Older workers
(1967 folder)

JOB REDESIGN for OLDER WORKERS:

TEN CASE STUDIES

BULLETIN NO. 1523

U.S. DEPARTMENT OF LABOR

Sponsored by: OFFICE OF MANPOWER POLICY, EVALUATION, AND RESEARCH

Prepared by: BUREAU OF LABOR STATISTICS

W. Willard Wirtz, Secretary

Curtis C. Aller, Director

Arthur M. Ross, Commissioner

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Preface

With 40 percent of the labor force made up of workers 45 years of age and over, redesigning jobs to accommodate the actual capacities of older workers is attracting increasing interest. It is coming to be recognized both as a practical need under current conditions of shortages of experienced workers and as an opportunity for translating enlightened social policy into action.

In his 1965 report to Congress, The Older American Worker, Secretary of Labor W. Willard Wirtz stated that "Labor and Management must be relied on to work out techniques to help older workers meet the requirements of new jobs while they are still employed," including techniques, "for the redesign of jobs to permit greater numbers of older workers to function effectively and at high levels of productivity."

This bulletin was prepared by the Bureau of Labor Statistics under contract to the Office of Manpower Policy, Evaluation, and Research, under title I of the Manpower Development and Training Act, P.L. 87-415. It was undertaken as part of the U.S. Department of Labor's program to promote the full use of all our human resources, as recommended by the President in his 1966 Manpower Report.

The project was carried out in the Office of Productivity, Technology, and Growth, Jerome A. Mark, Assistant Commissioner. It was directed by Herman M. Sturm, under the general supervision of Edgar Weinberg, Chief, Division of Technological Studies. The case studies were prepared by Herman Rothberg and Edward Mitnick. Staff of the Division of Occupational Analysis, the U.S. Employment Service, and the Office of Manpower Policy, Evaluation, and Research were consulted in the planning of this study.

The Bureau of Labor Statistics is deeply grateful to the 10 companies which cooperated in the detailed case studies and to several hundred companies who replied to a letter of inquiry.

Contents

JOB REDESIGN FOR OLDER WORKERS: TEN CASE STUDIES

Introduction

Maximum use of available manpower resources becomes increasingly important as the U.S. economy begins to operate at full capacity. Waste of manpower through arbitrary and discriminatory practices toward particular groups of employees often results from lack of knowledge about how to use capacities of workers who have specific problems. Declining physical capacities of older individuals are examples of such problems.

One approach is to reassign older workers to positions which presumably make fewer physical or sensory demands at the same or lower pay. Reassignment often involves retraining to meet the requirements of the new jobs.

Another approach is to retire the older worker, at a full or reduced pension. Many private pension plans provide for disability retirement at any age, but workers must usually have at least 15 years of service. Early retirement rarely begins before age 55 and usually requires a reduction in pension benefits.

A third approach is to eliminate certain physical or perceptual demands of the job that create stress for the older worker--by modifying equipment, or rearranging workflow. The result is that older workers can perform more easily the remaining tasks. Job redesign and reassignment are the only approaches in which the older worker who cannot keep up with his old job may continue working for the same employer.

This report presents information about the experience of companies who have been successful in redesigning jobs for older workers. The introduction describes the scope and methods of the study. The summary presents the findings and conclusions. Ten case studies form the body of the report. A special case summarizing a study of a union-sponsored program is presented in the appendix. Also in the appendix are an annotated bibliography of references on job redesign and other aspects of older workers employment, the letter of inquiry to companies, and the checklist of questions used in interviews during the study.

Objectives of the Study

The focus of the study is on actual methods of job redesign used by U.S. companies and the experiences of those companies who have salvaged the skills of older employees through job redesign.

The specific objectives of the study are twofold; first, to ascertain the existence of specific cases of job redesign for older workers in American plants. While industry generally reengineers jobs to increase efficiency and lower costs, it is uncertain whether much attention is given to redesign to accommodate the reduced capacities of older workers. The initial objective in this study was to locate specific cases of job redesign that might be studied in detail.

The ultimate objective was to obtain detailed information about actual cases of job redesign that would indicate to employers the type of jobs and workers involved; changes that have been made; and the benefits, costs, and problems resulting from job redesign.

Method of Study: The study was carried on in two phases. First, a mail canvass of 500 companies was made to locate possible cases of job redesign which could be studied more intensively through personal visits. A list of 500 companies was drawn from the Fortune Plant and Product Directory of the 1,000 Largest U.S. Industrial Corporations. Beginning with the first entry, alternate selections were made throughout the list of companies. These corporations employ a substantial proportion of all factory employees in the United States. Most of the companies selected had many establishments, varying in size from less than 100 to many thousands of employees. The Commissioner of Labor Statistics sent a letter explaining the study to the president of each company. Five examples of job redesign for older workers were attached to the letter. (See appendix B.)

In addition, the research staff reviewed the extensive literature on employment of older workers. They contacted company, union, university, and other experts who might know of examples of job redesign and practices used. The project was announced and described at the 1966 National Conference on Manpower Training and the Older Worker, sponsored by the National Council on Aging. Notices about the study were published in the National Association of Manufacturers' Monthly Newsletter, the Journal of Occupational Medicine, The Gerontologist, and the Journal of Industrial Engineering. Several other journals in fields of industrial medicine and geriatrics were informed about the study. The Administration on Aging of the Department of Health, Education, and Welfare, through its field staff, cooperated in seeking examples of job redesign for the study.

A total of 284 replies or 56 percent of the companies contacted responded to the mail canvass. No followup was made of nonrespondents because it was presumed that they did not have pertinent experiences to report. No cases suitable for case study were obtained from sources other than the mail canvass.

Of the 284 respondents, only a small number indicated that they had redesigned jobs specifically for older workers. Many had reassigned older workers to less strenuous jobs in the same plant. Some companies set aside

specific jobs for older workers. Several made job transfers in accordance with collective bargaining contract provisions. A few relied on early retirement plans to handle aging workers declining capacity.

The second phase of the study consisted of intensive studies of the 10 cases at the plants which had redesigned jobs for older workers. Two investigators visited each company and interviewed plant officials. A checklist was used in the interviews and is shown in appendix C.

The interviews were conducted with plant managers, personnel directors, medical staff, and safety engineers. Plant visits, which included observation or discussions with the workers affected, took from 1 to 2 days.

Each of the case studies in this report presents the information under four major subjects: description of the establishment; description of job prior to redesign; recognition of need to redesign the job; and the nature and results of the redesign. Each of the case studies is prefaced by a summary.

In addition to the case studies made through personal visits, appendix A presents the experience of a union-sponsored project for retaining on-the-job older workers who have limited functional capacities. This study was based on discussions with the project directors.

Relation to Other Studies

This study provides detailed information, based on personal interviews, on examples of job redesign for older workers--a subject which hitherto has been discussed largely in abstract terms. In 1933, a study, The Older Worker in Industry, was prepared for the New York State Commission on Old Age Security. This study described the advantages of retaining the older worker on his job as his capacity declined. It recommended transferring part of the job to other workers and providing mechanical devices for the conveyance of heavy materials.

In 1954, the New York Legislative Committee on Problems of Aging undertook a mail survey of about 500 establishments in New York State. The study found numerous cases of job reassignment but only a few examples of jobs redesigned specifically for older workers.

In recent years, the Organization for Economic Cooperation and Development (OECD) has sponsored various projects on job redesign for older workers, including seminars, research reports, and case studies (including this study) in several countries. The OECD publications are listed in the annotated bibliography presented in the appendix. The checklist used in this study was based on a questionnaire developed in the OECD program.

Studies of job redesign for older workers may be viewed as a special aspect of the broad and growing field of human engineering, sometimes called "ergonomics." Human engineering studies take account of scientific data on the actual physical limitations of workers, young or old, as they relate to requirements of the job. "Ergonomics" may alter the job in order to improve the worker's performance and efficiency while minimizing the physical strains or hazards to which he is exposed. Applications of human engineering usually remove those elements of jobs which are particularly difficult for older workers; at the same time they provide some benefit to younger workers.

Summary and Conclusions

Several findings on practices of job redesign affecting older workers in American industry emerged from this study. The following summary presents conclusions based mainly on 10 case studies, and on information obtained in the mail canvass, interviews, and other contacts with management during the preliminary phase of the study. Since the cases studied are not a scientific sample, the findings are illustrative rather than definitive.

1. Jobs are being redesigned constantly to improve efficiency, but only occasionally to adapt the job to the limitations of older workers. Management often changes the content of jobs to mechanize and to improve methods of production. Both old and young workers benefit from any reduction in lifting, carrying, stretching, prolonged standing, and other fatiguing tasks. Older workers derive the greatest benefits from such changes since physical stress affects them more than young workers. Although it is frequently difficult to determine the dominant motive for job redesign, in some cases the specific purpose was to ease the strain of the job on older workers.

2. Job redesign for older workers has been carried out in large and small establishments, and in a wide variety of manufacturing industries. Cases of job redesign were found in plants producing aircraft engines, aluminum framing, building materials, carpets, computers, copper pipefittings, footwear, heavy iron pipe, precision instruments, and printed novelties. The size of the total work force in these plants varied from fewer than one hundred employees to several thousand employees.

3. Job redesign has been applied in a range of jobs, affecting individuals with varying personal characteristics. Some older workers whose jobs were redesigned were employed in low-paid jobs such as porters; others were semiskilled machine operators; and a few were highly skilled craftsmen. Most of the workers affected were older men and women whose physical condition had not affected substantially their job performance, but there were several cases of workers whose ailments had significantly reduced their work capacity.

4. Informal actions by foremen or plant managers to modify jobs to older workers capacities were the typical case; formal programs were less frequent. One case study describes a formal program for job adaptation to the functional capacity of workers, involving the participation of medical and other specialized authorities at a large aircraft engine producer. Other large American corporations have similar formal programs. Job redesign to improve efficiency of a specific aging worker or group of workers, or to retain on the job an older worker who had suffered some type of illness was more common. In these cases, plant managers and foremen initiated the redesign, sometimes with the help of methods engineers, and in some cases, with arrangements for informing the union.

5. Changing the content of jobs in conjunction with equipment improvement was one of the approaches followed in job redesign. Another approach was reallocation of duties among workers on an operation to adapt particular jobs to the capacity of older workers. Some case studies describe the effects of mechanization in making work easier for older workers. In other cases, particularly strenuous tasks were removed from the older workers and assigned to younger workers of the same work group.

6. Job redesign for older workers usually involved very little money outlay for new equipment, and scarcely any loss in output due to work interruption. Most of the cases of job redesign required either rearrangements of work assignments or slight changes in work areas or layouts. Expenditures for equipment were minor and practically no loss of production time was involved. The few cases in which major investments for new equipment were required usually reflected normal costs of introducing improved machinery or techniques. The study was not intended to determine whether any companies were deterred from making job changes by cost considerations. Only successful examples of job redesign were sought.

7. Job redesign for older workers generally resulted in improved productivity. In several cases, a substantial rise in output per man-hour in the operation resulted from job redesign; in no case was productivity adversely affected. The quality of the work improved in some cases. Mechanization of work previously done by hand resulted in very large labor savings. Significant productivity gains also resulted from rearrangement or reallocation of tasks among groups of old and young workers.

8. Mechanization, which was involved in job redesign for some older workers, resulted in displacement of workers in some cases; reassignment or retirement for others. In several cases, changes in production methods not only reduced labor requirements per unit, but actually eliminated some jobs. In all such instances, the workers affected were either reassigned to other jobs or retired on pensions. The reassigned workers usually were transferred to jobs in which there was less physical strain than in their former jobs.

9. Job redesign has some advantages for both the older worker and management over the practice of reassigning older workers to other jobs. The cases reflect these advantages. The older worker is kept on a job he knows, in his customary work place, rather than being shifted to work and surroundings with which he is unfamiliar. He continues to use his skills, thereby maintaining his morale and avoiding reduction of earning capacity. Skilled employees whose capacity is declining can be retained where no job openings are available to which such employees could be reassigned, or where early retirement is not feasible. Management can avoid expensive labor turnover, and often can achieve higher productivity.

10. Wider dissemination of information about job redesign is needed. Findings of the mail canvass and interviews suggest that many managers are not acquainted with the advantages of programs for job redesign as a specific approach to dealing with problems of the declining capacity of older workers. A substantial number of firms reported that they often transfer or reassign (and sometimes retrain) older workers who can no longer meet the requirements of their jobs to less demanding work. The correspondence and conversations showed that many officials are interested in learning more about the potential of the job redesign approach.

Case Studies of Job Redesign for Older Workers

Crane Operator at a Slag Plant

Introduction and Summary

An electric locomotive crane operator, 56 years of age, who had been disabled for almost 2 years, sought to return to his job. The plant superintendent recognized that the physical strains of the work would need to be reduced, and arranged for installing mechanical footbrakes and pneumatic crane hoist controls on the crane to replace hard-to-work brakes and manual hoist controls. These changes enabled the operator to return to work.

Description of the Establishment

The plant is engaged primarily in processing slag (a residue of iron melting operations) from a nearby steel mill to produce various types of aggregate for use in ready-mixed concrete and for other purposes. Processing activities are spread over a 5-acre area, in an open "yard" operation embracing several structures, piles of aggregate, and lines of railroad tracks. Cranes are used to move slag and raw materials in and out of the yard.

A total of 47 male employees work at the plant. Thirty-nine are employed in various production activities (process and maintenance). Eleven of these are unskilled laborers. There are eight employees engaged in nonproduction activities (executive, supervisory, and clerical). Only the unskilled jobs allow employees to interchange work.

Three-fourths of the plant employees ranged between the ages of 50 and 60, and four employees were over 60 years of age.

The plant does not have a personnel department, nor does it employ an on-site doctor, nurse, or safety representative. The plant superintendent takes care of all personnel problems and is expert in first aid and safety matters. Representatives of the central office personnel department, including a full-time safety officer, frequently visit this plant. There are no formal training programs. A new employee will spend about 6 weeks on the job under the supervision of an experienced employee.

Description of Job Prior to Redesign

The job redesign pertains to the work of the operator of the electric locomotive crane. The crane is at least 40 years old. Its clamshell-type lift bucket has a 2-cubic-yard capacity; total weight handling capacity of the crane is 30 tons. The crane is used to load and unload different sizes of slag aggregate in open top railroad cars.

Prior to the redesign of his job, the crane operator exerted much physical effort working in the cab of the crane. To enter the cab, the operator climbed a short step-up ladder. He manually pushed and pulled three long-handled levers to actuate the booms (i.e., hoists) which either raised, lowered, or moved sideways the clamshell scoop-like bucket. One lever controlled the main boom or hoist; the second, an auxiliary hoist; and the third, a swing boom. He also manipulated a lever to move the locomotive crane car forward or backward along the track (third-rail powered). To apply a braking action involved almost continuous use of two friction clutch footbrakes, on which the operator had to place his full body weight while standing. Although he had a stool available, he seldom sat down. To operate these levers and brakes he exerted considerable physical strength, using arm, leg, back, and other muscles constantly. In the operator's own words, he "fought the machine all day."

The classification of the operator of the electric locomotive crane was one grade below the highest for direct production workers, and the hourly rate of pay was just 3 percent less. Skill ratings and pay rates are established by collective bargaining between the company and the union.

Experience at the job, muscular strength, and dexterity were prime requisites for good performance. The job entailed a substantial amount of responsibility. Carelessness could result in injury or death to the crane operator or others. However, there had not been any accident during the 5 years prior to early 1966, when an employee, stepping down from the crane cab, slipped and sprained his ankle. Responsibility for damage could range from $2,000 to $10,000, in material and equipment costs. Inattentiveness or inexperience could result in dumping wrong sizes of aggregate on piles of already sorted aggregate, necessitating costly rescreening.

The operator worked in an enclosed cab which shielded him from the dust resulting from the dumping and piling of slag aggregate. There were only one electric locomotive crane and one locomotive crane operator. The job of the operator was worker-paced, in repeated short-run cycles, on a continuing all-day, one-shift basis.

Recognition of Need to Redesign the Job

The electric locomotive crane operator, who was 54 years of age and had worked as a crane operator for most of his 25 years of service with the company, had developed a painful skin condition on his legs and thighs. He lost strength, was having trouble standing throughout the day, and his work output declined. The doctor diagnosed an infection and prescribed medication. Following a 4-month absence, he returned to work for a month, could not do his job, and left again.

He applied for and received disability benefits under the Federal Old-Age, Survivors, and Disability Insurance Benefits. Apparently he hoped to return to work eventually and did not apply for benefits under the plant's

pension system. The collective bargaining agreement provides for an old-age pension with maximum monthly payment at age 65, if the worker has had 30 years of service. Lesser sums are paid with fewer years of service. The minimum service requirement is 15 years and retirement is compulsory at age 70. Provisions for early retirement of disabled workers, on full pension, require 15 years of continuous employment. The company also pays for group life insurance and hospital and surgical benefits for its employees. These benefits are paid in addition to Federal Social Security payments.

When the leg condition responded to medication in 1964, 21 months after he left, he requested reemployment at his old job. He was now 56 years old. He would have to work in a sitting position much of the time because his legs were still weak.

Reassignment to another job in the plant was not feasible because all other jobs at the plant required standing most of the day. Moreover, the plant superintendent wanted to use the man's skill as a locomotive crane operator; replacements had not been altogether satisfactory. Neither the crane operator's helper nor a more experienced substitute was able to maintain output during peak load periods.

The company solved the problem by redesigning the job of the crane operator, rehiring the man who had been ill, and reassigning his temporary replacement to a job elsewhere in the plant.

Nature and Results of the Redesign

To permit the operator to sit in the cab during most of the day required that the locomotive crane controls and brakes be modified. The plant superintendent and a maintenance shop leadman knew of the improvements in control devices that are standard equipment on more recent models of cranes. They found that these devices--easily operated mechanical footbrakes and pneumatic controls--could be substituted for the friction clutch footbrakes and long-levered manual controls with which the crane had been equipped originally. The plant superintendent issued a shop order for the new parts, and for skilled worker time in the maintenance shop to install them. Procurement of the necessary parts required about 2 weeks. Actual installation of the parts on the crane was performed over a weekend, so there was no interruption in the use of the crane. Cost of the change, including parts and labor costs, amounted to approximately $500.

The operator now manipulates short airpowered levers or valves to work the clamshell bucket and to move the crane along the track. He no longer has to reach, pull, and push long-levered handles. Slight pressure on the valves actuates the booms. The newer mechanical brakes require very little pedal effort, enabling the operator to sit at his job most of the day.

There was no problem of retraining the rehired operator when he returned to work. The changes involved in the job redesign took place without any consultation between the plant manager and the union. The worker was reinstated to his previous job classification and pay rate level.

Electric Motor Repairman at an Aircraft Engine Plant

Introduction and Summary

In 1965, a 46 year-old electric motor repairman at an aircraft engine plant suffered a heart attack. After an absence of several months, he recovered sufficiently to return to work. He had been required previously to do a considerable amount of standing, climbing, lifting, and walking through the plant during the day. Following consultation among the plant's medical staff, safety engineer, and the foreman of the motor repair group, as part of the plant's thorough job placement program, his job was redesigned to reduce its physical demands. Climbing was eliminated. He no longer moved around the plant; he had to do little lifting; and he could sit frequently. He continued to use his skills as before, and retained his regular job classification without reduction in wage rate.

Description of the Plant

The plant manufactures aircraft engines and component parts. It covers 5 million square feet of floor space, and includes many different units, such as job shops, assembly lines for engine assembling, and other custom and mass production layouts.

In early 1966, this plant employed many thousands of employees, two-thirds of whom were "hourly" rated or production workers; the rest were "salaried" or nonproduction employees. Men comprised about 90 percent of the hourly workers and 77 percent of the large salaried force.

Many jobs in the plant call for the same skills, so employees can be shifted readily among semiskilled and unskilled jobs. Formal training includes apprenticeship programs for machinists, electricians, and similar types of fully skilled journeymen. Other training for workers is informal, on-the-job, and ranges from several days for unskilled workers, to several months for some semiskilled jobs.

The Personnel Department of the plant employs about 500 people, including approximately 90 employees in its Medical Unit (10 doctors, 50 nurses and 30 nurses' aides, medical technologists, etc.) and about 40 employees in a Health and Safety Engineering Unit. These units pertain to plant safety measures, employee health and safety practices, and form the nucleus for the job placement program. As part of the company's thorough job analysis and placement system, safety engineers of the Health and Safety Engineering Unit are each assigned to work with personnel in the Medical Unit. They also work with approximately 50 shop foremen, on all arrangements for initial worker placement, and handle problems of employee job retention, rehiring, and transfer.

The employee participates in the company's pension plan after 2 years of service provided he has reached age 30, otherwise he shares after 5 years of service. Normal retirement occurs at 65 years of age. At age 65, after at least 20 years of service as a participant in the cooperative retirement-income plan, or at age 55 after 10 years of service as a participant, certain benefit options are available. These benefits are provided in addition to Federal old-age and disability insurance payments.

Currently, it is more difficult for the company to find additional employees because of high levels of employment generally. It is advertising for employees through newspapers, television, and radio, and is using the U.S. Employment Service. The company's goal is to hire 1,500 new workers per month for the remainder of 1966. With some measure of success, it is trying to persuade retirees to return, and to retain those workers about to retire. Through its long-time placement program of modifying job demands to meet functional capacities of workers, the company has met some of its labor shortage problems. Much effort is exerted to use experienced workers most effectively.

Recognition of the Need to Redesign a Job

The Company's Employee Placement Program

This case study illustrates the company's policy of matching the physical demands of a specific job with the functional capacities of the employee.

The Personnel Department evaluates the physical demands of each job, and the functional capacities of each employee. This is part of the company's long standing practice of modifying the demands of a particular job if some physical factor unmodified, would require the removal of an employee. Although this practice covers all the employees, the matching of physical demand factors and the employee's functional capacities affects aging workers to a greater degree than younger employees.

The program generally functions as follows:

1. Safety engineers reduce to a minimum the physical demands and hazards of every job.

2. Physical demand analysts study detailed bodily activities required on each job, the job health and accident exposures, and personal protective equipment required on the job. Copies of a Physical Demand Record containing these data (see facsimile), are filed with medical examiners, safety engineers, employment interviewers, and personnel advisors. Every foreman receives a set of records covering the jobs under his supervision.

TITLE OF JOB	SURVEYED BY:	DATE:	ACCEPTED BY:	APPROVED BY:	OCC. CODE:	PLANT	DEPT.:	JOB CODE:
ELECTRIC MOTOR REPAIRMAN	[redacted]	10/14/63	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Supersedes Physical Demands Record of 12-21-59

PHYSICAL DEMANDS RECORD

HEALTH & SAFETY SECTION OF THE PERSONNEL DEPARTMENT

EXPLANATION OF ENTRIES

A NUMBER OR FRACTION	ACTUAL NUMBER OF HOURS THE ACTIVITY IS REQUIRED IN 8 HRS.
E	EITHER RIGHT OR LEFT ALONE WILL DO THE JOB.

PHYSICAL FACTORS

8	1	TOTAL HOURS ON FEET			ON FEET
6	2	STANDING			
2	3	WALKING — Level surfaces			
1/4	4	CLIMBING — Stairs, ramps			
1/4	5	11-20 lbs.	FLOOR TO FOUR FEET	TOTAL EFFORT IN LIFTING CARRYING PUSHING PULLING	WEIGHT EFFORT
1/4	6	21-35 lbs.			
1/4	7	36-50 lbs.			
1/4	8	51-65 lbs.			
	9	66-80 lbs.			
1/4	10	11-20 lbs.	FOUR TO SEVEN FEET		
	11	21-35 lbs.			
	12	36-50 lbs.			
	13	51-65 lbs.			
1/4	14	21-35 lbs.	BENCH TO BENCH		
1/4	15	36-50 lbs.			
	16	51-65 lbs.			
	17	66-80 lbs.			
	18	See Remarks For Weights			
1	19	BACK & HIP BENDING (30°—90°)			BODY
	20	CRAWLING, LYING			
1/2	21	CROUCHING, SQUATTING			
6	22	SITTING			
3	23	Right	FINGERING (Pinching or Manual Dexterity)		HANDS
3	24	Left			
5	25	Right	HANDLING (Grasping or Coarse Hand Motion)		
5	26	Left			
6	27	Right	30°—90° from straight	ELBOW BENDING	ARMS
6	28	Left			
1/4	29	Right	91°—120° from straight		
1/4	30	Left			
1/4	31	Right	Above shoulders	REACHING	
1/4	32	Left			
6	33	Right	Below shoulders		
6	34	Left			
1/4	35	Right	30°—90° from straight	KNEE BENDING	LEGS
1/4	36	Left			
1/2	37	Right	91°—120° from straight		
1/2	38	Left			

REMARKS

Locate trouble and repair or overhaul a variety of defective AC and DC electric motors and electrical apparatus such as heaters, switches, electric hand grinders and drills, fans and miscellaneous electric hand equipment. Visually checks parts for imperfections. Checks dials and gages on testing equipment. Uses a variety of hand tools and hand power tools. Operates various machines, etc. Performs some operations from a sitting position at bench. Moves material manually with help, by hand truck, tricycle, and chain hoist. Lifts alone 10 to 50 lbs. parts, tools, motors, fixtures, etc. Items 5-8, 10, 14, 15, all or any combination required for single work day. Pulling and pushing effort equal to 15 to 35 lbs. Total effort does not exceed 1/2 hour.

(4) Climbs stairs.
(40) Equipment dials and gages.
(44) Fine wiring, etc. (48) Wire color coding.
(49-50) Discuss problem, receive instructions. Hearing to detect foreign noises in equipment.
(52) Electric hoist. (53) Drill press, bench. grinders, coil wiring machine, etc.
(54) Airgun, Dumore Grinders (55) Rides tricycles to pick up and deliver motors.
(56) Icy ground. (58) Material stacked on floor, etc.
(59) Stepladder in crib. (61) Soldering acid, fluxes. (63) Paints, varnish, lacquer, thinner, 9004, 9054, 9001, 9101, 9006, (65) 9831, 9805, 9636, Residual oils and greases (66) Indoor and outdoor conditions. (73) Soldering fumes, abrasive dusts.
(74) 9004, 9001, 9006 Thinner, paints, etc.
Gen. Foreman H. Flagg Reviewed and Accepted

PERSONAL PROTECTIVE EQUIPMENT

Eye, hand protection. Protective cream.

EXPLANATION OF ENTRIES

BLANK NO ENTRY	PARTICULAR FACTOR NOT REQUIRED.
X →	PARTICULAR FACTOR IS REQUIRED.

SENSORY AND EXPOSURE FACTORS

SPECIAL SENSES	EYE-SIGHT	FAR RATING	A	39	
			B	40	X
			C	41	
			D	42	
		NEAR RATING	A	43	
			B	44	X
			C	45	
			D	46	
	THREE DIMENSION VISION			47	
	COLOR VISION			48	X
	TALKING			49	X
	HEARING			50	X
ACCIDENT EXPOSURES	OPERATING EXPOSURES	POWER VEHICLES		51	
		POWER HOISTS		52	X
		EXPOSED MACHINES		53	X
		POWER HAND TOOLS		54	X
		TRICYCLES		55	X
	WALKING EXPOSURES	SLIPPERY SURFACES		56	X
		HOLES AND PITS		57	
		OBSTRUCTIONS		58	X
	ELEVATIONS	LADDERS		59	X
		UNGUARDED (over 5 ft.)		60	
SKIN EXPOS	PRIMARY IRRITANTS (acids, alkalis, etc.)			61	X
	SENSITIZERS (synthetic resins, etc.)			62	
	DEFATTERS (solvents, strippers, etc.)			63	X
	SOAPS (soluble cutting oils, soaps, etc.)			64	
	FOLLIC, IRR. (insol. oils, greases, etc.)			65	X
ENVIRONMENT	TEMPERATURE	HIGH (10° above shop)		66	X
		LOW (10° below shop)		67	
		RAPID CH'NG'S (30° ±)		68	
		COLD WATER		69	
	NOISE	80-90 DECIBELS		70	X
		91-100 DECIBELS		71	
		OVER 100 DECIBELS		72	
	AIR CONTAMINANTS	Dusts, Fumes		73	X
		Mists, Gases, Vapors		74	X
	RADIATION	X-Ray, Gamma Rays etc.		75	
		Ultra-Violet, Infra Red, etc.		76	

3. Whenever a company physician examines a job applicant or employee (including a worker returning to work after an illness), he records his evaluation on a Functional Capacity Record (see facsimile). He indicates the limits of the physical activity of the person examined as the activities relate to specific physical factors (time on feet, weight effort, body movement, climbing, etc.), and sensory and exposure factors (involving eyesight, hearing, accident and walking exposures, etc.). Three copies of the Functional Capacity Record are made: one for the employee's medical record, one to the employment files, and one to the job foreman.

4. The physician, nurse, safety engineer, and other placement personnel compare the applicant's or employee's Functional Capacity Record with the Physical Demand Record which have identical items. It can be readily determined whether the examinee is fit physically for a specific job.

If some physical requirements of a job exceed the functional capacities of an applicant or employee, the company representative considers his placement on part of the job, or recommends job redesign. Such revisions are aimed at reducing the lifting demands, push or pull effort, or physical, sensory, and other demands sufficiently for the placement of a job applicant or retention of an employee. If the employee or applicant cannot do some part of the job, or the physical demands of a job cannot be modified, attempts are made to place him in another job within his functional capacities.

The examining physician makes decisions about his functional limitations, and the safety engineer reviews the working environment and decides on the demands of the particular job. The foreman must agree that the employee is acceptable for working within a limited portion of a job before placement or retention of the employee takes effect. In the case of retention of an older worker whose functional capacities have declined, the foreman's personal knowledge of the worker's experience and skills is an important factor affecting the decision on his retention in a particular job.

Under the foregoing procedures, job modifications are sometimes initiated as a result of a company doctor's routine physical examination of a continuing employee. Whether the examination is done on routine schedule, at the request of an employee, at the suggestion of the foreman, or because the employee has returned to work after an illness (which requires a medical examination), the diagnosis remains confidential between worker and physician. The foreman will not know the nature of the illness unless the employee informs him. The job modification would be based solely on the worker's functional capacity report, which establishes the limitations on his job performance.

NAME	CLOCK	DEPT. AND SHIFT	JOB CODE	OCCUPATION	DATE OF BIRTH	SEX	TYPE OF EXAM.	DATE OF EXAM.	M	S	I
[redacted]	[redacted]	[redacted]	[redacted]	Elec. Motor Repairman	1 13 20	M	09	9 16 65			

FUNCTIONAL CAPACITY RECORD

Replaces Record of 11-6-61

HEALTH and SAFETY SECTION of the PERSONNEL DEPARTMENT

EXPLANATION OF ENTRIES

NUMBER OR FRACTION — INDICATES MAXIMUM HOURS PER 8 HOUR DAY IN WHICH EMPLOYEE IS CAPABLE OF PERFORMING THE PHYSICAL FACTOR INVOLVED.

PHYSICAL FACTORS

3	8	1	TOTAL HOURS ON FEET		ON FEET
2	8	2	STANDING		
1	8	3	WALKING – Level surfaces		
1	8	4	CLIMBING – Stairs, ramps		
1		5	11-20 lbs.	FLOOR TO FOUR FEET	WEIGHT EFFORT
0		6	21-35 lbs.		
0		7	36-50 lbs.		
0		8	51-65 lbs.		
0		9	66-80 lbs.		
1		10	11-20 lbs.	FOUR TO SEVEN FEET	
0		11	21-35 lbs.		
0		12	36-50 lbs.		
0		13	51-65 lbs.		
✓0		14	21-35 lbs.	BENCH TO BENCH	
✓0		15	36-50 lbs.		
0		16	51-65 lbs.		
0		17	66-80 lbs.		
0		18	IF "X", SEE REMARKS	TOTAL EFFORT IN LIFTING CARRYING PUSHING PULLING	
2	8	19	BACK and HIP BENDING (30°-90°)		BODY
0	8	20	CRAWLING, LYING		
2	8	21	CROUCHING, SQUATTING		
	8	22	SITTING		
	8	23	Right	FINGERING (Pinching or Manual Dexterity)	HANDS
	8	24	Left		
	8	25	Right	HANDLING (Grasping or Coarse Hand Motion)	
	8	26	Left		
	8	27	Right	30°-90° from Straight	ELBOW BENDING	ARMS
	8	28	Left		
	8	29	Right	91°-120° from Straight	
	8	30	Left		
1	8	31	Right	Above Shoulders	REACHING
1	8	32	Left		
4	8	33	Right	Below Shoulders	
4	8	34	Left		
	8	35	Right	30°-90° from Straight	KNEE BENDING	LEGS
	8	36	Left		
	8	37	Right	91°-120° from Straight	
	8	38	Left		

REMARKS

ITEM NO.	
1-4	Should be intermittent and
	allowed or about 15 minutes
	sitting each hour.
14	May lift up to 20 lbs. for ⅓
	hour per shift.
59	No ladders allowed
60	No elevations allowed
	To park within 200 feet of Plant entrance. - Special Parking Privileges
1-18-65	Placement arranged with
	[redacted], Foreman by
	[redacted], R.N., Medical E.
05	[redacted]

EXPLANATION OF ENTRIES

X → EMPLOYEE HAS CAPACITY FOR THE SENSORY OR EXPOSURE FACTOR SO MARKED.

O → EMPLOYEE DOES NOT HAVE CAPACITY FOR THE SENSORY OR EXPOSURE FACTOR SO MARKED.

SENSORY and EXPOSURE FACTORS

SPECIAL SENSES	EYE-SIGHT	FAR RATING A	39	X
		FAR RATING B	40	X
		FAR RATING C	41	X
		FAR RATING D	42	X
		NEAR RATING A	43	X
		NEAR RATING B	44	X
		NEAR RATING C	45	X
		NEAR RATING D	46	X
	THREE DIMENSION VISION		47	X
	COLOR VISION		48	X
	TALKING		49	X
	HEARING		50	X
ACCIDENT EXPOSURES	OPERATING EXPOSURES	POWER VEHICLES	51	X 0
		POWER HOISTS	52	X
		EXPOSED MACHINES	53	X
		POWER HAND TOOLS	54	X
		TRICYCLES	55	X 0 ✓
	WALKING EXPOSURES	SLIPPERY SURFACES	56	X
		HOLES and PITS	57	X 0
		OBSTRUCTIONS	58	X
	ELEVATIONS	LADDERS	59	X 0 ✓
		UNGUARDED (over 5 ft.)	60	X 0
SKIN EXPOS	PRIMARY IRRITANTS (acids, alkalis, etc.)		61	X
	SENSITIZERS (synthetic resins, etc.)		62	X
	DEFATTERS (solvents, strippers, etc.)		63	X
	SOAPS (soluble cutting oils, soaps, etc.)		64	X
	FOLLIC. IRR. (insol. oils, greases, etc.)		65	X
ENVIRONMENT	TEMPERATURE	HIGH (10° above shop)	66	X
		LOW (10° below shop)	67	X 0
		RAPID CH'NG'S (30°+)	68	X 0
		COLD WATER	69	X
	NOISE	80-90 DECIBELS	70	X
		91-100 DECIBELS	71	X
		OVER 100 DECIBELS	72	X 0
	AIR CONTAMINANTS	Dusts, Fumes	73	X
		Mists, Gases, Vapors	74	X
	RADIATION	X-ray, Gamma Rays, etc.	75	X
		Ultra Violet Infra Red.	76	X

Description of the Job Prior to Redesign

The electric motor repairman repaired and overhauled defective electric motors and other electrical apparatus. He visually checked parts for imperfections, inspected dials and gauges on testing equipment for short or open circuits, reviewed schematic diagrams, and planned details and sequence of operations for necessary repair work. Using a variety of hand tools, he disassembled motors, cleaned parts, made adjustments, and repaired or replaced worn parts. He also operated various power machines (drill press, bench lathe, etc.) to carry out overhaul operations, and modified available parts to suit special purposes. Difficulties were referred to a work leader.

The job required manual dexterity, visual skill, and diagnostic ability in locating sources of trouble and repairing or overhauling electrical motors or equipment. The worker had to understand electrical repair, be familiar with different models and types of motors, and know techniques for motor rewinding. He was expected to have the equivalent of 2 years of high school education plus 2 or 3 years of trades training. One to two years of on-the-job experience were necessary also in order to reach the full job classification. Ingenuity and good judgment were essential. The plant's skill classification levels rated the job four steps from the plant's highest skill grade (for tool and diemakers).

In performing his duties, in the repair crib or shop or in the plant production areas, the repairman moved material manually or by handtruck, tricycle, and chain hoist. Without mechanical help, he lifted objects (parts, tools, motors, fixtures, etc.) weighing from 10 to 65 pounds perhaps as high as 4 feet from the floor. Push and pull effort, bench to bench, was equal to 15 to 35 pounds and did not exceed one-half hour over an 8-hour workday. The repairman was on his feet most of the workday climbing stairs, ramps, or occasionally using a ladder to reach a work area.

The repairman was engaged in a worker-paced activity. Carelessness in handling motors or parts could result in injury to himself or others. Damage to equipment and materials could result also from his carelessness, but its cost would be unlikely to exceed $ 250.

The accident rate on the job was "low" because of the company's efforts in "human engineering" as part of the Health and Safety Engineering program. Though shock or burns from lighting and power circuits was possible, there had not been any fatalities on the job. There were some "shock" incidents, but no lost time cases.

There were no unusual hazards or discomforts in the conditions of work set by the plant's environment. Lighting was good; the large enclosed plant buildings curbed temperature extremes. A few minor discomforts in the electric repairman's job might be expected, such as noise of a machine shop operation, or oil and dirt from cleaning, repairing and overhauling parts.

The 46 year-old repairman was one of eight electric motor repairmen on the plant's day shift. Their average age was 40, and their service with the company ranged from 10 to 20 years. They were paid on an hourly rate basis ($ 3.15 per hour).

Nature of the Redesign: Action Taken and Results

The 46 year-old electric motor repairman suffered a heart attack early in 1965, but he recovered sufficiently to return to work several months later. When he received the required medical reexamination the physician found that the standing, climbing, lifting, and movement demanded by his job would be too strenuous. His new Functional Capacity Record indicated that some modification would be necessary to accommodate his limited functional capacities. The examining physician, the safety engineer, and the motor repair foreman altered the job to meet the restrictions on his functional activity.

The repairman still located motor trouble and repaired or overhauled a variety of defective electric motors and other electrical apparatus and equipment--all basic duties of an electric motor repairman. However, he no longer moved about and worked in the plant production areas. He remained in the electric motor repair crib doing the necessary repair work. He now lifted items weighing no more than 20 pounds for 30 minutes during an 8-hour shift, rather than the full job weight effort of 65 pounds, for possible 2 hours of a shift. He did no push and pull effort. He had to stand only 3 hours a day, on an intermittent basis, with at least 15 minutes each hour allowed for sitting rather than 8 hours as previously required. Climbing ladders and riding a tricycle, formerly part of the required activity, were also removed from his specific job demands.

By eliminating the heavier lifting tasks, climbing, and standing for long periods, the repairman resumed work without discomfort or danger and used his skills and experience fully. The changes in the requirements of the job did not affect skill classification, or rate of pay.

Packer-Shipper at an Aluminum Frame Plant

Introduction and Summary

An aluminum frame plant redesigned a packing job to retain an older worker who was unable to keep pace with the workload. Tasks requiring frequent lifting of heavy objects were assigned to other workers, and the less physically demanding aspects of his job were expanded. The change resulted in greater productivity for the operation as a whole.

Description of the Establishment

The plant manufactures aluminum extrusions, such as window, door, and truck framing, and conduits. Of the approximately 250 workers employed in the plant, 40 are engaged in nonproduction activities (executive, supervisory and clerical). About 15 percent of all employees are women, half of whom work in production operations.

All training is informal and on the job, under supervision of a foreman or experienced employee. Plant services include a personnel department headed by the Superintendent of Industrial Relations, a fully equipped medical dispensary on the premises attended by a full-time nurse (with a part-time medical doctor on retainer), and a full-time safety representative assisted by a formal plant safety committee. The company has a pension plan which requires 15 years of service for retirement benefits at age 65.

Description of Job Prior to Redesign

The job of "packer-shipper" previously involved the frequent manual lifting, handling, and packing for shipment of bulky aluminum products of varying shapes and sizes, weighing up to 25 pounds. The worker cut paper and cardboard packing material to proper dimensions, checked products for defects, and lifted and placed them in containers. After positioning items properly and packing them securely in the shipping containers, the worker nailed lids on the containers and secured them with wire bands. The worker was responsible for a proper count of all pieces packed. In performing his duties, the worker used hammers, knives, and wire handling tools. He placed heavy items on hand trucks to move them within the shipping department. In terms of physical demands, the activity would be classified as "medium."

The "packer-shipper" job was regarded as semiskilled. It was rated at the number 8 level in the plant's job rating schedule. The top skill level, that of maintenance diemaker, is number 18. Job rates are classified by union-management agreement. The worker had to have some degree of manual dexterity in the lifting, packing, and container closing duties. Inspection,

counting, and recordkeeping required minimum skills. He needed to exercise some care in handling products and in performing other aspects of the job, such as papercutting. Losses that might result from damage to the product or from improper order filling would be unlikely to exceed $ 100.

The work is not machine paced and is organized on an individual basis. It does not involve production runs or operational cycles. The workers are paid on an hourly basis of a 40-hour workweek. No incentive pay is involved.

Prior to redesign, there were 15 "packer-shippers," 14 of whom were female. The average age of the 15 was 42 years.

The work is done in an enclosed, well-ventilated and lighted building with little dust or noise in the shipping area. There are no unusual health or safety hazards.

Recognition of Need to Redesign the Job

The need to take positive steps was realized first in 1961. The shipping foreman complained to his department superintendent that an older worker, age 70, the only man in the "packer-shipper group," was having difficulty in lifting and handling items to be packed. He could not keep up with the workload. The matter was brought to the attention of the Superintendent of Industrial Relations, who discussed it with the supervisor and the plant's union shop representative. Management desired to retain an employee who had been a dependable worker for 6-1/2 years and who wished to continue to work. He was not eligible for a company pension and would have had to live on Social Security payments exclusively if he retired. Except for janitorial work, which would reduce substantially his income, all jobs, to which he could be reassigned, required frequent lifting of heavy objects. Management finally removed the more burdensome physical aspects to retain the worker.

Nature of the Redesign

This job redesign which is called "packer cutter" eliminated the lifting required for packing the aluminum products. While sitting, the older worker was given the primary function of providing supplies for use to other packer-shippers for packing, i.e., to cut cardboard and other packaging materials to prescribed dimensions. He also assisted in banding packed shipping containers, and in pushing hand trucks and dollies to and from the shipping department, a task he had performed previously. He used the same tools he had used in performing his former chores. These light tasks involved no lifting of bulky materials or frequent bending, and were within his physical capabilities. He rested for brief periods since his workload was not continuous, as it had been previously.

The union representative and Superintendent of Industrial Relations agreed on the content of the new job. It was agreed also that the job, with the weight lifting excluded, should be classified at a slightly lower grade. Although this represented a 5 percent reduction in his hourly rate of pay, the worker was satisfied with the change which required no retraining. No costs were incurred by the company; no new equipment was required; and no lost time was involved.

Results of the Redesign

The company made the change smoothly and in a short period of time. Overall output of the work unit increased slightly after the redesign. The packer-shippers benefited by having a ready supply of materials while performing their packing work. The older worker continued to work effectively for 3-1/2 years at his new job, retiring at the age of 74.

Die Press Operator at a Stamping Plant

Introduction and Summary

A 57 year-old man stood all day pulling heavy levers to operate a manual die press. Company engineers, in an effort to increase productivity and reduce the arduous nature of the job, designed and installed a hydraulic press which eliminated the heavy physical requirements and allowed the worker to perform his duties from a sitting position. Output tripled as a result, and the employee's working life probably has been extended.

Description of the Establishment

Work at the plant involves cutting, stamping, and pressing sections of copper tubes into various types of fittings that are used for connecting water and steampipes. The availability of low wage labor was a major reason for the continued operation of this old plant, as much of its equipment is obsolete. Highly mechanized competitors have been able to cut prices on items produced at this plant, on the basis of their lower unit labor costs. Further price reductions by competitors could compel this plant to close its doors unless it installs comparable equipment.

After the plant changed ownership 2 years ago, management adopted plans for mechanization. Some operations, which have already been made semiautomatic by the introduction of new machines, have resulted in an average productivity increase of 20 percent. The new management intends to install improved, automatic machinery throughout the plant within the next 2 years. Some upgrading of the work force and raising the average earnings will accompany the installation of new machinery.

The plant employs about 100 workers. Production workers include 6 skilled, 13 semiskilled, and 80 unskilled employees. All production workers are paid on an hourly basis. Semiskilled and unskilled employees can be transferred readily from one job to another since most jobs consist of simple tasks, such as feeding unfinished parts into a machine.

A plant manager handles personnel and safety matters. A union represents plant employees. Salaried employees have a pension plan but production workers have no pension plan.

The work force is composed largely of disadvantaged workers, including members of minority groups, older workers, and others with handicaps. Because of low wages and poor working conditions, labor turnover is extremely high; it amounted to almost 100 percent last year. The new management is interested particularly in keeping older workers on the job, because they have tended to be stable and dependable.

Description of Job Prior to Redesign

The job of reducing press operator involved the manual operation of a die press machine in making a fitting, i.e., to reduce the circumference of one end of a piece of expanded copper tubing. The worker, standing at this press machine, placed the fitting into a device somewhat like a vise to be held in position by manual pressure on the vise lever. He then reached over his head and pulled down another lever which brought the die press down with a stamping action on the fitting. The worker then stepped on a pedal which released the die, after which he manually released the vise by pushing the lever up. He then removed the part and threw it into a box. Throughout the day, the worker continued this operation in a processing cycle of three to five fittings per minute.

Each fitting had to be reduced six times on six different size die press settings before it was the desired size. The six operations were performed by three workers on three different machines. From time to time during production of a batch of fittings, each machine was set to two alternative size die settings. All three of these workers were men in their middle years; the oldest was 57.

Nature of the Redesign

In 1964 new management requested its engineers to design a multiple die press which would increase output, while reducing the physical stress on the workers. After observing the three workers on this arduous manual job, the engineers proposed developing a semiautomatic press capable of performing successively all six reducing operations in the same machine. The plant machine shop made the press for $3,000.

One worker sits and feeds fittings into the machine all day. He removes the fittings after they have been processed and reduced to the desired size. The machine does all the heavy manual work. Except to feed and remove the work piece, the worker does not interrupt the action as the hydraulic press goes through its cycle of operations. It has a fixture with six dies of different sizes which hydraulically reduces each fitting six times. He pulls a switch to activate the machine and shuts down the operation if it is malfunctioning.

Results of the Redesign

The job redesign requires less physical energy from the operator who no longer has to stand, exert manual pressure, and stretch upward. The oldest worker operates the machine freeing the two other men who formerly worked on the machine to perform other tasks in the plant. The hourly earnings were not affected by the change. In all likelihood, the new machine has prolonged the working life of the older worker.

Materials Handlers at a Carpet Plant

Introduction and Summary

The job of warehouseman at a carpet manufacturing plant involved frequent lifting and handling of carpet rolls weighing from 500 to 800 pounds. The 11 warehousemen required to do this job averaged 55 years of age. The plant methods engineer and safety engineer redesigned the job by introducing a specially designed forklift truck which eliminated much lifting and handling of the heavy carpet rolls. The company retained six men on the job; retired four; and reassigned one. Redesigning the job reduced injuries and both management and workers were reported satisfied with the results of the change.

Description of the Establishment

Over the years, as the company opened plants in other parts of the country, employment at this plant has declined from over 4,000 to the present total of 750. This included about 600 hourly rated production workers, of whom 100 are women and 140 are salaried employees in executive and clerical positions. All 70 skilled workers and three-fourths of the 375 semiskilled workers are male. Also, all 165 unskilled workers and all executive employees are male; the clerical workers are predominately women. The average age of all production employees is 53. This relatively older labor force reflects the plant's long-time position as the principal employer in a small town. Also, the collective bargaining agreement has seniority provisions favoring the retention of older employees.

The company's funded pension plan, which is part of its negotiated union contract, provides for normal retirement at 65 with 30 years of service. A man may retire at 60 with 20 years of accredited service at a reduced pension. There is also a disability retirement provision after 15 years of service. Maximum payments under the company plan are $50 a month or $25 a month with supplemental payments received under the Federal Old-Age and Disability Benefit system.

Training is given on the job, the duration depending on the skill required. Older and younger personnel, who are reassigned occasionally at the plant, involve mostly semiskilled and unskilled workers. Operating conditions determine these reassignments.

The personnel department at the plant, in addition to its usual duties involving job classification, pay rates, union matters, etc., offers employee counseling. A fully equipped clinic staffed by a full-time nurse (with a medical doctor on a part-time retainer basis) is located on the premises. There is also a full-time safety engineer.

Description of Job Prior to Redesign

The job of warehouseman had been physically arduous, requiring participation in 5- or 6-man teams that did frequent lifting, handling, carrying, and positioning of rolls of carpet weighing from 500 to 800 pounds. The workers manually lifted and loaded the carpet rolls on dollies in the warehouse, transported them to a loading platform, and then manually loaded the rolls onto freight cars or trucks. Each trip took about 15 to 20 minutes and covered approximately 150 feet.

Removing the carpet rolls from piled stacks in the warehouse and placing them in freight cars and trucks required frequent stooping, squatting, reaching, and climbing. Usually, one man on the team, on a rotating basis, kept a simple record of the items transported to and from the warehouse.

Recognition of the Need to Redesign the Job

The company recognized the need for lessening the heavy physical demands of the job because of the increasing number of accidents and the age of the men. The average age of the 11 warehousemen was 55 with their ages ranging from 46 to 68. All had a minimum of 25 years service with the plant and three were eligible for full retirement under the company pension plan. The warehouse area had the highest incidence of injury among departments in the plant. Hernia, chest and back strain, turned ankles, and elbow fractures were among the 15 reported injuries in the 5-year period preceding the job redesign. Six of these injuries resulted in lost time.

Nature of the Redesign

Previous efforts to ease the warehousemen's jobs had resulted in a proposal to install overhead tracks and traveling hoists in the warehouse area. Management abandoned this idea because the building was not suited structurally for such equipment. After studying alternatives, the methods engineer and safety engineer decided that the most effective solution would be some type of mobile materials handling machine which would not be hampered by building limitations. A forklift truck, designed to operate with an 18-foot steel ramming rod or shaft, which was 4 inches in diameter and affixed to its front, was proposed. The operator of this truck could lift and carry rolls of carpet with the rod, which could be lowered or raised as required. When inserted into the hard paper core center of a carpet roll, the operator could dislodge a particular roll from a stack of rolls and then lift it for movement to the area or loading station. The company ordered two forklift trucks, specially designed according to specifications developed by the equipment manufacturer in collaboration with the plant's staff. The workers required 1 week of on-the-job training to learn to operate the forklift trucks.

Before the new equipment could be put into full use, the plant's maintenance staff widened some doorways. Also, the manufacturer of the hard paper cores, around which the carpeting was rolled, extended the cores several inches in length so that the rod could be inserted more easily. These two changes took place over a period of from 6 to 8 months.

Results of the Redesign

The new system needed only 6 men to do the work of the 11-man team previously required. The average age of the six was 54, with a range from 46 to 59. Four of the men retired with benefits of company pensions (three with full benefits) and Federal Social Security payments. Their ages at the time of retirement were 68, 66, 65, and 63. The fifth worker, a 58-year-old man, was transferred to a different department, where his earnings level was unaffected by the reassignment.

The base pay rate of the warehousemen remained the same. However, the group incentive rates were revised to reflect the change in method. The increased output per man of the mechanized operation resulted in a net increase of approximately 15 percent in workers hourly earnings.

In the 6 years since job redesign, there have been only five work-incurred injuries. One of these injuries involved loss of time from work, as a result of the elimination of heavy lifting, handling, and moving tasks. This number compares with 15 work injuries over the same time period preceding redesign. Six of those injuries resulted in lost time.

Top-Stitch Workers at a Footwear Factory

Introduction and Summary

The "top stitch" workers at a shoe plant were a group of 20 women, most of whom were over 50 years of age. During 1965 their efficiency was declining because of the physical strains of their job. Some of their tasks required frequent bending and squatting. Not only was their output declining, but absenteeism and complaints increased. After studying the requirements of their work situation in relation to their physical limitations, management redesigned their job by assigning to younger workers the tasks causing physical stress.

Description of the Establishment

The plant employs about 7,700 workers, of whom roughly 1,300 are nonproduction workers, consisting of salaried managerial and clerical employees. There are over 100 skilled repairmen, e.g., electricians, mechanics, etc. Production workers, who number about 6,200, averaged 44 years of age at the end of 1965.

No formal training program exists at the plant, except for occasional classroom training for management development. Most training is conducted on the job. Proficiency at the shoe machines requires about 6 months for most workers. Reassignment of workers is possible when jobs are similar.

The plant maintains a personnel department staffed by 22 workers: 12 professional, 10 clerical. There are four full-time safety representatives. There is no union at this plant.

The company's medical program provides workers and family members with medical treatment by company doctors, and if necessary, by outside specialists, at no cost to the employee except for a $2-administration fee. The medical department employs 60 persons. Last year this service cost the company about $2\frac{1}{2}$ million.

Employees qualify for partial pension at 62 with 25 years of service, and for full pension at 65 after 20 years of service. The company matches employee contributions to the pension plan. If an employee quits before becoming eligible for retirement, the amount he has paid into the fund is refunded plus a minimum of 3 percent interest.

Description of Job Prior to Redesign

The job of "top stitcher" involves stitching the shoe's lining to its upper leather on a sewing machine. The sequence of tasks, prior to the job redesign, was as follows: The worker walked from her sewing machine to a

supply rack, 10 to 15 feet away, to collect a batch of materials--12 pairs of leather uppers for shoe tops and 12 pairs of linings--which weighed about 10 pounds. Finding the appropriate batches of leather and linings on the rack usually required squatting, stooping, bending, and occasionally some eye strain. The worker carried the materials to her machine and performed the stitching operation, at her own pace. She would trim then with scissors the threads of the joined parts. Finally, she put her completed work into a box which she would carry later to a nearby area for the next operation.

The entire top stitching operation took approximately 15 to 20 minutes per batch. After this was completed, the worker went back to the rack for another batch of materials and repeated the entire procedure. Additional duties included changing the bobbin when necessary, repairing thread breakage, obtaining supplies from the thread cage, and contacting maintenance men when a machine needed any repair work.

The top stitcher must have considerable manual dexterity and ability to coordinate eye, hand, and foot action in operating the sewing machines. She sets the bobbin in motion by depressing the clutch pedal with her foot, and stops it by depressing the footbrake. She needs high visual acuity to stitch the lining properly.

Recognition of the Need to Redesign the Job

Shortly before the job redesign was undertaken, the plant superintendent and department manager had found that the productivity of the stitchers, all of whom were women with long periods of experience in their work, had dropped 13 percent below standards previously set by time study engineers. Moreover, the workers complained about the frequent bending, squatting, and stretching required to procure materials from the supply rack. Finally, a steady increase in absences supported the decision that some changes were needed.

The plant superintendent, department manager, and other management people discussed the problem and decided that the jobs of the top stitchers should be redesigned. Reassigning the workers was rejected for a number of reasons: (1) the company did not want to lose the experience and skill the women had acquired over more than 25 years on the job, (2) relatively low wages caused difficulty in recruiting experienced workers, and (3) no other jobs were available that did not require constant standing at machines.

Nature of the Redesign

The plant superintendent and department manager redesigned the job of top stitcher by removing work that was not involved in the actual stitching operation. They assigned these tasks to two "service workers," chosen from among the 20 stitchers after bids were opened to any stitchers who were interested. Two of the younger stitchers were chosen to become the service workers because of the more strenuous nature of the new job, which would

require constant bending, stretching, squatting, and possible eye strain. Of the 20 stitchers, all of whom were women, only 4 were under 45 years of age. Two were between 45 and 50, eight between 50 and 60, and six between 60 and 65. With the reassignment of two of the workers, the top stitchers were reduced to 18.

The stitchers are able now to sit and work uninterruptedly at their machines. Standing, bending, squatting, and straining the eyes have been eliminated. Productivity increased by 16 percent, 2 months after the job redesign. Since then, absenteeism has declined also and employee complaints have become infrequent. The earnings of the top stitchers, who are paid on a piece rate incentive basis with a guaranteed hourly base, have increased as a result of the higher output per man-hour. The two service workers receive higher earnings now than they did as stitchers. After an experimental period when service workers were guaranteed their average earnings as stitchers, time study engineers established piecework pay rates. Since their proficiency at locating supplies has increased steadily, their earnings have also increased.

No retraining of either stitchers or service workers was needed. The redesign involved redistribution of tasks in which both groups were experienced. No expense was incurred by the job redesign, since there was scarcely any interruption in work, and no new equipment was needed.

Press Operator at a Novelty Products Manufacturing Plant

Introduction and Summary

At a plant manufacturing novelty spheres, management redesigned the job of a 68 year-old worker so that he would be less fatigued. By isolating and assigning to him a part of the total job and allocating to other workers the tasks that required standing, the older worker could remain seated.

Description of the Plant

The plant manufactures paperboard spheres and other novelty products of metal and plastic materials. It employs approximately 215 people, nearly half of whom are men. About 40 employees are in executive and clerical positions; 175 are in production jobs. Two mechanics and one die setter, the only skilled workers, have served their formal apprenticeships elsewhere. All the other factory workers are either semiskilled (82) or unskilled (90). None of their jobs required more than 3 weeks on-the-job training.

Over the years, the company's production supervisors have made many changes to lessen the manual workload and to simplify tasks at specific stages on the assembly line. These improvements have resulted in operational procedures which require few highly skilled production workers. On-the-job training is the only type of training practiced.

The plant employs a full-time personnel director, who is responsible for safety and "first aid," along with the usual duties of this position. No union exists at the plant.

Description of Job Prior to Redesign

The job of press operator and sphere joiner, which was redesigned for an older worker, covers three separate semimechanized tasks: first, stamping out paperboard sphere halves on a hydraulic press; second, joining the halves to form a sphere by means of a special machine; and third, cutting parts for use in joining. These tasks are rotated among the 13 workers classified in this job category.

In the press operation, the worker, while standing, manually feeds a lightweight paperboard sheet into a press and then actuates the stamping action by depressing lightly a foot pedal. The die forms the sheet into the shape of a half sphere. The worker repeats this action until he completes a batch. He moves the completed work to the joining operation on a handtruck.

The worker, standing at the joining operation, first manually fits a hard paperboard hoop, 5/8-inch in width, partially into a half sphere. Adhesive covers the hoop to hold the two halves together. Next, he visually inspects the halves for marks which guide him in aligning them properly. The joiner places the two parts into a joining machine and pulls an overhead lever which brings air pressure to bear at the juncture of the two halves, firmly joining them. He then stretches up to hang these spheres on an overhead conveyor which carries them to the next operation.

Whenever the supply of hoops needed to be replenished, each joiner cut his own hoops from a large roll. Standing before a cutting machine, the worker placed the roll in position and started the cutting operation by pulling a lever. After cutting a batch of hoops, he brought them back to his workplace.

The sphere joining function required a greater degree of manual dexterity and visual acuity than the two other tasks. In performing the sphere joining task, the worker must position carefully the halves to get a perfect fit of the pictured areas on the joined sphere. The older workers tended to avoid this task, and to spend more time at the press operation, because the latter job required less visual acuity and dexterity.

The position of press operator and joiner whose pay rate is $1.65 an hour is in a low level of the semiskilled job classification. The job did not involve any unusual degree of hazard to the workers, nor would any worker's neglect result in damage to equipment or materials of more than a few hundred dollars.

Recognition of Need to Redesign the Job

There were 13 male workers on the job prior to its redesign. Their ages ranged from 28 to 68; the average age was 38. All of the workers were under 50 except the older worker for whom the redesign was carried out. Average length of service of those on the job was less than 10 years.

The 68 year-old worker had been employed at the plant for 10 years in the combination job of press operator-sphere joiner. He had performed his tasks skillfully and plant supervisors regarded him highly. He appeared to be free of any physical difficulties. The vice president in charge of production decided that the output of a man of 68 would decline if he had to continue to stand at his job during most of the day. The vice president, therefore, requested the foreman, who supervised the worker, to design a change in job content that would enable the worker to sit rather than stand most of the workday. It was felt the worker, who himself had not complained about the standing that was required, would not have requested special consideration.

The worker was eligible already for a retirement pension from the company when the job change was effected. Payments, including those under Social Security, would have been smaller than his wage income, in view of

his brief employment with the firm. Under the circumstances, both he and his employers preferred that he keep working.

The company's pension plan, financed entirely by contributions from the employer, provides for initial eligibility during the fiscal year in which an employee reaches his seventh anniversary with the company. Normal retirement is at age 65 for males, 60 for females. The company contributes 10 percent of the amount equal to an employee's annual earnings to the pension fund. After 15 years of service, an employee acquires a 50 percent equity in the amount paid into his account; after 20 years, he has a 100 percent equity.

Nature of the Redesign

The personnel director and foreman decided to assign exclusively the hoop-cutting task to the 68 year-old worker as a separate job. This redesign would eliminate from his duties the standing, pulling, lifting, and stretching which were involved in the press and joining operations. The total volume of the hoop-cutting work would keep the older worker occupied full time.

As part of the job redesign, the company relocated the machine used for cutting the hoops to one side of the press and sphere joining workroom. More free space in the working area provided a place to sit in front of the machine, allowing the older worker to remain seated while working. He had to rise only occasionally, to obtain a supply of paperboard rolls from which to make and supply hoops to other workers. There was no problem of retraining since he was already familiar with the hoop-cutting task.

Results of the Redesign

Production of the unit increased by approximately 10 percent as a result of this job change. The man assigned to hoop-cutting was able to keep the joiners supplied with all the hoops they needed at the pace required. The latter no longer had to interrupt their sphere joining tasks to make their own hoops.

The older worker was reported to be pleased with the change because it permitted him to sit most of the time. The new arrangement relieved him of the visual strain of matching sphere halves. There was no change in rates of pay for any of the workers. Output increased by an estimated 10 percent on the press operating and sphere joining operation.

The job redesign incurred no costs and only a few hours of interruption of work to relocate the cutting machine.

Grinders at a Foundry

Introduction and Summary

This case study discusses the redesign of a pipe grinding and test press operation at a cast iron pipe foundry. Prior to the change, the operation was largely a manual activity occupying 10 men--standing, lifting, and handling heavy pipe under very dusty and noisy working conditions. At least four of these men were over 45 years of age. The redesign converted the entire system to a pushbutton, fully automatic method, using only 1 of the 10 workers to operate the new equipment. This worker, 50 years of age, sat most of the workday, operating easily actuated pneumatic electric controls. The company reassigned the other workers to less physically demanding work in the plant.

Description of the Establishment

This plant, which manufactures iron and steel castings, is one of the largest independent foundry operations in the United States. Its production facilities are located on a 230-acre plot housing three types of foundry operations in three separate buildings. One is a cast iron pipe foundry, built in 1926; the second is a cast iron fittings foundry, built in 1940; and the third is a steel foundry which the company built a few years ago and which contains the latest types of steel tube casting equipment.

The company has been mechanizing since its earliest years. Hand-molding of cast iron pipe and iron fittings was mechanized at the plant in the early 1930's. Over the years, the company made advances in casting techniques and in material handling methods. Overhead traveling cranes, conveyor belts, palletization, and other motorized material movement equipment, and procedures have been introduced extensively to eliminate very heavy lifting and moving of castings. A pneumatic system operated from a central control panel receives molding and core sands in bulk and moves them to storage and work areas.

These changes have reduced the hard, manual labor and have employed men who might have been compelled otherwise to leave the company because of aging or other physical handicaps. A considerable number of tasks in the plant still require strenuous physical effort. Many jobs require men to work in hot temperatures and very dusty, dirty conditions. The goal of the company's management is to eliminate these conditions as much as possible.

The company employs approximately 2,500 people, 2,000 of whom are men engaged in production. The remainder work in nonproduction activities. About 23 percent of the production workers are employed in skilled jobs (journeymen molders, coremakers, maintenance mechanics, etc.); 39 percent in semiskilled work; and 38 percent in unskilled jobs.

Formal job training in the plant is limited to a 5-year apprenticeship training program for skilled journeymen jobs such as molders, coremakers, and some maintenance workers. Until the journeymen pay rate is reached, a formal, graduated rate scale is set up for the entire training period. Apart from this program, every new employee attends 10 2-hour sessions on plant practices and employee services. Semiskilled or unskilled workers are trained on the job under the guidance of a supervisor or experienced worker.

Men in semiskilled and unskilled occupations can be reassigned or transferred to many jobs in the plant. Generally, skilled workers cannot be reassigned easily, especially where formal apprenticeship has resulted in a journeyman status. When such workers are transferred to less skilled jobs, the company maintains the employee's rate of pay at the level which he received in his former job. The company does not have any collective bargaining agreement.

The company's personnel, medical, and safety services are quite extensive. The personnel department offers many aids to employees, including counseling. There is a full-time safety representative. The company pays the total cost of all medical services needed by its employees and their immediate families. The company's medical staff includes five full-time medical doctors, six full-time dentists, and a large number of consulting specialists who attend the employees at clinics. The company also pays for hospitalization.

The company's employee pension plan does not require any employee contributions. A "normal" full pension can be obtained at age 60 with 30 years of service. Retirement is compulsory at 65 years of age, but 20 years of service is required for pension rights. An employee may be retired on disability with 15 years of service. A formula weighted toward the workers at lower earnings levels establishes retirement payments. The president of the company indicated that some of the company's interest in redesigning jobs by making work less arduous was to curb early retirements.

Description of Job Prior to Redesign

The "pipe grinding and test press station" operation, which is one of the final stages of the process flow in the foundry, is in the "clean and ship" department. Grinding is required to remove metal burrs or rough edges from the interior surfaces of the pipes. The hydraulic water press test subjects the pipe to water pressure of 500 pounds per square inch to locate defects and test metal strength.

The work at the station consisted of three physically demanding manual functions. A "loader" man, wearing protective gloves, pushed and rolled still hot pipes along an inclined rack into each of three electrically driven rotating pipe rolling machines, locking the pipes in position. An operator started the

machines by manually pushing long levers. Six "grinder" men, one at each end of the three machines, individually lifted a 10-foot metal shaft or pole topped with an abrasive grinding head or "rock"--total weight 40 to 50 pounds--and inserted it into one end of the cast iron pipe. They manually pushed and pulled the poles back and forth in the pipe for approximately 2 minutes, at which time the operator stopped the machines. The grinders pulled the poles from the pipes, placed the poles on the floor, released the pipes from the machines, and started them rolling to the test press. The grinders were ready then for the next pipe grinding cycle. The two men at the test press machines manually rolled the pipes into the saddles of the machines, locked them in position, tested them, pried the pipes loose with a wooden post, and pushed them on to a final cleanup area.

In the job classification series, the jobs at the pipe grinding and test press station were all classified as semiskilled but the jobs of loader, grinders, and test press-machine men were all rated just one step above the common laborer category. The operator who manipulated the levers for the pipe rotating machines was classified somewhat higher in the semiskilled job range.

The workers were all paid on an hourly rate basis. The operator's rate was approximately 18 percent higher than the rate of the other workers in the operation.

For all the workers, except the operator, the prerequisites for performance were brawn and good physical condition. The operator had to stand most of the workday. Though pushing and pulling of levers was fatiguing, his work was not so strenuous physically as the work of the others. In addition to being on their feet most of the day, these workers performed tasks demanding arduous physical effort. The 2-minute, machine-paced cycle, requiring constant lifting, pulling, and pushing of the 40 to 50 pound poles, imposed a heavy physical burden on the grinders. They turned out approximately 90 pipes per hour. The loader and two test press men also did a great deal of exhausting manual moving, pushing, and pulling.

To avoid accidents, the workers exercised at least ordinary care in doing their jobs. The company did not expect financial responsibility for damage to material or equipment to exceed $ 200. If the workers were careless in performing the grinding job, the pipe had to be run through the operation again for reworking.

The men worked in an enclosed foundry area, which was somewhat noisy, very dusty, and exposed to steam vapor. They wore protective helmets, face shields, and nose respirators during some parts of the process.

In 1961, the average length of service of the six grinders and the operator was 19 years; the range was 14 to 25 years. By comparison, the average plant seniority was 14.5 years. The average age of the seven men

was 46, ranging from 39 to 52 years. Three of the men were at least 46 years old and the operator was 50 years of age. (Age and service data were not available for the loader and the two test press men.)

Recognition of the Need to Redesign the Operation

In anticipation of increased business, the company redesigned the "pipe grinding and test press station" in 1961 to increase output capacity of the operation and to reduce costs. A contributing factor in the decision to make the change was the fact that most of the workers had requested frequently to be transferred from the operation because the work was unusually exhausting physically. The men were in good health and (as reported) "they realized they had to be to work at their jobs." Given the opportunity, they preferred to be placed elsewhere in the foundry. Past records had shown that men rarely remained in this operation after their early fifties. At least 4 of the 10 men then in the unit were between 46 and 52 years of age.

After considerable discussion with his production staff planners and supervisors, the Vice President in Charge of Production requested a redesign of the pipe grinding and test press station. He brought this request to the attention of the Vice President of Engineering, who was responsible for planning and accumulating the data necessary for making the change. The company's engineering department designed the change. The company's maintenance shop made some of the equipment and necessary parts and some were purchased. The maintenance shop employees also installed most of the equipment. Out of pocket costs for the new system were estimated at $ 150,000.

Nature of the Redesign

Under the new system the basic process flow remained the same as before, but the company made specific tasks automatic. These specific tasks included loading and feeding the cast iron pipes to the pipe rotating machines, grinding or cleaning the pipe interiors, pipe pressure testing, and removal of the pipes from this last step. Motorized grinding units, fitted with long poles topped with abrasive grinding rocks and linking pipe conveyors, replaced the three previous pipe rotating machines. To replace the manually controlled levers which actuated the pipe rotating machines, the company installed pneumatic electric controls. The station's operator activated these controls from a pushbutton panel to carry through the complete operational cycle, including the test press, without any manual assistance.

The change eliminated the hard, physically demanding jobs of the loader, the six grinders and the two test press men, all of whom were transferred to other jobs. The worker operated the new equipment after a few weeks of on-the-job training. Because of the pushbutton pneumatic control system he could sit during most of his work tour. Previously fatigue resulted

because he had to stand most of the day. Five years after the redesign, the operator, the only man in the pipe grinding and test press operation and who is now 55 years old, is still working.

The six grinders who were transferred from the rotating grinding machines to other jobs, also experienced a reduction in physical demands. Three were moved to another section of the cleaning department, and assigned to touchup grinding work, using handtools (manual or electric) to grind or clean rough or irregular surfaces on castings. They frequently sit while working. The company assigned two of the men to pipe-bundling fork-lift trucks and the sixth man to operating a pipe printing machine, via push-button control. These men needed only a small amount of on-the-job training to prepare them for their new jobs, which were much less difficult, physically, than their former jobs. The former grinders are employed currently at the foundry. The other workers (loader and two press men) were transferred also to less fatiguing work.

The new system has reduced greatly the extent of possible hazards to health and safety. The operator works in a protected enclosure, freed from exposure to the dusty conditions. The other workers have been transferred to areas where the dust conditions were not so bad and where there is no steam vapor problem. Thus, although the redesign was not undertaken specifically to accommodate the work to the limitations of older workers, it did lessen the heavier physical work. It also bettered the work conditions for all of the workers involved, including at least four men who were over 45 years of age.

The new pipe grinding and test press system was designed to accomplish the grinding and testing of approximately 135 pipes per hour, a 50 percent increase in production over the former method. (However, the anticipated increase in demand for the plant's pipe products did not materialize, and the actual output has remained at the former level of 90 pipes per hour.) Labor cost savings as a result of the reduction in manpower for the operation were estimated at $6,000 per worker, per year, or a total of $54,000 per year for the nine men transferred to other jobs.

The employees were reported satisfied that the change made their jobs somewhat easier and improved their working conditions. They retained their same job grade levels and there was no downgrading of wage rates.

Wirecutter and Porters at an Instrument Factory

Introduction and Summary

A plant, which produces precision instruments, emphasizes the modification of jobs to accommodate the physical limitations of employees. Two instances relate to job redesign for older workers. The first case concerns mechanization of a manual task. The plant assigned the easier work on a full-time basis to a 63 year-old worker with an arthritic condition. Productivity doubled and the man remained on the job until he was eligible for a pension. The second case involves the reduction of weights that the plant's porters lift. Middle-age workers may extend their working lives because of this reduction of weights.

Description of the Establishment

The plant manufactures potentiometers and other precision control instruments, mostly for use by the Government in space and defense programs. Production systems vary according to the instrument or component being made. This system includes unit operations in which the worker makes the entire part on a custom basis as well as batch and assembly line operations.

The plant employs 440 persons, of whom nearly half are nonproduction workers, including 110 supervisory, engineering, and technical, and 106 clerical. Production workers include 80 skilled and 154 semiskilled, most of whom perform operations of a bench-assembly nature. Nearly all production jobs require some degree of training. Much of this training is obtained informally on the job, under the supervision of a foreman.

A personnel department extends plant services for workers. These services include a medical unit staffed by a registered nurse, a safety coordinator, and a safety engineer. Workers at the plant are represented by a union. The company has long had a policy of utilizing physically handicapped workers on some jobs.

The company pension plan provides for benefits to employees who retire at age 65 with a minimum of 10 years of service. Earlier retirement is possible after 20 years of service if the company management consents or if the employee becomes permanently and totally disabled.

I. Mechanization Benefiting a Handicapped Worker

Nature of the Redesign

One of the many tasks of a group of potentiometer finishers is to stretch wire to reduce its diameter, and then cut it to the desired length. They use the processed wire as a component in a potentiometer. Each of

these workers stood a small part of the day at a cutting fixture, using small hand tools to clamp the wire and to adjust the fixture. This task required a moderate degree of manual dexterity and strength.

In 1964, as part of normal efforts to increase productivity and cut costs, the plant production manager conferred with the methods engineer and foreman concerning the mechanization of the wire stretching operation. After thorough study, the engineer designed an automatic wire stretching fixture costing $700 which mechanically stretches the wire to proper dimension and cuts it off at a preset length. With this machine the worker can sit at his work, and perform the task with minimum physical exertion. Learning to operate the new machine requires only 1 to 2 hours of on-the-job training.

One of the potentiometer finishers was a 63 year-old worker who had been having increasing difficulty in performing various tasks because an arthritic condition had reduced his ability to move his hands and fingers. The plant foreman had been assigning him odd jobs to keep him at work until he could retire. However, as his condition worsened it became more difficult to find work he could perform. He had been employed by the company for 15 years. This length of time was not long enough to qualify him for early retirement or for disability benefits under the company pension plan.

The foreman and other management officials became concerned about keeping him productively employed. After the company mechanized the wire cutting task, which required very little manual dexterity, they assigned him this task exclusively on a full-time basis. He performed very satisfactorily, and relieved the other potentiometer finishers of cutting and stretching wire.

Results of the Redesign

The older worker is now expected to remain on the job until he retires late in 1966, at age 65. He will draw the company pension, in addition to Social Security benefits. The redesign of this job will enable him to complete his working life in a productive capacity.

Output per man-hour has doubled on the wire stretching task as a result of redesign. Moreover, the mechanized device produces more uniform diameters of wire. The wage rate of the older worker who received the standard hourly rate of a potentiometer finisher, has not been affected by the job redesign.

II. Reducing the Lifting Burden

Description of the Job Prior to Redesign

The company employs four porters, age 43 to 59, to clean floors and surrounding areas. They empty and clean trash containers, which are located in the factory and office areas of the three buildings of the plant.

Everyday three of the four porters do this task, which takes an average of $1\frac{1}{2}$ hours, one porter doing it in each building. Emptying large trash container units in the factory area occupies much more time than emptying office waste baskets.

The large metal trash container units in the factories were about 2 feet in diameter and 3 feet high. A hollow metal cylinder with a semiglobe top that housed a hinged door through which trash items were pushed covered the container. To empty the container, the porter had to lift this outer covering, weighing about 25 pounds, above the top of the inside container. The container itself weighed about 5 pounds when empty and 15 pounds when full. On trash collection rounds the porter emptied the container into a 55 gallon, 4 feet high, steel drum set on a heavy wooden truck with iron tracked wheels, which he pulled through the plant buildings. After emptying each container, he put it back in place and covered it with the cylindrical outer shell.

On completion of the rounds, the porter pulled the wagon to the side of a plant building to empty the heavy trash-filled drums into a large mobile trash receptacle, approximately 5 feet high and 10 feet square. Then the porter cleaned the drums with a water hose and stored them for the next day's use.

Nature and Results of the Redesign

In 1964, several of the metal trash containers and outer shells became badly rusted, and needed to be replaced. To benefit the porter crew, the Industrial Relations Manager purchased corrugated plastic containers that were lighter in weight and more convenient to handle. They are topped by a prism-shaped plastic lid, having a hinged opening through which trash is put into the container. Lid and container each weigh about 1 pound. The purchase of several of these units, with plans to purchase more, led to the replacement of the heavy ungainly truck, and the 55-gallon drums, by a lightweight, rubber-wheeled push-truck, costing about $100, on which two 30-gallon size plastic drums were set.

The new plastic container units cost about as much as the metal units they have replaced, and are expected to last equally long. Since they are lighter in weight, these plastic receptacles are easier to handle for cleaning. Moreover, the clean new receptacles and the quieter truck are more desirable in a plant where precision work predominates.

Reduced physical strain on the porters in lifting and handling trash containers is the most important gain from adoption of the new system. The new equipment boosts morale and produces a saving of 20 percent in work-time resulting in greater efficiency in the porters' other cleaning tasks. The easing of the porters' job through acquisition of the new equipment may lengthen the working lives of these older men.

Circuit Assembly Workers in a Computer Plant

Introduction and Summary

This case discusses a group of assembly workers at a computer manufacturing plant, all of whom were over 45 years of age. Some would have had difficulty continuing with an increased workload. To improve efficiency, the engineering staff designed a new system of operations which eliminated eye strain, bending, stretching, and squatting. The productivity of the group increased substantially.

Description of the Establishments

The plant develops and produces electronic computers and other component parts used in data processing equipment and computers. Production systems are changed frequently, sometimes to improve methods, but more often because of the introduction of improved models of computers offering greater speed, memory capacity, etc., over older models.

The general practice provides mechanical equipment to reduce fatigue and facilitate production. Hoists and other lifting devices assure that workers are usually not required to lift more than 25 to 30 pounds. Seats of varying heights are available for production workers. Although improvements in equipment and techniques are not usually undertaken with the limitations of individual workers in mind, some especially designed equipment has been installed to accommodate disabled and blind workers.

The plant employs 7,400 workers, of whom about 4,600 are nonproduction and 2,800 are production workers. The high proportion of nonproduction workers reflects strong emphasis on engineering. The plant has a personnel staff of 87 which includes 5 safety representatives, 2 medical doctors, and 9 nurses. Production worker training is primarily on the job. Nonproduction workers average 8 hours of classroom training during the year.

The company pension plan permits an employee to retire at age 55 on a partial pension with 15 years of service, and on full pension at age 65, which is the mandatory retirement age. There is no union at the plant. Workers' earnings are based on weekly salary only.

Description of Job Prior to Redesign

The production operation in which job redesign was carried out is called "chassis populating." Eleven workers, all of whom were over 45, stood at work tables and inserted 2- by 5-inch epoxy laminated cards containing electronic circuits, into a chassis frame, designed to hold approximately 200 such cards. Each worker placed an empty chassis frame on a worktable and visually scanned a long printed instruction list which indicated the proper circuit card to insert in each slot of the chassis frame. Next, he walked to a supply area, 15 to 20 feet away, chose the part he needed, returned to the

worktable, and plugged the part into the chassis frame. He repeated this procedure until he "populated" the chassis. The worker frequently had to search for cards in the supply racks, which contained several thousand differently numbered cards. Occasionally, cards were not stored conveniently, or were not easily identifiable. To find the proper part the worker had to bend, squat, and reach over his head. Some workers suffered eye fatigue trying to read the instructions to insert the individual cards.

When the worker finished a chassis (now weighing 15 pounds), which took from 45 minutes to an hour, he lifted it from the table and set it on top of completed chassis, ready for use as a component part of the total circuitry of the electronic computer. Then, using the same or a different instruction list, he started work on the next chassis.

Learning the operation required only a short period of on-the-job training. However, insertion required great care to prevent malfunction of a computer.

Nature of the Redesign

A staff of engineers is engaged constantly in studying work methods in all operations to reduce costs, increase output, and eliminate obstacles to high productivity. The project manager drew the attention of the engineers to the chassis populating operation in 1962, after management had requested him to find a way to increase productivity. While redesign of the operation was not undertaken directly because of physical strain experienced by the employees, greater accuracy and productivity among the group, of whom all were over 45, under conditions of growing workloads, were factors in making changes in the operation. After much experimentation, engineers designed a new system with three distinctly new elements: a new card storage system, a swivel top worktable, and a recording device which dictates taped instructions. The new system eliminated in several ways physical effort in reaching and bending, and possible eye strain.

The worker now places the empty chassis frame on a swivel top table which is raised or lowered hydraulically to bring the frame to supply racks at a convenient height for the assembler to work. Metal supply racks store the circuit card parts so that gravity pushes the cards forward as the worker removes them from the rack. The cards are arranged more systematically than before, and their numbers can be read easily.

A recording machine announcing vocal directions eliminates the reading of instructions from a printed list, and allows the worker to have both hands free for plugging cards. He no longer had to hold and read an instruction sheet. He places the tape in the recording machine, puts on earphones, and activates the machine by depressing a foot pedal. The voice gives the location of each card in the chassis. The worker listens and works simultaneously rather than having to read and then work. He regulates the speed of the tape. He plays it back or stops it as desired.

Several speaking voices were tested on the instructional tape before the workers accepted a few as satisfactory. Voices must be pleasing to the ear since workers listen to instruction intermittently throughout the day.

The new system required 2 to 3 weeks of on-the-job training in the use of the tape recording device and the location of parts in the storage racks. Earnings were not affected by the redesign since the workers receive weekly salaries.

The cost of equipping the 11 work stations was about $45,000. Each recording machine cost $400; the swivel top work table and storage racks accounted for the remainder. Engineering costs amounted to an additional $2,500 to $5,000. Engineers designed only one work station at a time to avoid serious work interruption.

Results of the Redesign

Since the redesign, the output per employee on this operation has tripled at least. Redesign shortened the time required to fill a chassis from 45 to 60 minutes to 15 to 20 minutes and reduced errors in insertion 65 percent. The new system has lessened fatigue substantially--the main cause of errors in insertion. Substituting auditory for visual instruction spread the workload over more of the operator's senses since auditory fatigue does not take effect so quickly as does visual (optical) fatigue.

Stooping, bending, squatting, and eye strain were eliminated virtually by installing the convenient hydraulic swivel top table and rearranging the storage racks. These new racks provided more efficient arrangement of circuit cards and clearer method of identification than the previous system.

Appendix A. Union-Industry Sponsored Rehabilitation Project

The experience of a union-industry sponsored project involving job redesign is described in this appendix. This description is based on discussions with the project directors and on the published report, Demand for Rehabilitation in a Labor Union Population: Part One: Research Report, Hyman J. Weiner, Shelley H. Akabas, Bruce Grynbaum (1964); Part Two: Action Program, Hyman J. Weiner, Shelley H. Akabas, Morris Brand, Bruce Grynbaum (1966); Sidney Hillman Health Center of New York, New York, N. Y.

Job modifications to accommodate some older workers in the men's clothing industry in New York City were carried out in this project as one part of a 3-year (1961-64) vocational rehabilitation research and action program conducted by the Sidney Hillman Health Center. The Center itself was established as an outpatient health facility, in 1951, by the New York Joint Board of the Amalgamated Clothing Workers of America (AFL-CIO) and the New York Clothing Manufacturers Association, to serve the health needs of union members and female spouses. It undertook the rehabilitation project as a result of a research and demonstration grant from the Vocational Rehabilitation Administration (HEW) and additional financial support from the New York chapter and national office of the American Heart Association.

The Center was selected for the project because it serviced the health needs of the industry's workers; relations between management and labor were good; and efforts at rehabilitating workers and placing them in jobs could be expected to receive full cooperation of all the parties, including public welfare and rehabilitation agencies. Additionally, the industry's work force in New York City is an aging one, whose median age is 50 as compared with the median age of the City's work force, which is 44. Almost 20 percent of the industry's male workers were over 65 years of age, compared with 5 percent for the City's working population.

Many groups welcomed the project, based on an industrywide approach to the rehabilitation of workers needing help. Apart from humanitarian aspects, maintaining a skilled work force in the face of labor scarcity was a concern of both union and management.

The initial or "research" stage of the project included a mail survey of 25 percent of 20,000 working members of the union--those who had worked full time at least some part of the year before the beginning of the project. The purpose of the mail survey was to learn the extent of rehabilitation need, based on chronic conditions (heart, arthritis, etc.) as reported by the membership. Spouses of the members were included. From a 60 percent response, a sample of 300 positive respondents was selected for intensive personal interview. A demonstrated need for rehabilitation due to a substantial limitation in a major activity (job or housework), personal care, or social participation, plus the physiological capacity to benefit from the program determined the selection of samples for help.

The second or "action" stage of the project involved the actual rehabilitation and placement efforts of the professional staff. Some of the mail respondents were not in need of help or could not be helped through rehabilitation efforts. Others were maintained on their jobs, or enabled to return to their work with some professional guidance. For still others, adjustments in their job duties or working environment made it possible for them to resume active working lives.

One case involved a 57 year-old skilled cutter who had had a heart attack several months before his referral to the project staff. He could do all of his duties as a cutter except lift the 60 to 100-pound bolts of cloth onto the cutting table. Other workers in the cutting room assumed responsibility for his lifting duties, enabling the cutter to return to work.

A number of other cases involved individuals with emotional problems. In some instances, partial successes were achieved in modifying working arrangements affecting these workers. When the project was extended after 1964, for another 4 years, rehabilitation of workers with mental health problems received greater emphasis. Job modification will be one of the techniques that will be significant in helping workers with mental and emotional difficulties.

Appendix B.

U.S. DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS
WASHINGTON, D.C. 20212

In reply refer to:
No. 400

Dear Mr. _____:

Efforts to improve employment opportunities for the older worker are an important program of the United States Department of Labor. Special problems of older workers, and ways in which private industry has helped them accommodate to changes in job requirements, have been studied.

Our Bureau is currently attempting to locate companies which have redesigned or adapted jobs to accommodate existing physical capacities of older workers. Practical applications of job redesign techniques could be helpful to other employers who wish to benefit from the skills and experience of older workers. Job adaptation may range from a simple change to an involved redesign. (The enclosed sheet presents some examples.)

We are asking a number of leading companies whether they have had any experience in adapting jobs for older workers. Later, we plan to visit a small number of companies.

Could you let us know whether any of your company's plants have ever redesigned jobs for older workers? If they have, we would appreciate it if you would give us the names of plant or company officials whom we should contact to discuss the circumstances leading to the redesign, the action taken, and the results for the worker and the company.

Your cooperation will be of great assistance. We should appreciate a reply by _____, in order to complete this phase of our survey.

Sincerely yours,

Arthur M. Ross
Commissioner

Enclosure

Illustrations of Job Redesign for Older Workers

Foundry: An operator of a mold-making sand-slinger machine in a foundry had to guide the suspended machine head back and forth over the mold by hand. This required heavy physical work and standing during the full work shift. After working at the job a number of years, the operator began to lose weight and he requested a transfer to other work. However, the company decided to alter the equipment so that the machine head was moved by hydraulic power remotely controlled by the operator from a sitting position. Shortly after the change, the operator had regained his weight, his health was improved, and the production of the sand-slinger unit went up 20 percent.

Chemical plant: Carboys containing chemicals and weighing up to 50 pounds, were stored in the storerooms of a chemical manufacturing plant. To fill an order, it was necessary to lift the carboys from storage shelves and then pour out the required amount. As the storeroom employees grew older, they found it increasingly difficult to perform the work. To make the task less physically demanding, the company placed the carboys in rockers and had siphoning devices attached.

Food processing plant: A company was confronted with the need for redesigning jobs of 40 older women engaged in a spinach trimming operation. The women worked an eight-hour day, standing up. They had to carry 30-pound spinach baskets. The job was reengineered by reducing the movement of hands 50 percent, supplying stools with backs and special work tables adjusted to standing-sitting positions, furnishing hardwood foot rests to provide insulation against cold steel, installing conveyors and improving work scheduling.

Chemical plant: Work of older men was made easier through installation of an automatic conveyor which brought raw materials directly to their machines, eliminating heavy lifting and carrying. These workers, who were skilled in blending the company's compounds, were thus able to remain on this job into their late years.

Radio and TV plant: The performance of a group of older workers engaged in inspecting printed radio and television circuits was improved by providing them with an opaque stencil in which a small number of holes had been punched. When placed on top of a circuit to be inspected, it kept the workers from being distracted by the mass of detail that was present and helped them to concentrate their attention on the areas to be inspected.

U.S. DEPARTMENT OF LABOR
Bureau of Labor Statistics
Washington, D.C. 20212

Budget Bureau No. 2872
Approval Expires 6-30-66

Appendix C. CHECKLIST FOR STUDY OF JOB REDESIGN FOR OLDER WORKERS

PART I: REPORT ON ESTABLISHMENT (to be filled in once only for all cases).

1. Name of Establishment

2. Location

3. Number of Employees: Total _____
   Nonproduction _____ Production _____

4. End Product or Service _____

5. Types of production system: Unit _____;
   Batch _____; Assembly Line _____;
   Mass Production _____; Continuous Flow _____

6. Plant Services: Personnel _____;
   Personal counseling and other services _____; Safety _____;
   Medical _____; Training (O.T.J., vestibule; formal, informal, etc.)

   _____

7. Jobs (percentage) Clerical _____; Skilled _____;
   Semi-skilled _____; Unskilled _____

8. Proportion of females of employees in each category:
   Total _____ Nonproduction _____ Production _____

9. Is there a range of jobs calling for the same skills or which allow for relatively simple interchangeability of employees? Describe.

PART II: REPORT ON JOB REDESIGNED (this part should be printed on a separate sheet to be filled out individually for each redesigned job).

1. Administrative procedure (describe the position of the person initiating the request; persons who collected the data to decide case; and person determining need for redesign; person who redesigned job).

2. Cite the critical factors that alerted the firm to the need for or desirability of job redesign (output, earnings, absences, turnover, accidents, medical review, employee request, etc.). Was the job redesigned to retain senior employee so he could complete service requirements for pension? Did labor shortage necessitate change?

3. Description of Job Conditions:

   A. Describe the job itself and machines (photograph if possible).

   B. Type of skill (manual, specific control, information handling, visual; diagnostic).

   C. Nature of manual work: light, medium or heavy.

   D. Organization of work: Individual, size of team or group, assembly line.

   E. Pace: Man or machine-paced.

   F. Production runs: single, short, medium or long runs (specify number).

   G. Operational cycles: short, average or long (specify time).

   H. Method of remuneration: time, piece, bonus, collective bonus.

   I. Responsibility (Financial, state in money terms the damage that can occur).

   J. Responsibility (degree to which worker on his own controls safety, quality and productivity of the job).

   K. Physical environment (Note unusual conditions as to noise, heat, cold, humidity, lighting).

   L. Safety hazards (rate and severity of accidents).

   M. Health hazards.

   N. Posture for work: Standing, sitting or others.

   O. Age Distribution of Employees on Job.

4. Personal Difficulties of Older Workers Necessitating Change.

   A. Physical disability (heart, lung, spinal weakness, handicapped movements, varicose veins, deafness, eyes...).

   B. Psychological disability (nervous state, memory).

   C. Other reasons: Output, inadequate physical stamina, pace, night shift, accident prone.

5. Action taken (describe under appropriate heading).

   A. Action in case of difficult physical work (e.g., elimination of difficulty, mechanization, change in position of controls).

   B. Action in case of machine or conveyor belt pacing (e.g., slow down, divert production from belt, more or less stations or machines, regrouping of stations or machines, changes in signals).

   C. Action in case of standing fatigue (e.g., addition of seat or support; change of height; support for components or elements to be carried).

   D. In case of Eyesight Inadequate or Strained (e.g., better lighting; enlargement of details; increased contrast; slow down of passing component; encourage wearing of glasses).

   E. In case of Inadequate Individual Output (e.g., change to day work; change work standards).

   F. In case of Extreme Physical Conditions (e.g., change in physical conditions).

   G. In case of Accidents (e.g., enforce regulations; redesign; mechanizations, automatic controls, machine protectors, protective clothing).

   H. In case of Health Hazards (e.g., change of substance; ventilation air conditioning, etc.).

6. Training.

   Please describe induction and retraining procedures for employees for redesigned job.

7. Experience with Change and Results.

   Please describe briefly the results of the change and its effectiveness on production, accidents, physical conditions, psychological pressures, earnings, recruitment of older workers, elimination of complaints, employee satisfaction, etc. Give date of change and of report.

Name of person reporting

Supplementary Checklist-Job Redesign for Older Workers

With regard to employee earnings--consider such matters as:

(a) Was the job redesigned and performance elements excluded which diluted the job content, and in turn, reduced the rate of pay, or--

(b) Since the job redesign was minimal and all important functions are performed by the incumbent older worker, did rate of pay remain unchanged (--or increased).

Selected Annotated Bibliography on Older Worker Employment and Job Redesign

Older Worker: General

Birren, James E. (ed.). Handbook of Aging and the Individual: Psychological and Biological Aspects (Chicago, Ill., University of Chicago Press, 1959). 918 pp.

Summarizes age changes in physical and mental functions as they affect performance. Describes methods of matching older people and their jobs. Discusses the performance of older people in industry, and considers the difficulties of retraining older workers. Concerns the biological and psychological bases of changes in behavior and capacities of the individual organism which occur with advancing age.

Birren, James E., Robert N. Butler, Samuel W. Greenhouse, Louis Sokoloff and Marian R. Yarrow (eds.). Human Aging: A Biological and Behavioral Study. Public Health Service Publication No. 986 (Washington, D.C., U.S. Government Printing Office, 1963). 328 pp.

Presents the efforts of 22 investigators in understanding the aging experience and the processes involved.

Clark, F. Le Gros and Agnes C. Dunne. Ageing in Industry (London, Nuffield Foundation, 1955).

Detailed survey of 32 selected occupations compares the varying conditions of work, the opportunities for modifying the work processes, and the retirement and superannuation practices peculiar to different occupations.

Crook, G. Hamilton and Martin Heinstein. The Older Worker in Industry: A Study of the Attitudes of Industrial Workers Toward Aging and Retirement (Berkeley, Calif., The Regents of the University of California, 1958). 143 pp.

Presents and analyzes attitudes of 850 older industrial workers toward aging and retirement. Constitutes part of a Rockefeller interdisciplinary study of the problem of aging in an industrial society.

Fox, Harland. "Utilization of Older Manpower," Harvard Business Review, Vol. 29, November 1961, pp. 40-54.

Examines three aspects of the question of work opportunities for the aged: post-retirement utilization of workers, workers' preference for the normal retiring age, and utilization of workers at ages 45 to 65. Concludes that the prime obstacle to utilization of workers over 65 is the growth of private pension plans. Because of the need for economic security as well as the need to maintain certain noneconomic values, the majority of employees who reach 65 prefer to continue to work.

McConnell, John W. "The Problems of Work and Time for Older Persons," A Summary of the Proceedings of the State-Wide Conference on Aging (Albany, N.Y., New York State Office for the Aging, 1962), pp. 29-38.

States that automation and other technological innovations are creating greater productivity with fewer people needed in the labor force. As new automated processes of production are introduced, older workers with poorer educational backgrounds are eliminated; examines relationship of work to leisure.

Organisation for Economic Cooperation and Development. Age and Employment (Paris, Organisation for Economic Cooperation and Development, 1962). 62 pp.

A brief account of the proceedings and conclusions of the Stockholm Seminar on age and employment. States that the popular notion of aging in relation to work has to be radically revised. General report prepared by Dr. Alastair Heron.

Proceedings of National Conference on the Aging. Manpower Training and the Older Worker (Washington, D.C., 1966). 756 pp.

Entire text of proceedings sponsored by the National Council on the Aging. Includes counseling and vocational training addresses, conference findings, and background papers.

Ross, Arthur M. and Jane N. "Employment Problems of Older Workers," Studies in Unemployment. Prepared for the Special Committee on Unemployment Problems, U.S. Senate, 86th Congress, 2d Session (Washington, D.C., U.S. Government Printing Office, 1960), pp. 97-120.

Discusses economic and social developments which have contributed to unemployment problems of older workers. Reviews employer hiring policies and summarizes the types of protection given older workers under union agreements.

Sobel, Irwin and Richard C. Wilcock. Placement Techniques for Older Workers (OECD, March 1966). 84 pp.

Deals with the problems of the competitiveness of older workers in the labor market and the specific procedures and techniques for helping in their reintegration into the labor force.

U. S. Department of Health, Education and Welfare. Aging in the Modern World: An Annotated Bibliography (Washington, D. C., U. S. Government Printing Office, 1963). 194 pp.

Presents annotated references to books published between 1900-1963 and to articles appearing from 1958 to 1963 related to the field of aging.

Wolfbein, Seymour L. and Ernest W. Burgess. "Employment and Retirement," Aging in Western Societies, Ernest W. Burgess (ed.) (Chicago, University of Chicago Press, 1960). 492 pp.

A statistical examination of length of working life, the older person as a worker, and the older worker and retirement in the United States and other Western societies. Occupational distribution of older workers, factors affecting retirement, and the prolongation of the working life are discussed.

Older Worker: Job Redesign

Abrams, Albert J. "Job Engineering and Job Re-Assignment for the Older Worker in American Industry," Growing with the Years. Legislative Document No. 32 (Albany, N. Y., New York State Joint Legislative Committee on Problems of the Aging, 1954). 159 pp.

Results of a survey of industry methods to meet declining capacities of some older workers. Reassignment found most common; redesign specifically for older workers used infrequently.

Barkin, Solomon. "Job Redesign: A Technique for an Era of Full Employment," Manpower in the United States: Problems and Policies. Industrial Relations Research Association Publication No. 11 (New York, Harper and Brothers, 1954), pp. 39-50.

Emphasizes need to redesign jobs for older workers to make more effective use of potential labor force. Cites success of redesign in cases of handicapped workers. Presents guides for reengineering jobs in order to suit them to individual abilities of workers.

Barkin, Solomon. "Redesigning Jobs in Industry for a Maturing Population," Age Is No Barrier. Legislative Document No. 35 (New York, New York State Joint Legislative Committee on Problems of the Aging, 1952). 171 pp.

Discusses the feasibility of compulsory hiring of older persons, and the redesign of jobs. Advocates requiring new concerns to meet specific ratios of mature persons (men over 45, women over 35) to the total work force.

Clark, F. Le Gros. Ageing on the Factory Floor: The Production of Domestic Furniture (London, Nuffield Foundation, 1957). 35 pp.

Study concludes that some adjustments or concessions had to be made for about 3 in 10 of those men in their early sixties, for about 6 in 10 of those in their late sixties, and for practically all the working survivors who were in their seventies. Where retirement occurred, it was due as often to old age as to some chronic ailment or physical impairment.

Griew, Stephen. Job Re-Design (Paris, Organisation for Economic Co-operation and Development, 1964). 86 pp.

Concerns application of biological data on aging to design of equipment and organization of work. Emphasizes potential sources of stress upon an individual or group of older workers and brings to light methods of removing strain in order to extend employment potential.

Organisation for Economic Co-operation and Development. Job Redesign and Occupational Training for Older Workers: Final Report (Paris, Organisation for Economic Co-operation and Development, 1965). 95 pp.

Summarizes the papers presented at the International Management Seminar, London, 1964, and ideas exchanged in the course of seminar discussions. Outlines problems; presents papers on job redesign for older workers, occupational training for older workers, vocational training methods for older workers and case studies of experiences of older people undergoing vocational retraining.

Organisation for Economic Co-operation and Development. Job Re-Design and Occupational Training for Older Workers: Supplement to the Final Report (Paris, Organisation for Economic Co-operation and Development, 1965). 132 pp.

Contains reports prepared for London Seminar in 1964 other than those that appear in final report; together with papers on training in the United States and the United Kingdom. Includes a questionnaire distributed to employers of member countries and papers submitted by participants describing the situations in their own countries.

Rey, Paule. Various Cases of Job Re-Design for Older Workers, Report No. 3 of International Management Seminar on Job Re-Design and Occupational Training for Older Workers (Paris, Organisation for Economic Co-operation and Development, 1965). 12 pp.

Uses examples of job redesign for older workers to illustrate the maintenance of output and the reduction in fatigue and effort which result. Discusses the possibilities of several methods of redesign, such as mechanization and some simpler, less expensive methods.

Older Workers: Job Performance

Barkin, Solomon. The Older Worker in Industry: A Study of New York State Manufacturing Industries (Albany, N.Y., J.B. Lyon Co., 1933) 467 pp.

A study conducted under the auspices of the New York State Commission on Old Age Security to investigate and report on the industrial conditions affecting aging men and women.

Belbin, R. M. Training Methods for Older Workers (Paris, Organisation for Economic Co-operation and Development, 1965). 72 pp.

Surveys current knowledge concerning changes in capacities resulting from aging; deals specifically with changes in learning ability and power of adaptation. Describes methods of training already in use. Designed to collate and evaluate existing information and to serve as a source book for further study.

Greenberg, Leon. "Productivity of Older Workers," The Gerontologist, March 1961, pp. 38-41.

Concludes that many individual older workers can and do exceed the output of younger workers, as illustrated by the findings of numerous studies. Yet surveys indicate that older workers are frequently eliminated from job consideration on the assumption that they are not productive.

Secretary of Labor. The Older American Worker: Age Discrimination in Employment. Report to the Congress (Washington, D.C., U.S. Government Printing Office, 1965).

Presents recommendations for dealing with arbitrary discrimination in employment because of age and with basic factors which impede the reemployment of displaced workers as they grow older. Discusses measures which should be considered for fuller use of talents and time of older persons in private enterprise and in community service. The special studies conducted for the reports are contained in a separate volume of research material.

Schneider, B.V.H. The Older Worker (Berkeley, Calif., The Regents of the University of California, 1962), pp. 35-50.

Findings show that older workers have as good or better attendance records than younger workers, and lower turnover and injury rates. Experience, judgment, reasoning ability, and accuracy of older people compensate in most situations for the physiological effects of age.

U.S. Department of Labor, Bureau of Employment Security. Employing Older Workers: A Record of Employer's Experience. BES No. R-179 (Washington, D.C., U.S. Government Printing Office, 1959).

Reports a series of cases in which companies successfully used older workers for a wide variety of jobs. Study stresses the capabilities of older workers as shown by status of their productivity, physical strength, skills, and flexibility, and suggests that increased mechanization of jobs promotes the retention of older workers by placing increased reliance on maturity and dependability.

U.S. Department of Labor, Bureau of Labor Statistics. Comparative Job Performance by Age: Office Workers. Bulletin 1273 (Washington, D.C., U.S. Government Printing Office, 1960). 36 pp.

Compares the relative work performance of older office workers with other office workers. Three important findings emerge. First, the differences in output per man-hour among age groups of the office workers within the scope of the survey were for the most part insignificant. Second, there were considerable variations among workers within age groups. Third, workers in the older age groups had a steadier rate of output. Findings substantiate the need for individual evaluation of workers.

U.S. Department of Labor, Bureau of Labor Statistics. Comparative Job Performance by Age: Large Plants in the Men's Footwear and Household Furniture Industries. Bulletin No. 1223 (Washington, D.C., U.S. Government Printing Office, 1957). 60 pp. Summarized by Jerome A. Mark in Monthly Labor Review, December 1957, pp. 1467-71.

Compares older and younger workers' attendance, productivity, and job stability. Concludes that some older workers outperform younger workers in all three areas, and that arbitrary discrimination against a worker because of age is not a valid criterion.

Welford, A. T. Aging and Human Skill. (London, Oxford University Press, 1958). 300 pp.

Final report of the Nuffield Unit on the study of changes in performance with aging. Includes both laboratory and field studies. Concludes that where age changes impinge upon performance, some relatively trivial factor may be limiting the aged's performance, and a comparatively small change in the task could bring it within the capacity of the older person.

Clark, F. Le Gros. Growing Old in a Mechanized World: The Human Problem of a Technical Revolution. Studies of Ageing Within Conditions of Modern Industry (London, Nuffield Foundation, 1960). 145 pp.

Concludes that the employment prospects of older men diminish as manufacturing methods change. Indicates a need for a new social theory of retirement. Appendix surveys employment prospects outside the field of manufacturing which might offer alternative occupations for elderly men.

Kreps, Juanita and Ralph Laws. Automation and the Older Worker: An Annotated Bibliography (New York, The National Council on the Aging, 1963). 43 pp.

Annotated bibliography published by the National Council on the Aging for those interested in the employment and retirement of aging persons in an industrial society.

U.S. Department of Labor, Bureau of Labor Statistics. Adjustments to the Introduction of Office Automation. Bulletin 1276 (Washington, D.C., U.S. Government Printing Office, 1960). 87 pp.

A study of some implications of the installation of electronic data processing in 20 offices in private industry, with special reference to older workers.

U.S. Department of Labor, Bureau of Labor Statistics. Industrial Retraining Programs for Technological Change. Bulletin 1368 (Washington, D.C., U.S. Government Printing Office, June 1963). 34 pp. Summarized by Edgar Weinberg under the title "Older Workers' Performance in Industrial Retraining Programs," Monthly Labor Review, August 1963, pp. 935-939.

Pilot study on older worker adaptability to technological change. Analyzes results of retraining programs of four companies in different industries, to compare performance of older workers with that of younger workers. Confirms conclusions of earlier studies that age alone is an insufficient criterion for determining capacity of older workers to adapt to technological change.

Human Engineering

Bennett, Edward, James Regan and Joseph Spiegel (eds.). Human Factors in Technology (New York, McGraw-Hill Book Co., 1963). 685 pp.

Encompasses a range of topics focused upon the many-faceted relation between man and his technology by an interdisciplinary team of scientists and engineers.

Berthon, Jean and Andre Ghelfi. About Fitting the Job to the Worker (Paris, Organisation for Economic Co-operation and Development, 1961). 63 pp.

Concludes that jobs will never be completely fitted to workers due to the differences in men. Because techniques are constantly developing, any adaptations achieved are never sufficient. This, however, is no reason to call a halt to the effort of accommodating the worker as best as possible. Discusses fatigue and work environment.

Chapanis, Alphonse, Wendell R. Garner and Clifford T. Morgan, Applied Experimental Psychology: Human Factors in Engineering Design (New York, John Wiley and Sons, Inc., 1949). 434 pp.

Describes role of experimental psychology in the field of human engineering. Provides an explanation of methodology--experimental and statistical techniques--necessary in the assessment and evaluation of human capacities and performance.

Department of Scientific and Industrial Research, Proceedings of Conference on Ergonomics in Industry (London, Her Majesty's Stationery Office, 1961). 190 pp.

Discusses implications of ergonomics in industry, particularly in relation to production engineering, equipment design, work study and industrial health. Includes all conference papers and reports of discussions.

McCormick, Ernest J. Human Factors Engineering (New York, McGraw-Hill Book Co., 1964). 653 pp.

Deals with results and implications of research investigations of some of the practical problems of design of man-machine systems and environments. Draws materials from a variety of disciplines that have relevance to the human factors area, including psychology, physical anthropology, physiology, and climatology.

McFarland, Ross A. and Frank Randolf Philbrook. "Job Placement and Adjustment for Old Workers: Utilization and Protection of Skills and Physical Abilities," Geriatrics, December 1958, pp. 802-807.

Presents a new procedure for matching physical requirements of jobs with the physical capacities of workers, together with the relative advantages and disadvantages of all other known placement methods. Emphasizes the value of the method in its application to older workers.

Murrell, K. F. H. Human Performance in Industry (New York, Reinhold Publishing Corp., 1965). 496 pp.

Describes the structure, functioning, and size of the human body. Discusses research findings and their application to design, environment conditions, and organizational problems.

Organisation for Economic Co-operation and Development. Fitting the Job to the Worker: Seminar on Ergonomics for Engineers (London, Organisation for Economic Co-operation and Development, 1961). 106 pp.

Report of a seminar aimed at giving wider exposure to the relatively new scientific discipline of ergonomics, or fitting the job to the worker. Includes chapters on: the structure of engineering education in the participating countries; present state and outlook for ergonomics in engineering training establishments; program of lectures and other events; and, recommendations to the OECD and other international bodies.

Organisation for European Economic Co-operation. Fitting the Job to the Worker: International Conference of Zurich (Paris, Organsation for European Economic Co-operation, 1959). 115 pp.

A report on papers presented at the conference concerning the application of ergonomic principles, and problems to be dealt with.

Organisation for European Economic Co-operation. Fitting the Job to the Worker: A Survey of American and European Research Into Working Conditions in Industry (Paris, Organisation for European Economic Co-operation, 1958). 170 pp.

A survey of experimental methods and results in the United States and Europe in the various disciplines and techniques involved in fitting the job to the worker.

Tufts College Institute for Applied Experimental Psychology. Handbook of Human Engineering Data for Design Engineers (Medford, Mass., Trustees of Tufts College, 1949).

Provides the planner and designer with the probable characteristics of the average individuals who will man machines of the future. Deals with quantitative measures of human capabilities and limitations and their application to machine design. Summarizes the relevant research findings without making any attempt at interpretation.

Welford, A. T. Ergonomics of Automation. Problems of Progress in Industry No. 8 (London, 1960). 60 pp.

Surveys in broad outline those aspects of ergonomics or human engineering which are likely to bear on questions of designing automatic equipment, and on human problems likely to arise in automation work; considers human capacities and job characteristics in designing automated equipment.

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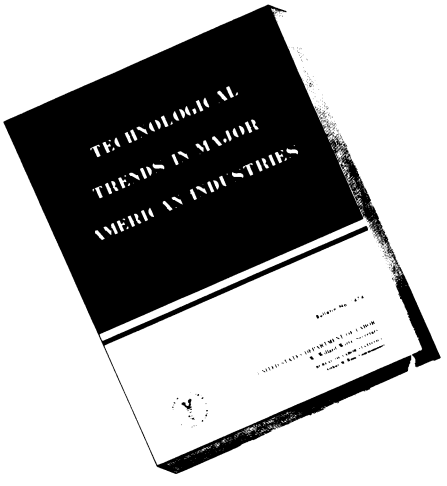

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