use computers interactively they become accustomed to faster response to their requests for information. This compresses time, which leads to more pressures to get more work done more quickly. Zuboff also notes that employees lose their tempers faster with CRTs than with people. They find they cannot negotiate, argue, explain, or discuss problems with a computer, so they become frustrated much more easily.

Without psychological considerations in office automation, such as allowing employees to control the pace of their work, they may channel their frustrations into various forms of resistance, says Zuboff—including seeking out trade unions to express their grievances.

The challenge is, therefore, to design computer systems for offices that motivate rather than de-motivate employees, and that increase the quality of working life rather than decrease it.

The socio-technical system approach

One approach to job design for offices that attempts to deal with these social and human aspects, as well as the technical aspects, is the socio-technical system (STS) approach, mentioned earlier. The intent of STS is to design work systems to effectively accomplish the work and, at the same time, provide jobs where the employees have more to say about how they perform their work.

Socio-technical analysis is most applicable where there is concern over specific problems in a work group and where the jobs within the group need to be re-defined. It is not aimed at re-designing an individual job.

To illustrate this approach to re-designing jobs, consider the work of Dr. James Taylor, at the Center for the Quality of Working Life at the University of California at Los Angeles (Reference 7). Work in this area is going on at numerous universities and companies around the world; Taylor's work gives a good idea of what is emerging.

Taylor distinguishes between a computer-automated system and a computer-assisted system. In the former, the computer sets the work pace by feeding work to the employees. In the computer-assisted setting, the employees set the work pace and use the computer as they need it. Through STS, Taylor attempts to achieve a computer-assisted system.

In Taylor's work, the STS design work is generally performed by a team of employees from the work group, under the guidance of an STS consultant. The approach has been successfully implemented in both blue collar and white collar environments; also, some of the employees used computers while others did not.

Here is how Taylor recommends approaching job design.

Step 1: Scanning the work group. The STS approach begins with an examination of the purpose of the work group—what exactly does the group produce? This evaluation defines the boundaries of the group (at what points they relate to other work groups), the inputs they receive, the product(s) they produce, the staff within the group, and their reporting relationships.

Step 2: Technical analysis. In the first portion of this step, the group's work process is dissected into the *changes* that take place in the product as it moves from 'raw material' (say, a customer order received) to 'finished product' (say, the shipping orders produced). One 'change' in this particular example is receipt of a completed customer order, another change is storage of that order in its proper file, still another is approval (or disapproval) of the customer's request for credit, and so on.

In the second part of this step, the design team identifies the technical requirements of the process and the major deviations (key variances) that occur during the process. Key variances are very important because they are the aspects of the process that must be controlled, in one way or another, to assure favorable levels of product quality, quantity, and cost. For example, if the customer order has been only partially filled out, then some of the necessary data is missing. That is a key variance that someone must handle. Results of breakdowns in the technical process are not considered variances.

Step 3: Variance control. In this step, for each variance, the design team determines how that variance is currently being controlled. For example, who finds the missing data for the customer order? The team should also identify alternative means for handling these variances for future use during the job re-design phase.

During this step, the team often finds that variances are not controlled where they originate, and that supervisors are often responsible for controlling them—either by directing a subordinate to handle the problem, or by co-ordinating with other supervisors. One goal of the STS approach is to eliminate the need for supervisors to intervene in the work group's handling of key variances.

Step 4: Social system analysis. The social system refers to work-related interactions among people—it is not the friendship system within a company. It is the co-ordination needed within a process that makes the technical process actually work under constantly changing situations.

The first portion of this step is the examination of each employee's role within the work process under study. The process' boundaries, which were identified in the first step, are important here, because often variances occur in one work group but are handled in another. How these two groups co-ordinate with each other is an important social relationship that needs to be identified.

The second portion of this step is the examination of the relationship of this work group to other work groups—for receiving needed information and supplying information to others. The group's 'end product'—say, the approval for payment of a supplier's invoice—may be the input to another department, such as the accounting department, where the invoice payments are actually made.

The third portion of this step seeks to discover from the employees themselves how they feel about their current jobs. A process that looks fine on paper may actually be stressful, due to physical separation of people who need to communicate often, unnecessary fragmentation or duplication of work, and so on.

Step 5: The socio-technical design. Once the elements of the technical and social aspects of the process have been separated, they can be recombined in a new way, to keep control of variances within a group. The objective is to allow the employees within the group to determine how they will handle variance control themselves.

For example, one possible key variance is an uneven workload—one day a person is swamped with work and the next day he/she has little to do. If the employees are given the authority to schedule their own work within the group, workload can be balanced by them, not assigned by the supervisor.

Taylor points out that variance control should be placed at the earliest possible point in the process and with the fewest number of people involved. Variance control should not involve passing the work from one person to the supervisor, then to another supervisor, and then to a subordinate in another group, unless absolutely necessary.

STS studies often result in pushing decision-making down to lower levels within an organization. The group members, not the supervisor, now schedule the work amongst themselves. They decide how to handle a problem, not pass the problem along to the supervisor. The supervisor's job is thus changed to involve more training, more co-ordination with other supervisors, and less involvement in resolving problems within his or her group's work process. Supervisors who do not have confidence in their subordinates will find this change hard to make.

The benefits of the re-designed jobs are that employees have more control over their work pace and the work they perform. First and foremost, quality and costs of products and services are usually directly improved because the key variances are controlled more effectively. Generally the employees within a group perform many of the jobs within the group, which opens up new career opportunities to them. Also, the re-alignment seeks to increase the interaction among people, which is what most workers want. In so doing, companies that have re-designed jobs in this manner report that turnover decreases, absenteeism decreases, quality of employee effort increases, and therefore productivity increases.

Taylor gave us several hints for improving the likelihood of a successful job re-design effort. First of all, top management must actively support the STS analysis, and understand the possibility of changes in organizational reporting relationships, levels of authority, and decision-making. Also, this support must be communicated to other employees in the organization, says Taylor, especially middle and first-line managers.

Second, employees must be assured in advance that the STS project will not cause any of them to lose their jobs. The STS approach has been used most successfully when employees at all levels participate in the project; employees will not participate in a project that may cost some their jobs.

And third, management must plan for the consequences of a successful STS project. The methodology has been in use for the past 20 years, and it has improved productivity and the quality of working life where successful. Failures are generally the result of management reluctance to make the recommended changes. Therefore, management needs to plan beyond the first successful project by placing it in the context of a larger organizational change. If management does not plan beyond the first project, that project often appears as a threat to other employees, rather than a successful model for change, says Taylor.

In summary, office automation brings with it new and different people problems—problems that are not within the specialty of data processing employees. Combining computer equipment and people in an office, where both can operate comfortably, is a growing challenge. So too is designing work around people rather than around machines. We believe companies will want to pay more attention to these human factors in the not-distant future.

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Computer usage in companies is changing, and in a way that some data processing executives are not happy with. A growing number of users—both user departments and individuals—are asking for (and getting) their own computers. The situation is sure to accelerate, as small computers continue to increase in power and decline in price. Our next two reports will deal with this subject. Next month, we discuss why users want their own computers and how some companies are dealing with this trend. Month after next, we will look at reasons that data processing departments themselves are installing minis and micros.

COMMENTARY

The European Experience with Ergonomics

by Thomas Stewart, Butler Cox & Partners Ltd., London, U.K.

It has become part of the folklore of the industry that ergonomics (human factors) is more important to European computer users than to their North American counterparts. Certainly the demand for ergonomically recommended features, seems to have been far greater in Europe.

In Sweden, for example, workers have a right to ergonomically sound equipment and workplaces under the Work Environment Act of 1974. Since that time, there have been a number of guidelines issued dealing specifically with video display terminals; in addition, legislation enacted even earlier was sufficient to virtually outlaw non-detachable keyboards.

In West Germany, the legal framework is even stronger. The West German standards authority has more than a dozen standards relating to video display terminal ergonomics. There is also industrial safety insurance legislation which lays down legally binding standards for video display terminals and their workplaces. These not only specify detachability in the keyboard but also displayed character quality, and terminal and workplace dimensions.

American suppliers who have re-designed their products to comply with these requirements are now vigorously promoting an awareness of their human engineered equipment features in the U.S., to develop a home market. As a result of these pressures, many U.S. terminal designers are incorporating good ergonomic features in their products.

The latest office-oriented terminals have thin detachable keyboards, which allow the user to rest his arms on the desk surface and to optimize the relative position of keyboard and screen to suit his own requirements. Lightweight, compact display heads mounted on integral turntable/pivot mechanisms allow the user to swivel and tilt the display to suit his viewing conditions. Such features are becoming commonplace and available at reasonable cost.

The enthusiasm for specially designed video display terminal furniture (usually expensive, complex, and unworkable) is likely to disappear in the future as the terminals themselves become more suitable for conventional office environments. Indeed, as hardware prices fall, the desk will soon become much more expensive than the terminal.

There is still the belief that most American buyers are primarily concerned with price-performance, and can ignore the wishes of employees or labor unions. The European manager, on the other hand, is believed to be at the mercy of the trade unions and forced to buy more expensive products to obtain their co-operation.

While there is some truth in these simplifications, the emphasis on ergonomics simply as a European weapon in industrial strife seems to me totally wrong. Nor is European ergonomics solely concerned with avoiding operator fatigue—important though that may be. The principal benefit that improved ergonomics can bring to the workplace is greater productivity through the reduction of errors and the easing of procedures. This increased usability is highly desirable in many current data processing systems. I believe it is essential in office automation, for the following reasons:

Discretion. More and more employees use office automation equipment as a small part of their jobs, whether they are secretaries, clerks, professionals, or managers. Their jobs are usually defined in business terms; they are not there just to operate the equipment. Therefore, if an automated system does not appear to provide the service they require, they will simply not use it and will seek out more 'comfortable' alternatives. Office automation systems cannot be forced upon these employees; they have the discretion on whether to use the system or not—and many will choose not to use 'uncomfortable' systems.

Complexity. The integration and inter-connection of different items of equipment—features of many office information products—greatly increase the complexity of operation. The options open to individual employees are enormous. Therefore, the 'end user interface' must present these choices without over-loading the users' thought processes. Also, errors can be more significant and more far-reaching in integrated office networks than on stand-alone equipment.

Business needs. Many data processing systems were sold on a wave of optimism which was never fulfilled in practice. Office automation is being scrutinized more closely, to insure that it can deliver what the salesman promises. If it cannot be used easily, or cannot do the job properly in the users' eyes, then it will be rejected and the entire system will fail. Office automation must not only provide solutions to business problems, but the solutions must be seen to be workable and effective.

European organizations which started to involve their employees in office automation planning, and only considered ergonomics to avoid union resistence, have found that the real payoffs come from the improved effectiveness of the systems they have implemented. Of course, there are still managers who ignore the views of their employees—and then wonder why there is resistance to the new equipment. And there are still unions that believe that their job is to find weaknesses in proposed new systems, and then exploit these for more pay. To these people, ergonomics is a weapon in their combat.

To managers who believe in productivity as well as the well-being of their employees, ergonomics is a necessary ingredient in successful, useful office automation. Without proper attention to the human factors, office automation just does not work.

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