

REPORT OF SUMMER SCHOOL

HELD AT

BAVENO (ITALY)

JUNE 1927

ON THE SUBJECT OF

THE ELIMINATION OF UNNECESSARY FATIGUE IN INDUSTRY

EDITED IN THE ORIGINAL LANGUAGES, WITH
AN INTRODUCTION AND SUMMARY OF DIS-
CUSSION IN ENGLISH, FRENCH AND GERMAN

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PREFACE

The following pages are not intended to present more than a summary of the proceedings of the Summer School.

The compilation of a verbatim account of a week's lectures and discussions would result in a volume, the publication of which is at present more than the Association can undertake.

The approach to the subject was made both from the psychological and the physiological side. The directly psychological aspect was studied under Prof. Pear, the physiological under Dr. Lipmann, Dr. Vernon and Mr. Weston. Prof. Loriga developed the historical aspect of the subject, supplemented by a lecture from Mr. Piacitelli, who referred specially to the methods in operation in the U. S. A.

The allotted time for each subject was one and a half hours, half of which was devoted to the delivery of the lecture and the remaining half to the putting of questions. Not the least valuable were the contributions made by the lecturers in answer to these.

With regard to the reports here given, the reader will readily understand that each subject was actually treated by the speaker in much greater detail. The outlines of the three most stimulating lectures given by Prof. Pear must perforce leave much unrecorded. Lack of space has also made it necessary to omit part of Mr. Weston's most interesting paper, while it will be seen from the brief summaries of Dr. Lipmann's lectures and the reproductions of his thought-provoking statistical charts, that much of what actually transpired cannot be passed on.

A course of lectures dealing with the subject of the elimination of unnecessary fatigue cannot be complete without treating the question of "Posture". It proved difficult however to secure a speaker on this subject, and though Mme. Ch. B. Thumen of the Redressement Français, Paris, had very kindly consented to undertake this, the time left for preparation proved too short, Mme. Thumen gave instead an interesting paper on recent developments with regard to "Rationalisation" in France.

The sessions of the School were presided over by Lillian M. Gilbreth, Ph. D., Consulting Engineer, U. S. A.; the organisation was in hands of Miss M. L. Fleddéus, Honorary Secretary of the I. R. I.; whilst Dr. A. Correggiari of Milan was in charge of the social programme and acted as host.

PRÉFACE

Les pages suivantes prétendent offrir qu'un simple résumé des travaux du Cours de Vacances. L'établissement d'un compte-rendu littéral de conférences et de discussions qui se sont étendues sur une semaine nécessiterait un volume dont la publication serait au-dessus de ce que l'Association peut actuellement entreprendre.

Le sujet du Cours a été envisagé à la fois sous son aspect psychologique et sous son aspect physiologique. L'aspect psychologique proprement dit a été étudié sous la direction de M. le Professeur Pear et l'aspect physiologique sous celle des Drs. Lipmann et Vernon et de M. Weston. Le Professeur Loriga a exposé l'histoire de la question et a été secondé par une conférence de M. Piacitelli, traitant spécialement des méthodes appliquées aux Etats-Unis.

Le temps disponible pour chaque sujet particulier était d'une heure et demie, dont la première moitié était consacrée à la conférence et la seconde aux questions posées par les auditeurs. Une des parties les plus fécondes du travail réside sans doute dans les réponses faites à ces questions par les conférenciers.

En ce qui concerne le compte-rendu des conférences, le lecteur comprendra aisément que chacun des sujets aura été traité par l'orateur d'une façon beaucoup plus détaillée. Le résumé des trois conférences extrêmement intéressantes faites par le Professeur Pear ont nécessairement dû omettre bien des considérations. Le manque de place nous a également contraints de ne pas reproduire une partie du très suggestif exposé dû à M. Weston; on verra en effet par les brefs résumés des conférences du Dr. Lipmann et par la reproduction de ses tableaux statistiques si véritablement éloquentes, qu'il était impossible de réduire encore le peu qu'on en a pu laisser effectivement transpirer.

Une suite de conférences traitant de l'élimination de la fatigue inutile ne serait pas complète si elle n'englobait pas aussi la question de la "Position du Corps". Il fut toutefois malaisé de trouver un orateur sur ce sujet et bien que Mme. Ch. B. Thumen, du "Redressement Français" (Paris) ait très aimablement consenti à se charger de cette tâche, le temps dont elle disposa pour la préparation se montra trop limité. Mme. Thumen prononça à la place une conférence intéressante sur les développements récents de la "Rationalisation" en France.

Les séances du Cours de Vacances ont été présidées par Lilian M. Gilbreth Ph. D. Ingénieur Conseil, E. U. A.; l'organisation était confiée à Mlle. M. L. Fleddéus, Secrétaire Honoraire de l'I. R. I. cependant que le Dr. Correggiari, de Milan, assumait les charges d'un hôte.

VORWORT

Der folgende Bericht bietet eine knappe Zusammenfassung der Erörterungen der Sommerschule. Die wortgetreue Wiedergabe der während der Studienwoche gehaltenen Vorlesungen und der anschliessenden Aussprachen hätte einen Band gefüllt, dessen Veröffentlichung die finanzielle Leistungsfähigkeit der Vereinigung weit überstiegen haben würde.

Das Thema der Studienwoche wurde sowohl von der psychologischen wie von der physiologischen Seite behandelt. Die psychologischen Studien wurden von Professor Pear, die physiologischen von Dr. Lipmann, Dr. Vernon und Mr. Weston geleitet. Professor Loriga gab einen Ueberblick über die historische Entwicklung; seine Darstellungen wurden ergänzt durch einen Vortrag von M. Piacitelli, der besonders auf die in den Vereinigten Staaten angewandten Untersuchungs- und Arbeitsmethoden einging.

Die einzelnen Themen wurden in etwa 1½ Stunden behandelt und zwar entfiel die Hälfte dieser Zeit auf den Vortrag, die andere Hälfte auf die Aussprache. Sehr wertvoll waren die Ausführungen, mit denen die Referenten die von den Hörern an sie gerichteten Fragen beantworteten.

Selbstverständlich konnte in den mündlichen Vorträgen sehr viel ausführlicher auf Einzelheiten eingegangen werden, als in den hier veröffentlichten Referaten. In der Zusammenfassung der drei äusserst anregenden Vorträge von Professor Pear mussten daher manche seiner Ausführungen unberücksichtigt bleiben. Der Mangel an Raum machte es auch notwendig, Teile des interessanten Vortrages von Mr. Weston auszulassen; ebenso wird der Leser bei der Durchsicht der Auszüge aus den Vorträgen von Dr. Lipmann und seiner instructiven graphischen Darstellungen bemerken, dass vieles, was in dem Vortrag zum Ausdruck kam, hier nicht wiedergegeben werden konnte.

Eine Vortragsreihe, die das Problem der Ausschaltung überflüssiger Ermüdung behandelt, muss notwendig die Frage der "Körperstellung" (posture) einbeziehen. Es erwies sich jedoch schwierig, einen Redner für dieses Thema zu gewinnen; Mme. C. B. Thumen, die die Behandlung der Frage freundlichst übernommen hatte, hielt, als sich die Zeit für die Vorbereitungen zu kurz erwies, einen interessanten Vortrag über die jüngste Entwicklung der Rationalisierung in Frankreich.

Die Vorträge und Sitzungen wurden geleitet von Mrs. Lillian M. Gilbreth, Organisationsingenieurin, Vereinigte Staaten; die Vorbereitungen lagen in den Händen der Schriftführerin der Vereinigung, Fräulein M. L. Fledderus; die Besichtigungen und gesellschaftlichen Veranstaltungen hatte der Gastgeber der Studienwoche, Dr. Correggiari, Mailand, übernommen.

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INTRODUCTION

In choosing as the subject for its Summer School "The Elimination of Unnecessary Fatigue in Industry", the Association was actuated by the desire to give immediate expression to its fundamental purpose, namely that of providing a common meeting ground for all sections of the industrial community, for the dispassionate study and consideration of developments in the vast world of industry.

The subject of industrial fatigue, and how far it can be eliminated, necessarily draws together on one platform Management and Worker, the Engineer and the Psychologist, the Foreman and the Scientific Investigator, the Personnel (Welfare) Worker, The Factory Inspector and the Educationalist.

Hand in hand with the present intensification of production and efforts towards the elimination of waste, grows an even greater need for concentration on human wellbeing.

The increasing tendency on the part of the technician to cooperate with the anthropologist, the physiologist, the psychologist, the psychiatrist, may be regarded as evidence of a growing consciousness in this direction.

The question may be raised whether, apart from the vast field of industrial science to be covered, full concentration on one essential does not "per se" tend to exclude full realization of another, thus still further strengthening the need for this close cooperation.

The three great essentials in Production are Men, Methods and Machinery. Where the technician is primarily concerned with machinery, the human scientist is primarily concerned with man, their common meeting ground being the application of methods.

The adjustment of machinery to man gives rise to many complex problems, for the solution of which all points of view are needed. The very distinction recently made between "maximum" and "optimum" output is in itself an illustration of this.

That it should be possible to speak of the "human element" in industry is, when one comes to think of it, self-condemning, as by so doing there stands unconsciously revealed the attitude that man is only one consideration among many. It certainly does not convey the truth that man ranks first and that production only exists as the consequence of his needs.

The expression is, however, an attempt to indicate the physiological and psychological processes which always accompany the entry of man into the method of production.

Concerning these the following pages do not more than touch

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upon a world of knowledge, partly investigated, partly still to be discovered.

Science in itself, however, can never ameliorate man's condition or add to life's happiness. All depends upon the motive governing its application. Here again, with all the knowledge available, we may still find man and production confronting each other with interests opposed, unless the desire for gain be replaced by one for service and for that harmonious cooperation which is the hall-mark of human progress.

M. L. F.

INTRODUCTION

En choisissant pour sujet de son premier Cours de Vacances "L'Élimination de la Fatigue inutile dans l'Industrie", l'Association a obéi au désir de donner une expression immédiate de son objectif fondamental, qui est d'établir un terrain de rencontre commun à toutes les sections de la communauté industrielle pour une étude impartiale et pour l'examen de tous les développements qui se manifestent dans le vaste domaine de l'industrie.

La question de la fatigue industrielle, celle de savoir jusqu'à quel point cette dernière peut être éliminée, rapprochent nécessairement sur la même plateforme la Direction de l'Entreprise et l'Ouvrier, l'Ingénieur et le Psychologue, le Contre-maître et l'Enquêteur Scientifique, le Surintendant, l'Inspecteur d'Usine et l'Éducateur professionnel.

Conjointement à l'actuelle intensification de la production et aux efforts qui tendent à en éliminer tout gaspillage, grandit un besoin d'autant plus considérable de concentrer notre attention sur le problème du bien-être humain.

La tendance croissante, chez le technicien, à collaborer avec l'anthropologue, le physiologue, le psychologue, le psychiatre, peut être considérée comme la preuve d'une conscience accrue dans cette direction.

On peut se demander si, abstraction faite du vaste domaine qui reste encore à défricher pour la science industrielle, la préoccupation unilatérale d'un seul des éléments essentiels, n'aboutit point "per se" à exclure la pleine réalisation d'un autre élément non moins essentiel, et n'en vient pas ainsi à renforcer encore le besoin de leur étroite collaboration.

Les trois éléments essentiels, dans la Production, sont les Hommes, les Méthodes et les Machines. Tandis que le technicien s'occupe avant tout des machines, le savant dont la discipline relève des sciences morales s'intéresse tout d'abord à l'homme, et leur commun terrain de rencontre réside dans le domaine de l'application des méthodes.

L'adaptation des machines à l'homme soulève un grand nombre de problèmes complexes dont la solution exige la confrontation de tous les points de vue. La distinction qui a été faite récemment entre le rendement "maximum" et le rendement "optimum" constitue en elle-même l'illustration et l'exemple de cette nécessité.

Qu'il puisse être possible de parler de "l'élément humain" dans l'industrie, c'est là, en réalité, un langage qui se condamne lui-même, car en en faisant usage, on avoua inconsciemment ce fait que l'être humain est seulement l'objet d'une considération entre

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beaucoup d'autres. C'est faire, autrement dit, cette vérité que l'homme vient au premier rang et que la production n'existe que comme la conséquence de ses besoins.

Toutefois, cette expression d' "élément humain" n'en constitue pas moins une tentative pour indiquer les divers processus physiologiques et psychologiques qui accompagnent toujours l'entrée de l'être humain dans la méthode de la production.

Les pages qui suivent ne font qu'effleurer tout un monde de problèmes ayant trait à ces questions, monde en partie exploré, en partie encore à découvrir.

La science, en soi-même, ne saurait toutefois jamais améliorer la condition humaine ni ajouter au bonheur dont la vie est susceptible. Tout dépend des motifs auxquels en obéit l'application. Ici même, les connaissances les plus riches et les plus utiles ne nous empêcheraient pas de continuer à voir l'homme et la production se confronter l'un à l'autre avec des intérêts opposés, tant que la soif du gain n'aura point fait place à la volonté de servir et à cette collaboration harmonieuse qui constitue la marque distinctive du progrès humain.

M. L. F.

EINFÜHRUNG

Ausschlaggebend für die Wahl des Themas der ersten Sommerschule "Die Vermeidung unnützer Ermüdung in Industriebetrieben" war der Wunsch der Vereinigung, ihrem Hauptzweck zur Verwirklichung zu verhelfen, d.h. einen Boden zu schaffen für verurteillose, gemeinsame Untersuchungen aller an der Produktion beteiligten Gruppen über industrielle Fragen und Entwicklungserscheinungen.

Das Problem der industriellen Ermüdung und in wie weit dieselbe vermieden werden kann, führt Betriebsleitung und Arbeiterschaft, den Ingenieur und den Psychologen, den Werkmeister und den Leiter wissenschaftlicher Betriebsuntersuchungen, Fabrikpfleger, Gewerbe-Inspektoren und Pädagogen notwendigerweise auf demselben Forum zusammen.

Hand in Hand mit der gegenwärtigen Intensivierung der Produktion und den Anstrengungen jegliche Vergeudung zu vermeiden, geht die wachsende Notwendigkeit sich auf das persönliche Wohl des am Arbeitsprozess beteiligten Menschen zu konzentrieren.

Das lebhaft hervortretende Bemühen der Ingenieure, mit dem Anthropologen, dem Physiologen, dem Psychologen, dem Psychiater zusammenzuarbeiten, ist ein Zeichen des zunehmenden Verständnisses für diese Fragen.

Wir müssen uns fragen ob, ausser dem grossen noch zu erforschenden Gebiet der Arbeitswissenschaft, völlige Konzentration auf einen Faktor, nicht zwangsläufig die gänzliche Berücksichtigung anderer Faktoren ausschliesst, und somit die Notwendigkeit des Zusammenwirkens der verschiedenen interessierten Gruppen in erhöhtem Masse bedingt.

Das Wesentliche der Produktion sind die drei Faktoren: Mensch, Methode und Maschine. Das Interesse der Technik konzentriert sich vornehmlich auf die Maschine, das Interesse der Arbeitswissenschaft in erster Reihe auf den Menschen - ihr gemeinsames Interessengebiet ist die Methodik.

Die Anpassung der Maschine an den Menschen zieht eine Reihe verwickelter Probleme nach sich, zu deren Lösung sämtliche Gesichtspunkte in Betracht gezogen werden müssen. Die in jüngster Zeit betonte Unterscheidung zwischen Maximalerträgen und Optimalerträgen ist hierfür bezeichnend.

Schon die Gepflogenheit vom "Menschlichen Element" (human element) in der Industrie zu sprechen, ist im Grunde belastend, weil sie die Tatsache entschleiert, dass der Mensch nicht höher gewertet wird als alle anderen Elemente der Produktion. Zweifellos wird diese Bezeichnung der Wahrheit nicht gerecht, dass der

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Mensch das Mass aller Dinge ist, und dass die Produktion nur als Folge seiner Bedürfnisse existiert.

Dieser Ausdruck ist indessen ein Versuch, die physiologischen und psychologischen Vorgänge anzudeuten, die von dem Augenblicke an erscheinen, wo der Mensch in den Produktionsmethoden berücksichtigt wird.

Die folgenden Seiten streifen nur leicht ein grosses Wissensgebiet, das zum Teil erforscht, zum Teil noch Neuland ist.

Die Wissenschaft an und für sich wird nie die Zustände verbessern oder die Menschen glücklicher machen können. Alles hängt von dem Beweggrund ab, der die Anwendung der Wissenschaft bestimmt. Auch hier taucht die Möglichkeit auf, dass, allen verfügbaren Kenntnissen zum Trotz, Mensch und Produktion mit entgegengerichteten Interessen sich gegenüberstehen, wenn das Gewinnstreben nicht einer Anschauung Platz macht, die die Industrie als Dienst auffasst und in dem harmonischen Zusammenwirken der Kräfte das Kriterium des Fortschritts erblickt.

M. L. F.

HISTORIQUE DE L'ETUDE DE LA FATIGUE

PAR PROF. G. LORIGA

Médecin en Chef du Service d'Inspection des Usines, Rome.

La fatigue est difficilement définissable parce qu'elle n'est pas à proprement parler une maladie à manifestations anatomo-pathologiques claires et constantes, mais plutôt une condition prédisposante à de nombreuses maladies et comparable aux états constitutionnels. Le passage de l'état physiologique à l'état pathologique, s'effectue par degrés insensibles. C'est de ce fait que provient la distinction entre fatigue normale et pathologique, fatigue latente ou confirmée.

L'extériorisation de l'énergie mécanique qui représente le travail est toujours accompagnée du développement d'énergie thermique, chimique et nerveuse. Il est donc naturel que la répercussion de la fatigue doive se rechercher non seulement sur le système musculaire et sur le système nerveux, mais aussi dans toutes les fonctions organiques (circulation, respiration, digestion, excrétion et sécrétion). Pour les mêmes raisons la connaissance de la fatigue n'est pas due à la découverte d'un savant et elle ne possède pas une date fixe de naissance. C'est pourquoi il n'est pas facile de faire une exposition ordonnée et d'attribuer des dates déterminées aux diverses étapes des études qui se rapportent à cet argument. Il est nécessaire en conséquence, pour en tracer l'histoire, de suivre la méthode que les statisticiens appellent verticale et d'examiner séparément les différentes manifestations de la fatigue.

Cette constatation toutefois n'enlève rien à l'importance pathologique d'elle, considérée comme facteur de maladie, parce que la fatigue reste toujours une des causes les plus répandues et les plus puissantes de dommage pour l'organisme aussi des travailleurs intellectuels que des travailleurs manuels. La guerre spécialement a mis en lumière cette terrible puissance et après cette époque les savants ont transféré leur laboratoire dans les ateliers, en reliant l'étude des manifestations cliniques sur les travailleurs à celles des répercussions de la fatigue sur la quantité et la qualité de la production industrielle. De ce transfert ont ressorti nombreuses connaissances utiles spécialement à l'hygiène et que nous ne pouvons négliger, car l'hygiène résume aussi bien les conclusions des nombreuses études faites que le but vers lequel ces études tendent.

F. Lagrange a défini la fatigue une diminution du pouvoir fonctionnel des organes, provoquée par un excès de travail et accompagnée par une sensation caractéristique de malaise. Cette définition rappelle surtout les effets de la fatigue sur le mouvement, c'est à dire sur l'activité des muscles et du système nerveux, mais ne tient pas assez compte des troubles des autres fonctions (cir-

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culation, respiration, calorification, chimisme du sang, sécrétions glandulaires etc.). Elle a cependant le mérite de donner une place importante à la sensation de la fatigue, qui en forme un caractère indispensable pour la clinique. Cette sensation est un phénomène subjectif psychologique, mais elle est le symptôme prépondérant dans l'homme et sert comme moyen de défense organique. C'est le cri d'alarme de l'organisme menacé qui l'empêche d'arriver jusqu'à l'épuisement total et se manifeste soit lorsqu'il produit l'arrêt de la fonction motrice, soit lorsqu'il règle les fonctions intellectuelles, les émotions et les phénomènes de la volition. En tout cas la diminution de la production est plutôt la conséquence de la sensation de malaise que d'une véritable perte de l'excitabilité musculaire ou nerveuse.

Les recherches pour trouver l'explication du sentiment ou de la conscience de la fatigue se sont dirigées principalement dans trois directions:

- déterminer le siège central ou périphérique et la localisation de la sensation de fatigue,
- déterminer si l'intensité de la sensation correspond à l'état physique réel de fatigue,
- donner éventuellement une interprétation causale de la fatigue.

Sur la base des recherches faites il semble que l'on peut conclure que l'altération biologique produite par le travail serait en premier lieu localisée et ressentie dans les extrémités nerveuses intramusculaires (plaques terminales) et se manifesterait aussi bien comme excitation des centres cérébraux que comme impuissance motrice. Le premier degré de fatigue tout au moins est périphérique.

La sensation de la fatigue ne procède pas parallèlement avec l'état physique réel, parce qu'elle n'est même pas un symptôme précoce. Elle est en même temps un phénomène subjectif et une interprétation, et, par conséquent, on ne peut jamais en déterminer exactement le degré. Enfin elle est souvent masquée par de nombreux autres facteurs (volonté, amour propre, alcool, anesthésiques, etc.)

Les causes de la fatigue sont attribuables en partie à l'épuisement de l'énergie potentielle dû à la consommation du matériel dynamogène. Mais puisque dans les muscles déjà paralysés les substances dynamogènes ne sont pas même complètement épuisées, il faut penser que l'épuisement n'est pas la seule cause de la fatigue, et même qu'il n'en est pas la cause principale. Surtout l'accumulation des substances ponogènes, ou produits de la désassimilation, et la détérioration cellulaire qui en résulte sont considérées par les savants la cause principale de l'inexcitabilité progressive de la substance vivante.

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Les symptômes de la fatigue objective peuvent être mesurés (au contraire de ce qui arrive de la fatigue subjective, ou sensation de fatigue) par des méthodes directes ou indirectes.

Les premières peuvent se proposer les buts suivants:

la mesure de la force musculaire maximum ou totale, avant et après le travail,

la résistance des muscles à l'épuisement avant et après le travail, le comportement du système nerveux musculaire envers la fatigue (étude de la tonicité musculaire, du tremblement, de l'incoordonnation motrice, des réflexes des muscles et des tendons, des temps de réaction),

l'examen des organes des sens spécifiques (vision, audition, sensibilité cutanée),

l'examen de l'appareil circulatoire (volume du coeur, troubles de la circulation, fréquence et rythme du pouls, tension artérielle, réflexes vasculaires, athéromasie des artères),

l'examen du sang et des urines,

l'examen de la fonction respiratoire (fréquence et régularité de la respiration, variation de la composition de l'air).

Les recherches des trois premiers groupes coïncident avec celles de la physiologie des muscles et du système nerveux et ont conduit spécialement à la connaissance des lois de la fatigue musculaire et à celles de la fatigue intellectuelle. Les meilleurs résultats ont été obtenus au moyen de l'ergographe, fondé sur la méthode isotonique, c'est à dire qu'il enregistre les degrés maxima de la contraction des muscles fléchisseurs du doigt. Elles nous ont appris qu'il existe diverses courbes de la fatigue, qui dans le même individu, se conservent inaltérées pendant de nombreuses années. Elles ont en outre démontré que la courbe du travail d'un groupe de muscles dépend particulièrement de l'entité de l'effort et du rythme des contractions et qu'il y a, par conséquent, dans chaque travail le moyen de retarder considérablement l'apparition de la fatigue en combinant de façon appropriée le poids avec le rythme, c'est à dire l'effort avec la vélocité. En outre, il a été déterminé que la fatigue croît beaucoup plus rapidement que le travail, et qu'un travail effectué par un muscle fatigué est plus nuisible pour lui qu'un travail plus grand accompli dans des conditions normales. Enfin la durée du repos entre deux périodes de travail doit varier selon le degré de la fatigue.

Mais on a également fait ressortir l'influence qu'exercent sur une plus ou moins grande disposition à la fatigue l'entraînement et un grand nombre de circonstances extérieures et intérieures, telles que la température, la pression barométrique, les heures du jour, l'état de digestion, le jeûne etc. Et enfin, les dites recherches ont donné origine à diverses tentatives pour trouver la formule expressive

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du quotient de fatigue, c'est à dire du rapport entre la hauteur et le nombre des ordonnées dans l'ergogramme.

L'étude de la fatigue intellectuelle, qui est la conséquence de l'abus de l'attention volontaire, a mis en évidence les divers types du travail et les facteurs qui l'influencent (individualité, entraînement, durée et genre de travail, conditions hygiéniques du milieu etc.) arrivant à des conclusions analogues à celles qui ont été trouvées pour la fatigue musculaire.

L'une des premières manifestations de la fatigue est le ralentissement de la contraction et du relâchement musculaires. La co-ordination motrice diminue, quoique non proportionnellement au degré de la fatigue. On trouve constamment l'augmentation de la durée des temps de réaction, et ce phénomène est considéré comme l'un des meilleurs tests de la fatigue.

Parmi les organes de sens spécifique l'examen de l'oeil a permis de constater une diminution du pouvoir fonctionnel (acuité visuel, extension du champ visuel, perception des couleurs, etc.) et celui de l'ouïe une diminution de la perceptibilité du son minimum et de la distance à laquelle un son peut être aperçu.

L'index exthésiométrique est jugé excellent par nombreux auteurs: d'autres au contraire n'en doutent.

Les quatre autres groupes de recherches concernent le dépistage des symptômes pathologiques dans divers organes. Le volume du coeur qui est réduit pendant l'effort et la fatigue dans les individus sains, semble augmenté, au contraire, dans les individus affaiblis par les maladies ou par le surménagement chronique. Pendant les grandes fatigues on peut avoir une dilatation aiguë.

La pression sanguine a été trouvée en général augmentée, le tonus vasculaire diminué. L'artériosclérose suit de près le travail manuel fatiguant, parfois est localisée dans l'organe qui travaille.

Dans le sang on a constaté diverses variations dans le nombre des hématies, dans la hémoglobine, dans le leucocytes, dans le chimeisme.

Dans les urines augmentent la densité, l'acidité, les phosphates et l'ozate total.

Dans l'appareil respiratoire le test le plus intéressant est la mesure de l'assimilation gaseuse, c'est à dire de l'élimination de CO_2 et de la consommation de O_2 . Cette mesure est une forme de calorimétrie indirecte.

Les altérations fonctionnelles des divers organes sont des symptômes qui, en combinaison avec des symptômes subjectifs, servent spécialement au clinicien pour faire le diagnostic individuel de l'état de fatigue. Ils n'ont pas, cependant, tous la même valeur diagnostique et leur importance n'est presque jamais appréciable que dans les degrés extrêmes. On peut reconnaître qu'il n'existe pas un

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test de fatigue sur lequel on puisse se baser avec certitude pour le diagnostic, mais les divers tests se confirment et se complètent les uns les autres pour former devant notre esprit le tableau pathologique de la fatigue. C'est pour cela que nous croyons à la possibilité d'établir la fatigue limite physiologiquement tolérable dans un travail déterminé au moyen des tests directs.

Par contre nous devons constater qu'on n'a obtenu aucun résultat lorsqu'on a tenté de mesurer la fatigue par des méthodes indirectes. Le calcul du travail mécanique effectué néglige l'influence du travail statique (station debout) qui peut être considérable, et oublie que la fatigue est toujours nerveuse et ne croît pas parallèlement au travail mécanique.

L'enregistrement pratique de l'effort pourrait devenir un bon indice de la fatigue de certains groupes musculaires si l'on pourrait le faire pour de longues périodes de travail.

La mesure de la dépense organique au moyen des modifications des échanges respiratoires et de la quantité de chaleur dégagée donnerait de meilleurs résultats si la méthode pouvait être transférée du laboratoire au champ de travail.

Les arrêts du développement du corps, les déformations professionnelles et les crampes professionnelles ne résolvent pas davantage la question du diagnostic parce que ce sont des conséquences rares et lointaines.

Par contre, l'étude de la fatigue collective ou industrielle a commencé depuis peu et cependant promet de donner des résultats dignes de la plus grande considération. Même la méthode directe de l'enregistrement des sensations subjectives de la masse ouvrière, qui se manifestent avec la faiblesse, la nervosité, la perte de l'état de contentement, les absences fréquentes, le roulement de la main d'oeuvre etc. doit être considérée une bonne méthode pour déceler la fatigue. Au contraire, la morbidité et la mortalité ouvrières sont un phénomène trop complexe et partant peu sûr, pour le diagnostic de la fatigue, parce que l'une comme l'autre représente la somme de toutes les difficultés de la vie ou l'intervention d'autres causes graves. Toutefois, certains cas ont une signification clairement convaincante: ce sont par exemple les maladies dues au surmenage saisonnier et à la fièvre des apprentis.

L'interprétation de la statistique des accidents est souvent plus facile, parce qu'il y a une relation intime entre eux et le nombre des heures du travail, mais beaucoup d'autres facteurs exercent leur influence dans la production de la fatigue (défauts physiologiques ou psychologiques de l'individu, alimentation, rythme du travail, température, éclairage, défauts des machines, défaut de surveillance, alcool, etc.).

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Mais les données que l'on tire de la mesure de la quantité de la production (rendement) ou de sa qualité (malfaçons) (méthode de l'efficacité industrielle) sont aujourd'hui celles qui inspirent le plus de confiance, parce que c'est précisément dans cet indice que sont réunies toutes les défaillances organiques produites par la fatigue avant qu'elles n'atteignent la zone limite de la maladie. Cet indice représente en même temps la sensation subjective et la marche progressive de la fatigue et en outre ne peut pas être longtemps dissimulé dans les masses ouvrières par l'effort volontaire, comme ça peut arriver pour l'individu.

Nous attribuons une grande importance à ces méthodes, non pas qu'elles aient apporté une nouvelle contribution aux connaissances de la fatigue comme entité nosologique ou qu'elles aient révélé de nouveaux symptômes ou de nouvelles altérations des organes qui nous auraient permis une plus grande précision dans le diagnostic, mais surtout parce qu'elles confirment les lois scientifiques et en rendent le contrôle accessible aussi à ceux qui ne sont pas médecins. Elles ont en outre fait ressortir tout particulièrement la grande influence qu'ont, comme productrices de fatigue, non seulement les conditions physiques de l'individu, (alimentation, etc. etc.) mais les conditions hygiéniques du milieu de travail (température, lumière, etc. etc) et l'influence encore supérieure qu'exercent le choix des ouvriers, l'étude des mouvements, l'organisation du travail, et les facteurs psychiques.

Ces nouvelles recherches ont apporté une contribution notable spécialement en faveur de l'hygiène qui étudie ce chapitre de la pathologie du travail, non pas pour y chercher les théories de la vie, comme font les physiologistes, ou les éléments du diagnostic, comme le font les pathologistes, mais dans le but d'en tirer des enseignements pour la vie.

Les enquêtes faites dans les usines pendant la guerre ont démontré que les horaires prolongés et les mauvaises conditions hygiéniques du milieu de travail produisaient une diminution du rendement et une augmentation du nombre des accidents et des périodes de temps perdu. En conséquence la première Conférence Internationale de Washington a voté la convention sur les huit heures de travail. En même temps on ressentit partout le besoin de substituer la machine à l'homme dans l'exécution du travail physique, d'améliorer la technique dans chaque industrie, et on perfectionne les dispositions législatives tendantes à assurer la salubrité du travail. A cette tâche est venue s'ajouter, après la guerre, celle de l'utilisation maximum des forces physiques de l'homme pour collaborer à l'oeuvre économique du maximum de production. Pour cela l'axe des recherches scientifiques a été déplacé du domaine de la mécanique vers le domaine psycho-physiologique.

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Les études tendant à obtenir une meilleure utilisation des qualités physiques et psychiques de l'homme pour développer sa capacité de production et pour éliminer la fatigue inutile forment précisément la partie principale du programme de nombreuses institutions ou associations qui ont été créées après la guerre et qui fonctionnent sous les noms divers d'Instituts d'Hygiène Sociale, Bureaux de Recherches sur la Fatigue Industrielle, Instituts pour l'Organisation Scientifique du Travail, Instituts de Psychologie Sociale, Associations pour l'étude et l'amélioration des rapports individuels et des conditions de travail dans l'industrie, etc.

Les recherches entreprises se sont développées essentiellement dans deux directions:

Etude des modes du travail le plus économiques pour le moteur humain et le plus productif, étude qui se propose tantôt l'amélioration de la technique (organisation de l'outillage), tantôt l'éducation de l'ouvrier (réglementation de l'effort de la vitesse, de la volonté, des pauses, de la charge et du mouvement);

Etude des qualités mentales et des moyens éducatifs du travailleur, dans le but de trouver une place pour chaque homme et de placer chaque homme à sa place.

De nombreuses recherches ont été déjà faites dans les différents métiers ou dans les différents travaux pour l'exécution de la première tâche.

Les recherches au sujet de la seconde tâche envisagent le vaste domaine des aptitudes professionnelles, c'est à dire la psychologie professionnelle ou économique. Elle se propose essentiellement d'atteindre deux buts:

la sélection des travailleurs qui comprend tantôt le choix de l'individu pour la profession (sélection professionnelle proprement dit), tantôt le choix de la profession pour les individus (orientation professionnelle);

la formation des travailleurs, qui comprend, à son tour, l'éducation professionnelle, l'apprentissage et aussi la rééducation ou adaptation des mutilés.

Ces recherches ont été cultivées par des savants très renommés et des nombreux Bureaux d'Orientation ont surgi dans tous les pays. Les Gouvernements aussi y ont contribué au moyen de la création d'instituts spéciaux pour le recrutement des aviateurs, des marins, des automobilistes etc. et pour le placement des mutilés.

Quatre Conférences internationales de psychotechnic appliquées à l'orientation professionnelle se sont déjà réunies et des nombreux livres ont été publiés pour fournir les tests musculaires, sensoriels et mentaux du fonctionnement physiologique pour presque tous les métiers et professions.

De l'organisation de l'outillage et de l'organisation de la main

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d'oeuvre dans le sens taylorien s'occupent spécialement les Comités pour l'Organisation Scientifique du Travail, qui tiendront le troisième congrès à Rome dans le septembre prochain. L'Association Internationale pour l'Etude et l'Amélioration des Rapports individuels et des Conditions dans l'Industrie, qui a tenu ses réunions au Rigi Scheidegg (Suisse) et à Baveno, étudie de préférence le facteur humain. Un Institut pour l'Organisation Scientifique du Travail vient d'être constitué à Genève, près du Bureau International du Travail. Le Ministère de l'Economie Nationale en Italie a ouvert un concours pour un livre sur l'organisation scientifique du travail et a appliqué les principes d'une telle organisation dans une manufacture de tabacs et dans un bureau de poste.

La grande ferveur d'études dans ce champ fait que nous sommes fondé à espérer que l'on pourra bientôt formuler les lois psychologiques du travail et de la fatigue sur une base aussi solide que celles sur lesquelles s'appuient les lois physiologiques.

Ce jour là nous pourrions véritablement formuler la doctrine de l'organisation scientifique du travail, conciliatrice de la santé physique des travailleurs avec le meilleur rendement industriel, commercial et agricole. Si l'étude des questions économiques et des questions morales qui concernent le travail progressera de pair, on pourra espérer d'atteindre cette organisation humaine du travail, qui doit représenter l'idéal suprême de toute collectivité civilisée.

FATIGUE STUDY AS A FACTOR IN INDUSTRIAL DEVELOPMENT

BY JOS. PIACETELLI

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It is not my intention to discuss fatigue from the purely physiological or psychological viewpoint but I hope to point out some of the causes of fatigue in industry; to present to you some illustrative cases and to give you a brief description of some recent investigations.

Fatigue study is the analysis of surrounding conditions and any form of activity which affects the human organism. The late Major Frank B. Gilbreth and Dr. Lillian Gilbreth* set down the following factors describing its aims:

- to determine what fatigue results from doing various types of work;
- to eliminate all unnecessary fatigue;
- to reduce the necessary fatigue to the lowest amount possible;
- to provide all possible means for overcoming fatigue;
- to put the facts obtained from the study into such form that every worker can use them for himself to get more out of life.

These aims may be achieved with reasonable success by making a systematic attack on the problem, carefully considering the waste of human energy, eliminating as much of it as possible and to so distributing the necessary fatigue that recovery takes place while the employee is carrying on his work.

The causes of fatigue may for conveniency be divided into four classes, namely:

- fatigue caused by the surrounding conditions such as: lighting, noises, temperature, smoke, etc.;
- technical inadequacy of tools and equipment;
- improper layout of work place and relation of worker to work place;
- unnecessary expenditure of human energy due to inefficient methods.

When we enter a plant the things that first come to our attention are the lighting conditions, dust, smoke, temperature, noise and general layout of machinery and material. Considering lighting alone much is being done to reduce eye fatigue as well as emotional fatigue. During the past year investigations carried on in a group of plants representing many diversified industries, have shown that good lighting is an investment yielding reasonable dividends in terms of increased production, less fatigue, and enthusiasm of the worker.

* See Frank B. Gilbreth, Dr. Lillian Gilbreth: Fatigue Study.

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One of the most effective ways to reduce the fatigue caused by poor lighting is to increase the amount of reflected daylight. This has been done in plants where the idea seemed ridiculous. For instance, the usual darkness prevailing in foundries because of the unpainted walls, black painted moulding machines and equipment, together with the use of the dark moulding sand, has been greatly relieved by whitening the walls and equipment as far as practical. With the mechanical painting equipment now available it is inexcusable for any plant to have dark work rooms from this point of view. Eye fatigue is caused by many other unfavorable situations such as: kind of work, direct and indirect glares caused by polished surfaces, improper relation of worker with respect to source of light, and obstructions or shadow producing objects, such as corners and columns. It is needless for me to attempt to discuss further the fatigue caused by these conditions as well as that caused by noises, temperature, dust, smoke, etc., because I am sure that this phase of the subject will be amply covered later.

When designing machinery and equipment, hardly enough attention is paid to the motions involved in the method necessary to use them. In many cases the operator is required to make motions which are excessively fatiguing because foot and hand levers or other parts of the machine to be grasped are not within normal reach. Machines are often so constructed that they require the use of a method in which unnecessary effort is exerted. We have found on many occasions, after studying a method and finding the one best way to do the work, that the construction of the machine would not permit us to do the work in the desired sequence of therbligs and with the least fatiguing motions. This difficulty is usually overcome by either altering or redesigning the machine. When studying a shinglefolding operation at Barber Asphalt Company we found that in the best method possible with the machine as it stood, still existed motions which, altho seemingly necessary, could have been eliminated by making slight changes in the machine construction. With these changes made we were then able to do the work in the One Best Way. Many examples of this kind may be found in most types of machines and especially those which are fed by operators. This latter type often brings out the fact that they are designed without regard to the Gilbreth principles of ideal execution of hand motions*, some of which apply to this discussion and are as follows:

both hands should preferably begin their therbligs simultaneously;

* See Management Handbook, Ronald Press Co., New York.

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- both hands should preferably complete their therbligs at the same instant;
- motions of arms should be in opposite and symmetrical directions instead of in the same direction and made simultaneously;
- the number of therbligs required to do the work should be counted, for the One Best Way is almost always the sequence of the fewest therbligs.

Keeping these principles in mind when considering the method to be employed by the person who is to operate the machine, the designer can help greatly in avoiding unnecessary expenditure of energy by the operator. The fatigue caused by wasteful methods made necessary because of the construction of our present equipment, machinery or tools, should not be tolerated. The cause must be removed by altering or redesigning them if the benefits derived warrant it.

I have had the pleasure of investigating the fatigue caused by the improper layout of tools and equipment on work places with respect to the worker, with Russell W. Allen* and we have found that the materials and tools with respect to the worker are seldom arranged within the most convenient areas on the workplace.

The aims of our investigation were to determine:

- the normal working space within which work may be performed by each hand with least fatigue;
- the normal working space within which work may be performed by both hands together with the minimum of fatigue;
- the maximum working space for the left hand and right hand separately;
- the maximum working space for both hands working together.

Using equipment for making stereocyclegraphs** we were able to make visual records of the path of motions made by the worker on the vertical and horizontal planes.

In order to make the data obtained from different people comparable, the conditions under which motions were made were standardized as follows:

- the subject was so seated that his elbow was on the same horizontal plane as that of the workplace, when the upper arm hung normal;
- his body was approximately three inches from the edge of the workplace;
- the motions were made while the trunk and shoulders remained unmoved.

Under the above conditions we found that the arcs made by the

* Consulting Engineer, N.Y.

** See Management Handbook, Ronald Press Co., New York.

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various persons were similar and described approximately the same areas.

Now it may seem reasonable to expect that a person with a longer arm will describe an arc enclosing a much greater area than one with a shorter arm. At this point we must consider the physiological variables in that there exists a definite relation between the arm length and length of trunk. The person with the longer arms is generally equipped with a longer trunk. This has been found by Dreyer* in his investigation on these relations. It is obvious then that the person with longer arms will cover approximately the same area as marked out by a smaller person because of his longer trunk; his arm is pivoting on the ball joint of the shoulder at a higher level. This compensating feature reduces to a negligible degree the normal variations due to length of arms and trunk, when working on a horizontal plane.

The normal arcs drawn with the left and right hands on the horizontal plane representing a desk or workplace will cross each other at a point approximately in front of the worker. The surface marked out within these two arcs represents the most convenient areas within which work may be performed by the respective hands. There is also a definite zone which constitutes the place where work can be done with least fatigue with both hands together. This zone is that section of the workplace in which the two areas overlap. Areas corresponding to these normals also exist in the vertical plane and for any arc described by the worker whether in the vertical or horizontal plane, there is a maximum (made with arm fully extended), as well as a normal. Work done by either hand or both together, beyond their respective normal arcs in the vertical or horizontal plane, cause fatigue. When it is necessary to perform motions outside of these zones, the additional fatigue caused by them is allowable - altho not desirable - only up to the maximum arcs of the hand or hands making the motions. This limit is given because, reaching beyond the maximum arcs necessitates changes in the posture which, in case of repetitive operations, will cause excessive fatigue.

The principles set down as a result of our investigations may be stated as follows:

That for the least fatigue

motions with any one hand should be made within the space bounded by the normal arcs described by that in either the vertical or horizontal plane;

motions with both hands together should be made within the overlapping space marked by the normal arcs of each hand on the vertical or horizontal plane.

* Dreyer, Assessment of Physical Fitness.

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It is imperative that these principles be recognized when studying methods of work. They are especially important when the cycle of motions is performed thousands of times each day as is often the case in repetitive work.

At Barber Asphalt Company I had the opportunity to study some repetitive operations to which the application of the above principles was highly desirable. The work consisted of feeding Latite Shingles (12 and 16 square) into folding machines in which the operator completes a cycle of motions from three to four thousand times each hour. Any unnecessary effort in the cycle of motions of the operator would be expended approximately 30,000 times each day and it is apparent that they could not escape the effect of fatigue. Our knowledge of the Gilbreth principles of the ideal execution of hand motion and of those which I have just presented to you, was applied to this work and we are satisfied that the problem has been satisfactorily solved from the fatigue point of view. An inquiry was recently made and the opinions expressed by the men indicate that the fatigue has been reduced to a minimum. One of them said, "I don't feel tired when we quit at 5 o'clock but I do when we work till six". When questioned further on this matter in order to find out just why the work afforded recovery from fatigue during a regular nine and one-half hour day and not when they worked ten and one-half hours, he said, "Maybe I'm not exactly tired, but I just don't like the idea of the extra hour". It is evident then, that fatigue is caused by that extra hour but we can safely say that it is psychological rather than physiological.

An important aspect of fatigue study is the analysis of the worker's relation to his work place. If the work is performed in a standing position, one of the first thoughts of the investigator is whether or not it is possible to perform that work while seated. If it is absolutely necessary that the person must stand, consideration may be given towards making intermittent use of a chair. If the worker is seated before his work place, the situation must be analyzed for posture, the best type of chair, its height, etc. We have found that a saddle seat chair with small back-rest allowing free movement of the arms and equipped with foot-rest, is most desirable in encouraging good posture and reducing fatigue.

It is generally known that Motion Study is the science of finding the One Best Way to do work. The first step in motion study is the consideration of the amount of energy required to perform a given operation. It must be remembered that to find the one best way does not mean, as it is sometimes understood, finding the quickest way to do work, for the quickest way may prove to be

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most wasteful from the point of view of effort. Therefore, it is important that the selected method represents the utilization of the least fatiguing motions. The primary aim of motion study is to reduce the effort required to do the work by eliminating the unnecessary motions and arranging the necessary ones in a sequence which will yield the maximum of output with the minimum of time and effort.

I do not intend to discuss the motion study technique, for time will not permit, but I do want to present to you a brief description of the procedure from the point of view of fatigue study.

It is necessary to make a study of the arrangement of machines, materials, tools and the method employed by the operator. To do this a process chart* is made, showing the sequence of elementary operations in the desired degree of detail. Route and layout charts are also made, showing the flow of materials with respect to the machines and equipment and the relative positions of the operators with respect to machines and materials.

Analysis of these charts invariably point out radical changes.

Complete cycles of motions or parts of the major operation are often found to be unnecessary, materials retracting and cross-tracing; and it is sometimes found that much of the manual work can be done mechanically. The suggestions derived from the analysis are recorded on a possibility process chart showing the method embodying the new ideas. A motion picture film is then taken for the purpose of analyzing further for additional possibilities. If no radical changes are to be made, as may be shown by the possibility process chart, and if the analysis of the film does not suggest any, a simo chart** is made showing the motions made by the worker, therblig for therblig. On this the time element for each is also recorded. These simo charts are then analyzed from the point of view of the ideal execution of hand motions and a synthesis is made representing the new method.

In studying group work the motion picture film is especially useful because we are able to make simultaneous record of the workers, thus affording us the opportunity to make a comparative study of the amount and nature of the work done by each man.

The analysis often shows that one man does more than another and that parts of his work can without difficulty be transferred to some other worker who is not always performing useful work during his cycle time.

With the work of each man analyzed and a thorough understanding of its relation to the work of others in the group, we are able to view the problem as a whole, eliminate unnecessary

* See Management Handbook, Ronald Press Co., New York.

** Ibid.

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and fatiguing motions and rearrange the necessary work so that the burden of production, from the point of view of fatigue, will be equally shared by all and effect a better coordination between the workers in the group.

At Barber Asphalt Company a study was made of the cutting and packing of individual asphalt* shingles which was performed by a group of twelve men, and though I will not attempt to discuss in detail the old and new method, I shall point out parts of the method in which effort was wasted. The shingles (8" × 10") were cut from a continuous sheet 32" wide by a machine which deposited them, four at a time, on a flopper forming stacks side by side. When the desired number had accumulated on that side of the flopper it was turned over 90 degrees to the other side where four men stood by and grasped a stack each. These bundles or stacks were placed on bottom boards, prepositioned on the table by another operator, who later, when each of the four mentioned men had placed 4 stacks on each board making up a complete bundle, would lift the bundle from the table placing it on a short section of roller conveyor. The bundle of shingles was pushed down the conveyor by this man in order that it would be accessible to any of the four tyers whose work places were located on each side of the conveyor. The bundle was then grasped by one of the tyers who transported it three or four feet to his tying bench, where he completed the bundle by inserting direction sheets between the shingles and placing a board on top of it. The bundle was tied by looping a wire around each end and then tied permanently with a tying tool. It was then transported by him from the tying bench to the loading platform near by.

This description, though hardly complete, gives us enough information to enable me to point out some phases of the work indicating wasted effort. The table on which the shingles were stacked was approximately two feet higher than the flopper, making it necessary to lift each stack handled by the four men employed on this work. The fatigue due to this was greatly reduced by changing the relative height of the table and flopper. Another part of the method showing unnecessary exertion of effort was that in which each tyer was required to lift the stacked bundle weighing about 70 lbs. from the conveyor and transport it to his tying bench, where he performed the tying operation. Much time and effort was also unnecessarily expended in grasping the tying tool, transporting it to the work, using it and then transporting it back again to its place and released. Another phase of the work causing unnecessary fatigue was that in which the worker transferred the completed stacks from the stacking table to the roller conveyor.

* See Manufacturing Industries, April 1926.

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The fatigue caused by the unnecessary handling of the product and tools during the various stages of the packing process was greatly reduced by the adoption of a method in which each of the above causes was either eliminated or reduced to a minimum. Owing to the lack of time I cannot give you a description of the new method to show just how we solved our problem, but I will take the time to say that we are now doing the work which formerly required thirteen men with eleven, and the amount of effort exerted by each man is less with the new method than with the old. One of the workers expressed his opinion of the new methods as follows: "Before you changed the method we'd be so tired that we would hardly want to do anything when we went home, and now since we got used to the new way we hardly ever notice it."

Studies were also made of seven operations similar to this*. The unit costs were reduced as much as 20 % and although the men are now able to produce the same amount with less effort individually, their earnings have been increased as high as 4 %. Before these studies were made, difficulty was experienced in keeping the workers on the job, because of the excessive fatigue involved, while at present the labor turnover is negligible.

The new methods now permit some of the men to do their work while seated and, where it was not possible to distribute the effort evenly among the workers in any one group, the men are required to rotate functions every hour. This permits the worker to recover from the necessary fatigue by the use of a different set of muscles in the next operation. By this plan we get a more flexible organization as well as maintain the interest of the worker.

The application of physical laws to anatomical motions and their relation to fatigue and production was recently investigated at the Gilbreth laboratories by Dr. Franz Hahn of Berlin and S. F. Csohar of New York,** Their study consists of a space-time analysis of motions made by the arms while the rest of the body does not move, and aims to show the importance of the teaching of correct motions.

The results of their research bring out valuable data concerning the distribution of effort along the path of a motion.

They were able to show that the effort to perform a motion is a minimum when it is performed in the natural period of the member performing it. In performing a correct motion the force varies in magnitude as the action of gravity on a pendulum, that is, the maximum force is exerted at the beginning of the motion, diminishes to zero as the velocity reaches its maximum, and then,

* See Manufacturing Industries, May 1926.

** Ibid May 1927.

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with the same rate of change, increases to the same maximum when the moving arm comes to rest. This not only establishes the fact that the distribution of effort along the path of a motion is a function of the sine law, but also shows that for a given load carried by the hand there is a definite "period of vibration". The length of the pendulum will vary with different weights and shapes of the loads in hand, and consequently by this relation we should be able to determine in advance the time required to make a motion along the pendulum path for least fatigue. If it is desired to make the motion during a shorter period of time, it then becomes necessary to shorten the pendulum by moving the object in hand nearer to the pivot point of the arm, thus changing the distance from the center of gravity of the arm and object to the pivot point.

If a motion is not made in the natural period the extra force which is required to speed up or slow down the motion will introduce an extra element of fatigue.

In brief, this bit of research points out, that for the least fatigue a motion must not only be made in the correct path, but that the effort and time must be properly distributed along the path, and that total time must be equal to that of a natural period. Deviations from these principles will cause allowable fatigue when such deviation is necessary and superfluous fatigue when unnecessary.

WORK AND TEMPERAMENT

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To choose a title which shall convey the same meaning to an audience of different races, training and interests is difficult. The most one can achieve is to avoid misunderstanding. Before English hearers the lecture might have been headed "Work in Relation to Temperament and Disposition". For these two words in English are narrowing their meaning. When we speak of temperament and work we cannot exclude disposition. This lecture will deal with both these factors.

Temperament may be defined as the progressive effect of definitely bodily factors upon mental processes. Among these bodily causes are prominent the organs of circulation, digestion, secretion, excretion, reproduction; the muscular system, and peculiarities of structure and function in the nervous system. Temperament is affected by any or all of these.

An individual's disposition is the sum of all his inborn tendencies to action. These include not only simple reflexes but also instincts with their associated emotions. Thus we speak of a person as having a timid or affectionate disposition. Disposition, though inborn, is usually changed by later experience.

Temperament and disposition are always closely related. A big goodlooking healthy person is likely to find social life easy and so may be ranked as much more affectionate than he really is. A person who is under-sized, plain, unhealthy or with some bodily defect may compensate or over-compensate for this lack of his social behaviour. This over-compensation is an important factor in the psychological system of Alfred Adler.

It is unnecessary to emphasize the important roles which the sense of inferiority and over-compensation play in industrial disputes in all countries.

In the last thirty years psychological medicine has contributed data of great value for normal psychology. By studying the exaggerations or defects of mental adjustments, one can often see them functioning more simply than usual, and, in time, obtain a profounder knowledge of normality. It is therefore profitable to consider work from the pathological standpoint. We may ask why certain people do not want to work, or, when they do, work badly, even when external conditions and incentives appear to others to be satisfactory.

This negative aspect of work will be discussed with no moral judgments. This is not easy, at least in England. The names given to the various forms of inability to work which arise from some inner lack are: laziness, slackness, lethargy, stupidity, clumsiness, carelessness. And it is significant that we seldom attribute these qualities to our friends.

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Yet the National Institute of Industrial Psychology, when reducing the breakages of china in a catering establishment, found that the word "carelessness" obscured many different and independent factors. So the other words quoted above are of little use for the scientific thinker, except as starting points for analysis. They will be used here for this purpose only.

First, we will consider "laziness" as the antithesis of desire for work.

It is reasonable to seek the first causes of laziness in physiological factors. That certain structures of body predispose their possessors towards laziness seems certain.

Kretschmer, whose views have been summarised for industrial psychologists by Giese, is a recent exponent of this type-classification which dates back to very ancient times.

These body-types may be regarded as chronic systems of causes of laziness or "keenness". There are also acute causes. Different glands exercise specific effects at different times. Some of their secretions are temporary and periodic as, for instance, those concerned with menstruation and pregnancy; others, like the thyroid gland, may have functional peculiarities which last for months or years, and exercise great influence upon temperament. So a person's general activity, interest, placidity or quarrelsomeness may often be due primarily to glandular secretions and only secondarily to mental factors.

Laziness or keenness may express the bodily make-up which characterises certain races. Those who employ workers of different nationalities could supply data which, if critically treated, (it would be important to discount race-prejudices) would be of great value. The suitability of different races for different types of labour in ocean liners and cargo ships is assumed (though perhaps prematurely) by some employers.

Laziness caused by obviously pathological states of the body is a definitely medical problem, yet of industrial importance.

The outcome of this discussion is to suggest reasons why specific types of body are more likely than others to be connected with the desire for certain kinds of work. And here it is important to distinguish between heavy physical work and mental performances demanding the slightest muscular activity.

We now pass to the influence of disposition upon work.

A primitive laziness attributable to a mental factor is towards work which does not appeal to one or more of the fundamental instincts; those inborn forces which tend to make a person preserve himself, his race, or his own social group. This is well-known, but its particular relevance here is because attempts to force men to work usually exploit one of these classes of instinct. It is easy to get men to work if they are in the army, the navy

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or in prison. But the nature of the reasons for this fact makes it impossible to expect similar work in everyday life.

An important way in which work may appeal to a person without the nature of that appeal being clearly appreciated is through suggestion, sympathy or imitation. The importance, both in work and sport, of the example or pace-maker is well known. But they produce conscious imitation. Yet many persons, in almost everything they do, copy consciously or unconsciously, someone whom they consider their superior. Our admiration of some industrious individuals may be qualified by the belief that they would have been lazy if an attractive person had not lured them into good ways.

We must now consider the influence of the sentiments upon work. An English psychologist, Mc Dougall, uses the word sentiment in a rather restricted way; to designate an organized system of tendencies to emotion grouped about the idea of an object.

There is little reason to suppose that instincts and emotions differ much in the human race except in their intensity. But the difference in sentiments is notoriously great. An hour's crossing from Dover to Calais will prove this, or a shorter journey from one end of New York's Fifth Avenue to the other. Even in members of the same family the difference may be acutely marked. Sentiments are more usually organised about limited concrete objects (home, wife, children) than around classes of such objects, such as the human race, or national prosperity.

Laziness is often, due to the fact that the work appeals to no strong sentiments.

An understanding of the sentiments in any community is of the first importance for anyone concerned in administration. This subject is interestingly dealt with by Whiting Williams.

Since the sentiments are grouped about ideas of objects they are permanent or semi-permanent, while the instincts are aroused only transitorily. In a war or a strike a man might do an action at the behest of a transient instinct, which would have been controlled if a sentiment had guided him. And a sentiment, by its relative permanency, can override and control powerful instincts.

The attitude of employers and employed towards each other, being largely dominated by sentiments, is well worth psychological study.

ARBEITSLEISTUNG UND UNFALLHÄUFIGKEIT ALS SYMPTOME DER INDUSTRIELLEN LEISTUNGSFÄHIGKEIT

VON DR. PHIL. OTTO LIPMANN

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Die Arbeitswissenschaft ist die Wissenschaft von den Bedingungen und Wirkungen der menschlichen Arbeit. Sie hat in systematischer Weise einander zuzuordnen die Veränderungen von Bedingungen und von Wirkungen der menschlichen Arbeit. Solche Bedingungen sind z.B.

(die Aufzählung geschieht nicht in systematischer Weise):

- Beleuchtung (Art und Grad);
- Jahreszeit;
- Temperatur;
- Lohn (Form, Termin und Höhe der Lohnzahlungen);
- Entfernung zwischen Heim und Arbeitsstätte;
- Alter des Arbeiters;
- Berufliche Erfahrung;
- Persönliche Eigenschaften;
- Geschlecht;
- Dauer der Arbeitszeit;
- Stunde des Arbeitstages;
- Verteilung der Arbeitsstunden
- u.s.w.

Wirkungen der Arbeit sind z.B.

- Menge des Arbeitsproduktes;
- Qualität des Arbeitsproduktes (Menge der Fehler);
- Unfälle;
- Gesundheit des Arbeiters;
- Ausnützung der Arbeitszeit.

Wir haben heute zwei von den Wirkungen zu untersuchen: die Ergibigkeit des Arbeitsprodukts und die Unfälle; morgen haben wir uns zu beschäftigen mit zwei der Bedingungen: der Dauer der Arbeitszeit und der Verteilung der Arbeitsstunden über den Arbeitstag.

Bevor man versuchen kann Veränderungen der Produktionsmenge und Veränderungen von Bedingungen der menschlichen Arbeit einander zuzuordnen, muss man feststellen, in welchem Masse in einer bestimmten Industrie oder in einem bestimmten Betrieb die Produktionsmenge überhaupt von der menschlichen Arbeitsleistung abhängt. Wir stehen in einem Prozess derart, dass die Produktionsmenge immer mehr durch Maschinen und mechanische Einrichtungen bestimmt wird. Infolgedessen darf man oft nicht ohne weiteres die Veränderungen von Produktionsmengen als Aus-

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druck für Veränderungen der menschlichen Arbeitsleistung ansehen.

Die menschliche Arbeitsleistung hängt ab, erstens von dem Grade der **Leistungsbereitschaft**, den der Arbeiter in einem bestimmten Zeitpunkt besitzt, und von der **Leistungsgelegenheit**, die ihm Verwendung seiner Bereitschaft in mehr oder weniger hohem Grade gestattet. Manchmal z.B. gestatten es die natürlichen Arbeitsbedingungen (so z.B. in den Bergwerken) nicht, dass die volle Arbeitsbereitschaft des Arbeiters in der Menge des gelieferten Produktes zum Ausdruck kommt; in andern Fällen, z.B. in der Hütten- und in der Textil-Industrie, wird die Arbeitsleistung des Arbeiters gelegentlich durch die Wirtschaftslage, durch Absatzschwierigkeiten, gedrosselt. Auch in solchen Fällen darf man natürlich die Produktionsmenge nicht als einen Masstab für die menschliche Arbeitsleistung ansehen.

Die Arbeitsleistungsbereitschaft ist aus zwei Faktoren zusammengesetzt: der **Leistungsfähigkeit** und dem **Leistungswillen**, die beide Veränderungen unterliegen und deren Veränderungen zum Teil von einander abhängig sind. An der Wirkung kann man nicht erkennen was dem einen und was dem andern Faktor zugute zuschreiben ist. Aber theoretisch kann man sagen, dass manche Bedingungen, so z.B. die Dauer der Arbeitszeit, mehr, wenn auch nicht ausschliesslich, die Leistungsfähigkeit, — andere Bedingungen so z.B. die Lohnverhältnisse, mehr, wenn auch nicht ausschliesslich, — den Leistungswillen beeinflussen.

Wir haben uns nun mit einigen der Bedingungen zu beschäftigen, welche die Produktionsmenge und die Unfallhäufigkeit beeinflussen, aber ich möchte mich heute auf die Unfälle beschränken, weil die Zeit kurz ist, die mir zur Verfügung steht und weil ich morgen noch über die Wirkung der Arbeitsdauer auf die Produktionsmenge zu sprechen haben werde.

Die Zahl der Unfälle hängt ab von der Leistungsbereitschaft des Arbeiters und von der Häufigkeit der **Unfallgelegenheiten**. Je rascher das Arbeitstempo, desto grösser ist auch die Zahl der Unfallgelegenheiten. Wenn man z.B. finden würde, dass während der heissesten Stunde des Tages die Zahl der Unfälle am kleinsten ist, so würde dies wahrscheinlich daher kommen, dass in dieser Stunde auch das Arbeitstempo vermindert ist. Daher sollte man stets die Zahl der Unfälle während einer gewissen Zeit in Berechnung setzen zu der Menge des in dieser Zeit gelieferten Arbeitsproduktes.

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ARBEITSDAUER UND ARBEITSZEIT-EINTEILUNG ALS BEDINGUNGEN DER INDUSTRIELLEN LEISTUNGSFÄHIGKEIT

VON DR. PHIL. OTTO LIPMANN,

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Wir haben uns heute mit der Arbeitsdauer und mit der Arbeitszeitverteilung als Bedingungen der Arbeitsleistung zu beschäftigen. Ich muss zuerst noch einmal wiederholen, dass die Produktionsmenge nicht immer ein genauer Ausdruck für die vom Arbeiter aufgewendete Arbeitsleistung ist. Wenn die Produktionsmenge in einer Industrie völlig oder fast ganz von der Wirksamkeit der technischen Einrichtungen und von der Arbeitsorganisation abhängt und wenn der Arbeiter nur die technischen Einrichtungen zu beaufsichtigen hat, dann hängen selbstverständlich auch Aenderungen der Produktionsmenge direkt nur ab: erstens von der Vervollkommnung der technischen Einrichtungen und zweitens von Aenderungen der Dauer ihres Funktionierens.

In solchen Industrien und Betrieben also gibt es eigentlich kein wirtschaftliches Arbeitsproblem: je länger die Arbeitszeit, desto grösser die Produktionsmenge. Und das Problem lautet hier nur: wie ist die Arbeitszeit des Arbeiters auf die Arbeitszeit des Betriebes zu verteilen? Das ist also das Problem des Schichtwechsels. Aber dieses Problem ist überall da, wo unsere Voraussetzung: Vollkommenheit der technischen Einrichtungen, erfüllt ist, kein Problem der menschlichen Arbeitsleistung, sondern ein Problem der Sozialhygiene einerseits und ein Kostenproblem anderseits.

Wenn aber die Produktionsmenge nur, oder fast ausschliesslich, von der menschlichen Arbeitsleistung abhängt — und dies ist noch allerdings wie ich glaube, nicht mehr lange in manchen Industrien der Fall — so gibt es stets für die Länge der Arbeitszeit zwei kritische Punkte. Wenn die Arbeitsdauer über den erster dieser kritischen Punkte hinaus verlängert wird, dann nimmt die Leistungsfähigkeit des Arbeiters ab und gleichzeitig wird die arbeitsstündliche Produktionsmenge vermindert. Wenn die Arbeitsdauer dann noch weiter, auch über den zweiten kritischen Punkt hinaus, verlängert wird, so wird die Verminderung der arbeitsstündlichen Produktionsmenge so gross, dass auch die arbeitsstündliche oder wöchentliche Produktionsmenge sich zu vermindern beginnt.

Aber es ist sehr schwer, diese beiden kritischen Punkte genau zu bestimmen, denn sehr oft treten Aenderungen der Arbeitsdauer zugleich mit andern Veränderungen, z.B. von technischen Bedingungen auf. Eine solche, sehr oft gleichzeitig mit der Arbeitsdauer veränderte Bedingung ist z.B. die Arbeitszeiteinteilung. Wenn eine Verminderung der Arbeitszeit von 10 auf 8 Stunden

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gleichzeitig auftritt mit einer Veränderung der Arbeitszeiteinteilung, dann kann man natürlich aus den beobachteten Wirkungen keine theoretischen Schlüsse ableiten über die optimale Länge der Arbeitszeit. Vom wirtschaftlichen und hygienischen Gesichtspunkte aus wäre es besser, 10 Stunden, das heisst 2×5 Stunden mit einer längern Pause dazwischen zu arbeiten als 8 Stunden ohne Pause.

Das Arbeitszeitproblem hat drei verschiedene Seiten und ist unter drei verschiedenen Gesichtspunkten zu betrachten: dem wirtschaftlichen, dem hygienischen und dem sozialkulturellen. Je nach dem Gesichtspunkt wird auch die Lösung verschieden sein.

Die wirtschaftliche Frage ist: Welche Arbeitszeit liefert den grössten und billigsten Ertrag?

Die hygienische Frage lautet: Welche Arbeitszeit kann dem Arbeiter zugemutet werden, ohne dass er sich überarbeitet, d.h. dass er bei jedem neuen Arbeitsbeginn die Arbeit mit derselben Frische wieder aufnehmen kann?

Die kulturell-soziale Frage lautet: Welches Mindestmass an Freizeit braucht der Arbeiter zur Erfüllung seiner kulturellen und sozialen Pflichten und Bedürfnissen?

Je nach dem Standpunkt wird auch die Lösung des Arbeitszeitproblems eine verschiedene sein.

Im allgemeinen besteht bei der Lösung dieses Problems ein Konflikt zwischen der wirtschaftlichen Lösung einerseits und der hygienisch und sozialen Lösung anderseits. In vielen Fällen ist das Produkt grösser und billiger je länger die Arbeitszeit des Arbeiters ist; aber aus sozialen und hygienischen Gründen fordert man trotzdem in vielen Fällen eine Arbeitszeitverkürzung.

Beim Pausenproblem dagegen liegt der Konflikt zwischen dem wirtschaftlichen und dem hygienischen Standpunkt einerseits und dem sozialen anderseits. Für die Produktion und für die Gesundheit des Arbeiters ist es günstiger, die Arbeit für ein oder zwei Stunden zu unterbrechen und sie dafür ein oder zwei Stunden später endgültig zu beenden; aus sozialen Gründen aber ist es vorzuziehen, sie ein oder zwei Stunden zeitiger zu beenden, sodass die ununterbrochene Freizeit des Arbeiters und die Zeit, die er für seine Familie und für die Befriedigung seiner kulturellen Pflichten und Bedürfnisse übrig hat, länger wird. Es gibt da auch noch Unterschiede, je nachdem ob es sich um grössere oder kleinere Städte handelt, denn wenn der Pendelwanderungsweg, den der Arbeiter zwischen Heim- und Arbeitsstätte zurückzulegen hat, nur kurz ist, so kann er auch während längerer Arbeitspausen sein Heim aufsuchen, die von seiner Frau bereitete Mahlzeit verzehren, u.s.w.

Ich sagte, dass man die Wirkung einer Arbeitszeitveränderung

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nur schwer feststellen kann, wenn die Arbeitszeiteinteilung sich gleichzeitig verändert hat.

Ebenso ist es sehr schwierig festzustellen, ob eine solche Arbeitszeitveränderung die Leistungsfähigkeit des Arbeiters oder seinen Leistungswillen beeinflusst. In Zeiten mit längerer Arbeitsdauer wird zweifellos nicht nur die Leistungsfähigkeit, sondern in sehr hohem Grade der Leistungswille des Arbeiters in Mitleidenschaft gezogen.

Aus diesem Grunde werden oft nicht so sehr die Produktionsmenge, wie der Gesundheitszustand und die Unfallhäufigkeit die besseren Maßstäbe für die Wirkungen, die dadurch Veränderungen der Arbeitsdauer auf die Leistungsfähigkeit der Arbeiter ausgeübt werden.

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LIGHT AND VISION IN INDUSTRY

WITH SPECIAL REFERENCE TO THE ELIMINATION OF UNNECESSARY EYE-FATIGUE

BY MR. H. C. WESTON

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The eyes are of immense importance in industry, and an elementary study of the physiology of vision will show how easily they may be strained or fatigued under certain conditions which are frequently associated with industrial work.

The fatigue experienced may be muscular, due to extreme accommodation and convergence sustained for comparatively long periods, or to defects of vision involving constant overaction of certain muscles, or it may be cerebro-retinal, due to intense or monotonous stimuli.

The conditions of illumination in factories and workshops are intimately connected with the production and elimination of eye-fatigue, and we shall therefore consider the principles of good lighting and what practical effects arise from unsuitable conditions of lighting.

The two fundamental requirements of good lighting - by which is meant, of course, lighting which will ensure eye-comfort, and place no obstacle in the way of production, so far as this is dependent upon vision - are adequacy and suitability. Adequate lighting, whether by daylight or by artificial light, implies the provision of an amount of illumination which will enable every essential part of the work to be seen easily. The minimum degree of illumination which will satisfy this condition naturally depends upon the finesses of the work to be done, so that, as regards minima, every industrial operation requires individual consideration. It is never advisable, however, to provide only the minimum illumination required; allowance must be made for deterioration of lamps and fittings, dirty windows, etc. which, at times, will appreciably reduce the amount of illumination available. Further, illumination is not only important by reason of its direct relation to visual acuity; it is of no little importance indirectly, because it greatly affects the general aspect of the workplace and generally influences the subjective feelings of the workers, their sense of well-being and contentment.

A good deal of research work has been done and is still being done with the object of determining the relation between illumination intensity and acuity of vision. Work on this problem is being done on behalf of the Committee on the Physiology of Vision set up by the British Medical Research Council, and lighting requirements in actual factories are being studied by the Illumination Research Committee of the British Department for Scientific and Industrial Research. This and other means for reducing eye-

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strain in industry are also being studied in England under practical conditions by the Industrial Fatigue Research Board. The subject of lighting has also received very careful consideration in England from the Home Office Departmental Committee on Lighting in Factories and Workshops, which published three reports containing recommendations as to both adequacy and suitability.

Visual acuity and the speed of perception increases up to very high values of illumination and some interesting experiments have been made by Ruffer in Berlin in this connection. The results show a very considerable loss of efficiency with illumination values of less than 1 foot-candle, while up to 10 foot-candles marked improvement takes place.

It was found that with values of illumination above 10 foot-candles, or 100 Lux, improvement in visual acuity was much less noticeable, and the best value of illumination appeared to be between 10 and 20 foot-candles. Further experiments with much higher degrees of illumination and more difficult tests showed that visual acuity may continue to increase when the illumination is raised to 300 foot-candles. Such a high degree of illumination, though often obtained by daylight in well-planned factories, is seldom necessary in industry, since the improvement in visual acuity is so small as to have little, if any, effect on production and fatigue. The provision of adequate daylight illumination is obviously very largely a question of factory planning. In many old factories the window area is wholly insufficient for proper illumination and this defect is often aggravated by internal obstructions in the shape of tall machines and overhead shafting and belting, while the windows themselves are sometimes difficult of access for cleaning purposes. Probably the best method of securing really good daylight illumination is by means of roof lights, but the application of this method is limited to single storey buildings and to the top floors of higher structures. In congested areas the lack of space between adjacent buildings, especially if these are high, greatly reduces the amount of light which can enter the windows, and in these cases it is often necessary to fit large mirrors outside the windows, arranged so as to reflect light on to the ceiling of the room and thence on to the work bench. Other expedients may be necessary in the case of fine work, such as the employment of a device similar to that used by the Universal Electric Company of Berlin, which consists of a concave mirror mounted on a stand which can be turned towards the window and, if placed behind the work, reflects light on to it.

Daylight illumination varies within wide limits, but outside the factory it is frequently several thousands of foot-candles. The proportion of this light which is available inside a factory, however, is even in the best cases, comparatively small. Thus

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a factory having a daylight factor of 3 per cent, which is probably a fair average for a large number of factories, would have an illumination of only 21.6 foot-candles when the outside illumination was 720 foot-candles, which is about the average prevailing during December. In top lighted rooms, that is, rooms having a saw-tooth roof or other form of skylight, the daylight factor may be 7 or 8 per cent and the illumination with this type of window is more evenly distributed throughout the room. The reduction of the daylight factor which may result from dirty windows is quite considerable, and if economy in the use of artificial light is to be effected, it is essential to arrange for the cleaning of windows as frequently as may be necessary. The walls and ceilings of workshops need also to be kept clean and should be light of colour, so that there is no unnecessary loss of reflected light.

In recent years a great deal of attention has been devoted to the subject of artificial light, and as a result, the general tendency, especially among progressive manufacturers, has been to raise the standard of illumination provided. Comparatively little work has been done, however, with the object of accurately determining the amount of illumination which is necessary for different kinds of work in order to ensure eye-comfort and maximum production. Though industrial work is of great variety, it may be classified in a comparatively small number of groups, so that it is only necessary to determine the amount of illumination required for a few typical processes in order to establish a sound basis for the formulation of lighting standards.

As an example, may be quoted the recent work of Ives who has studied the relation between illumination and speed and accuracy of letter sorting in American post offices. The work of letter sorting, from the visual standpoint, is fairly typical of a number of other operations such as proof-reading, typewriting, general clerical work, certain kinds of inspection, and other types of work involving rapid discrimination of fairly small detail having relatively good contrast. Ives experimented with different conditions of lighting and studied their effects upon groups of workers selected according to eyesight. The production of each group was improved by increasing the illumination, the improvement being most marked in the case of those groups containing persons having relatively poor sight. The normal group attained maximum production when the illumination was raised to 8 foot-candles, and the sub-normal group when the illumination was 14 foot-candles. Ives also found that the number of errors diminished as the degree of illumination was increased, the errors being three times as many with an illumination of 3 foot-candles as with 14 foot-candles.

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The results of some recent experiments carried out with compositors for the British Illumination Research Committee, demonstrate very clearly the relation between the degree of illumination and the speed and accuracy of typesetting by hand, a process which is more exacting in its demands upon the eye than such work as letter sorting and which, moreover, is comparable with a number of other fine processes, such as the examination and manipulation of small metal parts in the engineering trade, clock-making, and die-cutting.

In these experiments five different degrees of illumination were tried, the values ranging from 1.3 to approximately 25 foot-candles. A sixth test was made in daylight in order to determine the normal rate of output.

The results of these experiments show that when the illumination is less than 2 foot-candles only about 75 per cent of the possible output can be obtained while the total errors are nearly $2\frac{1}{2}$ times as many as they are in daylight, or in artificial light when the intensity of the latter is about 25 foot-candles. If the illumination is raised to 7 foot-candles the output rises to 88.5 per cent and the number of errors is correspondingly reduced. Increasing the illumination still further to 14 foot-candles has the effect of raising the output to 95 per cent and again reducing the number of mistakes, while at 25 foot-candles the output is 100 per cent, or equivalent to the daylight output, and the number of mistakes is reduced almost to the daylight level. Clearly these results imply that with low values of illumination the process of perception is slowed down and unnecessary strain is imposed on the eyes of the compositors. The loss of output, which is inevitable with poor illumination, is a very serious matter in any trade where labour charges constitute the main part of the cost of production, and of course the loss will be of greater consequence in factories where night work, and work in underground rooms, is done than it will be where daylight can be utilised during the majority of the hours of work. The cost of providing artificial light to the extent of at least 20 foot-candles, in place of an existing intensity of perhaps 5 foot-candles, is only a small proportion of the cost of labour, in processes of the kind we are considering, and a very appreciable saving in the cost of production can be effected by the reduction of eye fatigue due to a suitable increase of illumination.

Though the degree of illumination used is of great importance in relation to production and eye-fatigue, the arrangement of sources of artificial light and the type of fitting used also requires careful consideration.

There are three principal methods of artificial illumination: the direct method, in which the work is illuminated directly by the

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lamp, which is usually fitted with some form of reflector designed to throw the light down and to spread it over a given area; the semi-direct method, by which some of the light reaches the work through a translucent diffusing bowl, and some is thrown up on to the ceiling, or on to a reflecting surface placed above the bowl, from whence it is reflected on to the work, and the indirect method, in which an opaque reflector is arranged under the lamp, so that all the light reaching the work is reflected from the ceiling and upper portion of the walls. Each of these methods has its advantages and each may be used in combination with another. Direct lighting may be either general or local, or a combination of both; if it is general the spacing and mounting height of the light sources should be arranged so that the illumination of the whole room is fairly uniform. Local direct lighting should be used, if it is necessary, only to supplement the general illumination, since local lighting by itself leaves a large portion of the room in semi-darkness, which is depressing to many workers, and makes it necessary for the eyes to adapt themselves to the darkness every time they are directed away from the immediate working area. Semi-direct is sometimes to be preferred to direct lighting; it is softer and more diffused and the actual lamps cannot be seen at all so that there is less risk of glare. Indirect lighting, though very uniform, practically eliminates shadows - which are very helpful in distinguishing the details of many objects - and is usually unsuitable for use in factories on this account, and also on account of its relative cost.

The effect of these different systems of lighting upon the eyes is not easy to judge very accurately from a study of output records, because the direct effect of a particular system of lighting upon the facility with which work can be seen is probably small in comparison with the psychological effect it may have, its influence on the subjective sensations of the worker, which doubtless play their part, though not always a consistent one, in determining both the speed and accuracy of work. For instance, there are individuals who are stimulated by bright light and who do not even object to working in close proximity to an unshaded lamp, while others are oppressed by excessive brightness and annoyed and irritated by the glare from bare lamps.

Regulations for the prevention of glare are now in force in some countries, and in England, the Home Office Committee on Factory Lighting recommended, in this connection, that all light sources above a certain brightness should either be effectively screened, or mounted at such a height that the angle between a line drawn from the eye to the light source and the horizontal line of vision should not be less than 20 degrees, or not less than 30 degrees, if the light source is within six feet of the worker. The position

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of a light source in relation to the work to be illuminated is very important if glare from polished metal surfaces is to be avoided, and also in connection with the elimination of undesirable and unpleasant shadows. A simple experiment with a mirror placed near a lamp will show how easy it is, when the mirror is tilted at a certain angle, to have the glare of the lamp reflected directly into the eyes. This sort of thing happens in industry and is very uncomfortable; it can only be avoided by altering the position of either the work or the lamp. Again, a lamp wrongly situated - over the head of a sewing machine for instance - will throw a deep shadow on that portion of the work which the operative has to see, and the eyes are in consequence strained in the effort to see it. Here again the remedy is simple, but is often neglected.

The provision of adequate and suitable lighting in factories - and this implies a standard considerably higher than the average existing to-day - will do much to eliminate eye-fatigue in industry, but there must always be unnecessary eye-fatigue so long as there are workers with uncorrected defects of vision, while there are also a number of very fine processes in industry which necessarily strain even normal eyes, unless they are assisted by suitable glasses. It is obvious that if, when work is illuminated to a high degree it is still impossible for the worker to see the details of it clearly, owing to the minuteness of the image formed on the retina, it will be necessary to view the work through a magnifying glass, or lens. But there are many kinds of work the details of which, though very small, can be seen by the normal fully accommodated eye without the aid of lenses, but maximum accommodation and convergence involves extreme muscular action, and we know that this cannot be maintained for long periods, or even for short periods, if these occur with great frequency, without the development of fatigue. If this fatigue is to be avoided we must reduce the accommodation and convergence required to an amount which can be tolerated for reasonable working spells.

We know that if our sight is normal we can read a book, or write, for some hours without discomfort to our eyes, and this is so because we do these things with the eyes at such a distance from the book, or paper, that the amount of accommodation and convergence required is not excessive. If then we use glasses designed so that details which are smaller than print or script, - or which for other reasons, such as lack of contrast, are more difficult to see - can be seen without any greater effort of accommodation and convergence than we are accustomed to use for reading, we shall probably experience no undue eye-fatigue in doing fine work for spells of the duration usually adopted in industry.

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Experiments in factories with glasses of this kind have recently been made in England for the Industrial Fatigue Research Board, and further experiments are still in progress. The technique adopted by the ophthalmologists who have prescribed the glasses has been to correct first any errors of refraction due to hypermetropia, myopia, and astigmatism, then to add a convex lens of such power as will reduce accommodation to an extent which can be sustained comfortably, and at the same time allow a range of distinct vision which is sufficient for the requirements of the work; and finally to add prisms when necessary, the subjects being allowed a certain latitude in the choice of these, so as to allow for individual difference of the power of convergence. In the first experiment made, the subjects were allowed to choose the lens which gave them most distinct vision at the working distance, thus allowing for individual variation of the power of accommodation; but the glasses in this case were of low power - about 1.5 dioptries, and no prisms were used, since the reduction of accommodation was not sufficient to introduce any discomfort due to the readjustment required of the normal relation between convergence and accommodation.

These glasses were worn by several operatives engaged in linking hosiery, and their effect was shown by the reduced time required to link the hose, the reduction amounting, in the case of experienced operatives, to 10 per cent and, in the case of a learner, to over 25 per cent. It appears, therefore, that long practice enables the linker to develop special facility of perception for the kind of detail with which she is concerned, so that the strain imposed upon the eyes has less effect upon output than it has in the case of the beginner, to whom it is a very serious handicap.

The worker who succeeds more or less in adapting the eyes to the conditions of the work may do so, however, only as a result of the development of artificial myopia, due to the habitual contraction of the ciliary muscle.

Another instance of the very great benefit of glasses to the comparatively inexperienced fine worker, has been observed in experiments with girls engaged in sorting and mounting very fine carbon filaments in a lamp factory. In this case the glasses prescribed were much stronger. The converging power was 4 dioptries, and 6 degree prisms were combined with the lenses.

The output rate of one of the girls who has had several years experience of the work, increased by 3 per cent when the glasses were worn, while the other girl, with much less experience, increased her output by 34 per cent. This girl, however, is slightly astigmatic and there is no doubt that the correction of this astigmatism accounts to some extent for the striking improvement of her rate of output. Very few of the workers examined, in the

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course of these experiments with glasses, have been entirely free from errors of refraction, the most common defect being astigmatism, and the total annual loss of production due to uncorrected defects of vision may be so considerable that it ought to be a matter for grave concern to workers and employers alike.

Experiments have also been made with women employed for the process of "drawing-in" done in weaving sheds. The increased rate of output of these women when wearing the glasses, which in most cases were prescribed with 2 diopter convex lenses and 2 degree prisms, varied from 13 to nearly 32 per cent, the maximum increase being obtained by a worker who was previously handicapped by marked astigmatism. The strength of the glasses used must, naturally, depend upon the amount of accommodation and convergence which the nature of the work demands of the unaided eye, and upon the amount of accommodation which the eye can use, since this decreases with age and, after the presbyopia limit, is less than the amount required to see clearly at comfortable reading distance.

When we have provided ample illumination and suitable glasses we shall have done a great deal towards the elimination of eye discomfort and strain, but there is another way in which the eyes may be strained and that is by the prolonged fixation of a small object which is frequently necessary when some delicate manipulation has to be done. A case in point is the mounting of fine filaments which has already been mentioned. We have probably all experienced the discomfort which this staring involves - it is an unnatural procedure and the eye is much more accustomed to momentary fixation, moreover it is known that visual acuity diminishes if an object is looked at too long. However, it is probably impossible entirely to avoid this form of discomfort, but it is less pronounced if the object looked at is some distance from the eyes - that is, it is more comfortable to stare into the distance than to stare at a near object - and this is due the fact that the muscles of the eye, though they are fixed, are not at the same time strained in the effort of convergence. In so far then as the glasses we are considering reduce the amount of convergence required, they will also mitigate the discomfort of prolonged fixation.

There is no doubt that a large number of persons commencing factory and office life do so with some defect of vision which is certain to make them the victims of unnecessary fatigue, while in certain cases fine work will cause rapid and permanent deterioration of their sight. There ought, therefore, to be a careful selection of candidates for fine work according to the condition of their sight and those who have defects, such as myopia, which are likely to be aggravated by fine work, should be discouraged

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from undertaking it, or, if they do so, their eyes should be periodically examined with the object of keeping their refractive errors exactly corrected. Though it cannot be shown that constant devotion to minute work actually produces errors of refraction in those who start with normal eyes, there can be no doubt that such individuals experience unnecessary fatigue, which can be avoided if they are supplied with suitable glasses.

If this is done in the apprentice stage, the facts which have been put before you suggest that the time otherwise equired by the learner to reach maximum efficiency may be considerably reduced. As for the experienced worker, we can never be sure of his maximum efficiency, unless we are sure that the conditions in which he works cannot be improved. Light and vision are two of the most important of these conditions - they are both intimately related - and it is certain that if either is defective, the comfort and efficiency of the worker, and therefore the welfare of the whole industrial organization must suffer.

INDIRECT CAUSES OF FATIGUE ARISING FROM THE WHOLE TWENTY FOUR HOUR SITUATION

BY PROF. T. H. PEAR M.A., B.Sc.

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A person's diminished capacity for work is complex in nature, and attributable to many causes, including a fair number which do not arise in his working hours. Home conditions, both physical and social, sleep or lack of it, leisure, play, ambition, worries and desires all play a part in "the total twenty four hour situation". It is impossible in this lecture to list the various complications which may arise during the twenty four hours of any workman. I can therefore deal only with a few, pointing out others.

Under the word "fatigue", English writers often class several states of mind and body which ought to be distinguished, e.g. fatigue, boredom and weariness.

"Fatigue" might more narrowly be taken to denote a state of actual wear and tear of the organism, i.e., a condition which, unlike boredom, could not be induced in a very short time by light work. "Weariness" would mean the awareness of such fatigue, for we can be fatigued without being weary, as Dr. W. H. R. Rivers has shown in his book "The influence of Alcohol and other drugs upon Fatigue". Fatigue and weariness, then, would require for their production long-continued work.

But in the present course of lectures, the word fatigue is probably understood in its widest sense, to include any diminished capacity for work which is the result of any or all of the factors prejudicially influencing the worker.

Some of these factors will have been included under "Temperament" in the preceding lecture. Amongst them are the important class which produce the psycho-neurotic worker, especially the emotional type, the obsessional type, the overscrupulous. Many of these persons apply far too much energy to their work, they become irritable, excitable, fatigued, and although fatigued, sleep badly, thus aggravating their state. Certain special types of work, especially repetitive work involving responsibility without much outlet for intelligence, are unsuited to such persons. In England, Miss May Smith and Dr. Millais Culpin are conducting investigations for the Industrial Fatigue Research Board into the medical problems involved in this relation of work to worker.

Repetitive work often produces various kinds of fatigue, though certainly there is a type of worker for whom it is suited. Many persons possess, or develop, powers of carrying out such work with ease and efficiency. Others, while disliking the work as such, readily undertake it for other reasons. Still another class supplies from its own mental resources the variety which the repetitive work lacks.

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To many persons repetitive work is not monotonous. If the word repetitive be used to mean a purely external feature of events in the physical world, and monotonous to signify a mental condition, we can see how it may be that repetition and monotony do not inevitably occur together. Persons who do not experience repetition as monotonous may themselves be supplying the variety. Such modifications of monotony may happen in different ways.

Repetition favours habit formation. Consequently some persons welcome repetitive work because it enables their mind to busy itself with other matters. To some workers this aspect of repetitive work is pleasant and desirable. A few welcome the chance to think connectedly about other things. Others perhaps spend their time in mind wandering or in "thinking of nothing". This mind-wandering should be distinguished from (though it shades imperceptibly into) continuous fantasy.

Some workers choose or continue to perform repetitive jobs because they involve little responsibility, few things can go wrong and "nobody bothers me". How far this type of person is inborn and how far it results from certain systems of education is a matter about which we know little.

Under conditions of repetitive work some workers indulge in long day-dreams in which many unsatisfied desires are fulfilled. This might appear to be a merciful accident, civilisation for once curing some of its own ills. And here and there this may be true. But some fantasies are constructive and securely rooted in possibilities while others are merely ways in which their possessors or victims flee from reality, or what they take to be their reality. There is no doubt that many of the "functional nervous disorders" are elaborate chronic flights from reality. Working conditions which favour such reality-evasions might be compared to climates in which certain disease agents attack the body more virulently. That many persons introduced to these climates resist these diseases and others rapidly succumb is an important fact.

Such an analogy would be drawn by certain writers. Yet it will help us little until we know more of the nature of the minds which are unaffected detrimentally by repetitive work. Granted that it gives facilities for such flights from reality, we have still to discover why "nervous breakdown" does not effect all repetitive workers.

There are probably several reasons. One is that many persons do not regard such work as their chief reality. To them it is but a means, through shorter hours and higher pay, to obtain or intensify more desirable experiences outside their work. To dream of these goals during their work may even stimulate them.

But, output apart, many people make the whole of their life

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tolerable or pleasanter through their fantasies. This result may be attained in different ways. Some fantasies may be merely modifications, slight or considerable, but significant, of the actual conditions or aims of the daily work. These alleviations are not confined to the rank and file. Employers have also been sustained by dreams, intimate or shared, which transform their daily routine.

The unpleasant effects of repetitive work are usually boredom and irritation rather than fatigue. Various methods have been adopted by operatives and employers to alleviate these unpleasant effects. Some of these devices are: *

Rest pauses. The shorter the work period the more buoyant the attitude of the worker. **

Changes in activity introduced within the spell of work. The greater the change, the more favourable the results obtained. There seems to be an optimal duration for each type of work which varies with different types. ***

Socialising isolated work. Boredom is reduced to a minimum when the worker forms a social group and can talk while working.

Reducing the size of the immediate task. Boredom is less when a worker is supplied with about an hour's material, and then receives another supply, instead of being confronted with a pile of material containing work for a day or more.

Workers on piece rates are generally less bored than those on time rates.

Some employers encourage singing as a remedy against boredom.

* For this summary I am indebted to Mr. S. Wyatt.

** Report nos. 25 and 32 of the Industrial Fatigue Research Board.

** Ibid no. 26.

THE ELIMINATION OF FATIGUE CAUSED BY EXTREMES OF TEMPERATURE, HUMIDITY AND DUST

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The title of this lecture is rather a misnomer, as it is impossible for us to eliminate altogether the fatigue caused by extremes of temperature and humidity. All that we can hope to do is to reduce the fatigue to a greater or less extent. Again, it is rather misleading to speak of dust inhalation causing fatigue, when its action is frequently so harmful to the lungs as to induce a fatal result. Hence a better title for my lecture would be, "The reduction of the adverse effects caused by extremes of temperature and humidity, and by dust inhalation". I make no mention of the subjects of vibration and noise, which are likewise included in the title of my lecture, for the simple reason that I know of no exact information about them. Vibration and noise are certainly very unpleasant to anyone who enters a boiler-maker work-shop, or other very noisy place, for the first time, but we do not know if they add appreciably to the fatigue of the workmen who are subjected to them every day, and who are in consequence acclimatised to them.

Fatigue caused by High Temperatures in the Coal Mining Industry.

The first industry I wish to speak about is coal mining, as this is our largest industry in Great Britain, with the exception of agriculture. Over a million men are engaged in it, four-fifths of whom are employed underground. Some of the mines worked are over 3000 feet deep, and the temperature may reach above 100° F (38° C). So hot is it that the men have to discard practically all their clothing, and they stream with perspiration. In one mine it was found that, during the course of the shift, the men lost, on an average, 11 lbs in weight from perspiration. This perspiration contains a considerable amount of sodium chloride and potassium chloride, and the removal of salt from the body in this way is apt to induce severe muscular pains in the arms and legs. However, the condition is very easily remedied by adding a small quantity of the salts mentioned, or even of common salt only, to the water drunk. The men found that they worked in more comfort, and felt less fatigue at the end of the shift, whilst the attacks of cramp did not occur.

The fatigue caused by working at high temperatures has a considerable influence on the efficiency of the miners, and in order to obtain a numerical estimate of this influence, Mr. Bedford and I made observations on 138 miners working at the coal face. We found that it was useless to estimate efficiency by determining

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the output of the men, for the ease with which the coal is got varies greatly in different working places, according to the geological conditions, and even in the same place it may vary a great deal from day to day. Consequently we had to devise other methods. One of our tests depended on the fact that no man, when engaged on severe labour, is able to work continuously. Inevitably he takes short rests from time to time, and the harder the work, the longer the rests. We found that on an average the coal miners working under the best atmospheric conditions tested by us (at a dry bulb temperature of 72° F (22° C), a wet bulb temperature of 66° F (19° C), with good ventilation) rested for 7 minutes an hour, and worked for 53 minutes. Those working under the worst conditions (when the dry bulb temperature was 86° F (30° C), the wet bulb 79° F (26° C), and the ventilation bad), rested for 22½ minutes and worked for 37½ minutes, whilst at intermediate atmospheric conditions intermediate amounts of rests were taken. Even when they did work the miners did not exert themselves so energetically when the atmospheric conditions were bad, for we found that the time taken to fill the tubs with coal was 20 % greater under the worst conditions than under the best. Presumably the men reduced their rate of hewing coal and doing their other jobs to a similar extent, and on this assumption we calculated that allowing for the longer rests taken, their rate of production was 41 % less under the worst atmospheric conditions than under the best conditions. As the conditions tested by us were not nearly as bad as those found in some mines, it is safe to say that miners, when working under the worst conditions, do not produce half as much coal as when working under the best conditions.

It is natural to ask to what extent, if at all, these adverse conditions of work can be appreciably improved. We were able to show that some improvement can be effected in the simplest and most direct manner, namely, by increasing the ventilation. Even a moderate increase in the ventilating air current caused over 10 % improvement in the efficiency of the men, and there can be no doubt that, by taking various precautions, the efficiency could be raised by more than this figure. For instance, it is customary to mine coal by two distinct methods, and we found that with one of them, the so-called longwall face method, the average velocity of the air current reaching the miners was twice as great as with the other (the pillar and stall method). It would be out of place for me to go into technical details, but there can be very little doubt that by adopting the best methods of ventilation the employers would at the same time benefit themselves and their employees. The miners would benefit, not only by producing ore coal with a less expenditure of energy, but they would also benefit

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in their health, and especially in the liability to accidents. The frequency of accidents amongst coal miners is greater than that observed in almost any other industry. In Great Britain about 1200 men are killed every year, or four men for every working day of the year. In addition, about 200,000 men suffer severe enough injury to incapacitate them for a week or more. Though many of these accidents are unavoidable, there can be no doubt that they can be greatly reduced by taking suitable precautions. Many of them are said to be due to the carelessness of the men, but even if this is true, it is possible to influence the men in the direction of taking more thought for their own safety. One of the best means of doing this is to improve the conditions of work. Striking evidence in support of this statement was obtained at a gold mine in Brazil, the Morro Vello mine. This is the deepest mine in the world, being $1\frac{1}{4}$ miles in depth, and as may well be imagined, the atmospheric conditions in the lowest workings were almost insupportable. Special machinery was installed which cooled the intake air of the mine to 43°F (6°C), and in consequence the (wet bulb) temperature fell from 89°F to 80° (32° to 27°C). This improvement of conditions not only led to a rise of 12% in the output of the mine, but also it greatly reduced the accident rate. In the 16 months previous to the installation of the machinery there were 20 fatal accidents, and in the 16 months after its introduction, only 6. Under the cooler conditions the men were presumably more alert to perceive and to avoid danger, and to take precautions.

The influence of atmospheric conditions on the accident rate was studied by Mr. Bedford and myself, and we found it to be quite considerable. In the deepest seam of one pit, where the air had a dry bulb temperature of 81°F (27°C), and a wet bulb of 76°F (24°C), we found that, over a six year period, the miners working at the coal face suffered 50% more accidents than those working in the shallowest seam of the pit, where the temperature was 15°F (8°C) lower. It does not follow that this excess of accidents was due wholly to the higher temperature, as there were various differences in the conditions under which the coal was mined, but as a matter of fact it was considered by the mine managers that the dangers due to falls of roof and coal, which are the commonest causes of accidents, were greater in the shallow seam than in the deep one. Again, on comparing the accident rate at two pits, in some areas of which the ventilation was better than in others, we found that the considerable variations of accident rate corresponded with the amount of ventilation.

Atmospheric conditions in mines likewise have a considerable effect on the sickness and mortality of the miners. It is difficult to obtain satisfactory evidence of this statement, and Mr. Bedford

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and I are at present engaged in working out the sickness rate of many thousands of miners who are employed in 10 pits. We have not completed our observations, but they undoubtedly show, on an average, the deeper and hotter the pit, the greater the amount of sickness. The mortality data, which are published at ten-year intervals by the Registrar General in England, tell the same tale. Thus if we divide up all the mortality rates obtained in the various coal fields in 1910 to 1912 (the latest period available), we find that the men working in areas where the pits averaged 1460 feet in depth, had a mortality rate 38 % in excess of those working in areas where the pits averaged 910 feet in depth. The deeper pits were about 9° F (5° C) warmer than the shallower ones, and the higher temperature must have caused the men to get more overheated when at work. - Apparently in consequence of this, they were more liable to catch chills on coming to the surface, for the mortality data showed that there was a specially large increase in the death rate from bronchitis and pneumonia. Instead of the average rise of 38 % in the death rate, it was 105 % and 86 % for these two diseases respectively. There is very little doubt that the increased sickness and death rate induced by working in deep and hot mines would be considerably reduced if the men were to take a bath immediately on coming to the surface, and to change into dry clothes. Unfortunately the usual custom in England is for the miners to go home in their damp clothes, and change there. Whilst in Germany and some other countries the provision of pithead baths for the miners is compulsory, there is no compulsion at all in England, and the available bathing accommodation does not suffice for more than 1 % of the miners. However, I am glad to say that a vigorous attempt is now being made to erect more pit-head baths,

Fatigue in the Iron, Steel and Tinplate Industries.

I will now pass on to describe some of the instances of avoidable fatigue which I have come across in the iron, steel and tinplate industries. These industries employ hundreds of thousands of men in Great Britain, and much of the work has to be done under very adverse atmospheric conditions. I will first of all refer to the tinplate trade, which afforded very convincing evidence. In the making of tinplates, slabs of steel are heated to a bright red heat, and are rolled out thin by passing them a number of times between revolving iron rolls. The men have to lift these red hot sheets by means of tongs and are necessarily exposed to the intense radiation from them. The men work in gangs of six, but as a rule only four of them are actively at work at a time, the other two resting. Every ten minutes or so they stop

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for about a minute, and then start a fresh bout of work. In order to get some idea of the severity of the work, I took the pulse rate of a number of men engaged on a particular occupation known as doubling. Just before starting on a bout of work the pulse rate averaged 90 per minute, and 9 minutes later I found, during a temporary cessation of work, that it had risen to 150 per minute. We have no means of converting various increments of pulse rate into terms of fatigue, but it is well known that the pulse only rises to 150 or more after very strenuous physical work such as boxing, or running up and down stairs for two minutes at top speed.

Perhaps a better proof of the arduousness of the work of the tinsplate millmen is afforded by the manner in which they responded to atmospheric conditions. I was able to obtain accurate information about the weekly production of tinsplate at five factories for periods of 1½ to 7 years, and I found that in every instance there was a distinct seasonal variation in the output. As the warm weather came on it fell away, and as cooler weather supervened, it rose again. It was lowest in July and August, which are the hottest months of the year, and highest in December and January, which are the coldest. On an average it was 9% less in the summer months than in the winter ones, but the extent of the summer fall varied a great deal in different factories. It appeared to depend on the character of the ventilation, for in many tinsplate factories it is customary to blow a current of cool air on the heads of the men while they are at work. In the best ventilated factory I came across, I found that the summer output was only 3% less than the winter one, whilst in another factory with a moderately good system of artificial ventilation it was 6% less. In two factories with no artificial ventilation at all it was 12% less in the summer, and it was calculated that in the hottest weeks of the year it was 18% less than in the coldest weeks. Now the installation and maintenance of a good system of ventilation is not a particularly expensive matter, and there can be no doubt that employers who effected it would easily recoup themselves in consequence of the greater efficiency of the men. The men themselves would not only be able to earn more, with less fatigue, but there is little doubt that their health would benefit in addition.

The evidence obtained from tinsplate millmen was found to hold in greater or less degree in a number of the occupations in the iron and steel trade. Take first of all the smelting of iron in blast furnaces. The men usually load the ore and coke into the furnaces by means of heavy barrows, which weigh as much as a ton when loaded. The men now work eight hour shifts, but once every three weeks they have to work for sixteen hours on end.

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During these long shifts their rate of furnace charging was found to be 8 % less than usual, the reduction of speed being specially marked towards the end of the long work spells. In the summer months (June to September) the rate of charging was 16 % less than in the other months of the year, this fall being in large part due to the effects of the high atmospheric temperature. The iron obtained from the blast furnaces is subsequently converted into steel, usually by means of so-called "open-hearth" furnaces. After the steel has been run off from a furnace, the men frequently have to fill up and mend depressions in its bed, and for this purpose they have to approach within a few feet of the white-hot furnace. The work is terribly exhausting, and with some furnaces it is worse than others. I found that where the sheds are large and well ventilated the production of steel was practically as great in the summer as in the winter, but when they were narrow and ill ventilated the summer output fell off 11 %, presumably because of the increased fatigue of the men. The steel from the open-hearth furnaces is cast into ingots, and these are rolled out into girders, rails and rods while they are at a bright red heat, by passing them through rolling mills. Here again the work is often very hot and heavy, and at two steel works the output was found to be 9 and 13 % less in the summer than in the winter.

You may be inclined to ask if this hot and heavy work can be to any extent lightened. The answer is that almost all of it can be avoided by the employment of the most up-to-date methods of iron and steel production. In the best blast furnaces the charging is done entirely by mechanical means. The latest form of steel furnace does not need repairing more than once in five weeks, whilst in modern rolling mills the whole of the manipulation of the red hot ingots is done by mechanical means.

Of all the varied occupations met with in the iron and steel industry that of the steel smelter is probably the heaviest, because of the excessive fatigue incidental to mending the open-hearth furnace after the molten steel has been drawn off. The effects of this fatigue are revealed in the sickness and mortality records. I was able to obtain the records of 20,000 workers in the iron and steel industry over a six year period, and I found that the steel smelters lost 23 % more time from sickness than the average, whilst their mortality rate was 20 % greater than the average. The men were specially susceptible to bronchitis and pneumonia, their death rate from these causes being more than double the average rate of the general population. Other groups of men engaged on hot and heavy work likewise showed an excessive mortality from these diseases, and there can be little doubt that this is due, at least in part, to the absence of facilities for the men to change

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into dry clothes when their heavy work is completed. They often get wet through with perspiration, yet I do not know of a single iron and steel works in Great Britain, and I have visited over half of the biggest works in the country, where the men can wash and change if they desire to do so. They have to wear their damp clothes until they reach home, though this sometimes takes them an hour, and involves a train journey, with its numerous possibilities of catching a chill. Hence an organised system of baths and changing rooms ought to be installed in all steel works, almost as much as at collieries.

Fatigue in the Textile Industries.

In the textile industries the physical labour of weaving cotten, linen and other goods is not so great as that incidental to coal mining and to iron and steel production, but the atmospheric conditions under which the work is done are frequently more trying, owing to the high temperatures and humidities experienced. It is found that the higher the atmospheric temperature and the greater its humidity the less are the breakages of the warp threads. A breakage necessitates the stoppage of the loom, and it was found in cotton weaving, for instance, that it was necessary to stop the looms on an average only once an hour when the temperature was 84° F (29° C) but two or three times when it was 70° F (21° C). Again at a temperature of 78° F (26° C) it was found to be necessary to stop the looms 3 times an hour when the air was 70 % saturated with moisture, but only half as often when it was 84 % saturated. Each stoppage entails a loss of working time and a corresponding diminution of output, but nevertheless it is found that the hot and moist atmosphere is so trying to the weavers that above a certain point the extra fatigue induced more than neutralises the favourable effects on warp breakages, and their output falls instead of rising. For instance, it was found that at a given humidity (78 % saturation) the output of the weavers was 5 % less at a temperature of 84° F (29° C) than at one of 74° F (23° C), or again at a given temperature (78° F), it was 5 % less at a saturation of 84 % than at one of 79 %. And it was found that whilst at a temperature under 73° F (23° C), the output of the weavers remained fairly steady from hour to hour during the course of their work spells, at higher temperatures it was at a maximum at first, and then fell steadily till it reached a minimum in the last hour of the spell.

The effects of the artificial humidification of the air in weaving sheds are so unpleasant that the weavers in Lancashire have demanded its total abolition, even though this would mean a considerable diminution in their earnings. However, it is difficult for the employers to comply, as they would no longer be able to compete on equal terms with other countries where artificial

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humidification is still in force. But is there no other remedy? Mr. Wyatt, one of the investigators attached to the Industrial Fatigue Research Board, has shown that if the ventilation in a shed is increased by the installation of electric fans, no harm is done to the weaving process, as the warp thread breakages are not affected. The weavers, however, greatly appreciate the increased ventilation, and it was found that on hot days their output was 5 or 10 % greater when the fans were running than when they were stopped. The chief objection to the fans lies in the expense of installing them; and again, a few of the weavers object to the ventilation caused by large fans. It seems probable, however, that a small fan could be fixed to each loom, and be operated mechanically by the loom itself, so that each weaver could control her own ventilation.

Another method of combating the effects of hot and humid atmospheres is to wear appropriate clothing. In Great Britain the weavers usually wear the same clothing in the factory as they do out-of-doors, except for a cloak or shawl, which they discard on entering. If, however, they could be induced to change into the lightest possible clothing, they would experience a great increase of comfort. This statement is supported by a series of experiments on the effects of clothing on body temperature which I made upon myself. I found, for instance, that when I was wearing warm winter clothing (but not an overcoat), my body temperature remained steady when the air temperature was 59° F (15° C), whilst at a higher temperature than this it rose, and at a lower it fell. When, on the other hand, I wore only a thin vest and flannel trousers, it was necessary to raise the temperature of the air to 73° F (23° C) in order that I should maintain my body temperature at a steady level. That is to say, the different amounts of clothing worn were equivalent to a difference of 14° F (8° C) in the air temperature. I am ignorant as to the extent of the clothing worn by the average weaver, and the extent to which it could be reduced with due regard to decency, but it seems possible that a reduction equivalent to a temperature of from 5 to 10° F could be made. That is to say, a weaver who finds a shed temperature of 78° F (26° C) unpleasantly hot could reduce it to the equivalent of a temperature of from 68° to 73° F (20° to 23° C) by wearing less clothes.

The Effects of Dust Inhalation.

In a number of industries it is difficult to avoid the inhalation of dust, and in many cases, but by no means all, such inhalation has a serious influence of the health of the worker. The dust is inhaled into the lungs, where it damages the lung tissue, and gradually causes the production of silicosis. There is a shortness

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of breath, and a persistent cough, and the subject is very liable to succumb to bronchitis or tuberculosis. That is to say, the dust inhalation has little or no immediate effect in the production of fatigue, but its ultimate action is more serious than the fatigue produced in the ways I have been describing. As the term "silicosis" implies, the dusts owe their harmful activity to the silica they contain, and other mineral dusts, such as coal dust and limestone dust, have no harmful action. In Great Britain silicosis is met with among tin and lead miners, sandstone quarriers, masons who dress sandstone, makers of silica brick, and among a large number of the men employed in the pottery trade. In such men the mortality from bronchitis and from pulmonary tuberculosis is very much greater than the average for the general population. In the years 1921 to 1923 the death rate of males aged 45 to 55 from pulmonary tuberculosis and fibroid phthisis was 13 times greater than the average among tin and lead miners, whilst in sandstone very much greater than the average for the general population. In some countries the effects of dust inhalation are more marked than with us. In South Africa, for instance, the gold mines of the Rand at Johannesburg consists chiefly of quartz or silica containing a very small proportion of gold. This quartz is mined by drilling and blasting, chiefly by native labours, of whom nearly 200,000 are employed. In the earlier days of the gold mining there was a terrible mortality amongst the miners, but of recent years it has been greatly diminished by adopting various mechanical precautions for the reduction of the dust in the air. For instance, all the drilling is done by machine drills with a water feed, which washes away the dust as it is produced. Blasting is allowed only once in 24 hours, and always at the end of a shift, so that most of the dust has settled by the time the fresh shift comes on to work. No broken rock is moved unless it is first thoroughly wetted. Even now, however, the cases of silicosis and tuberculosis are fairly numerous. Of the European miners, who are medically examined at regular intervals, about 4% are suffering from silicosis, and a considerable proportion of these cases end fatally.

In Great Britain we have a comparatively small number of miners who are employed on work comparable to that of the Rand miners, in that they are drilling rock containing a large proportion of silica. They are mostly employed in making tunnels through the rock in coal mines in order to join up different coal seams, or portions of a seam. The men use heavy drills which are rotated by compressed air, and the air current blows the dust backwards into the faces of the man who is operating the drill. No water is used, as in the Rand mines, because it is apt to clog the drill and retard the boring, but it follows that the men have to inhale

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air which is thick with dust. In a comparatively short time this causes the onset of silicosis, which is frequently accompanied by tuberculosis. The sufferers are totally disabled, and they drag out a miserable and breathless existence which soon results in death. Dr. Tattersall, who has made a special study of the subject, recounts a terrible instance which he met with personally. He states that 3½ years ago he visited a particular heading in a Welsh mine in which six men were at work. They were all in the prime of life, yet 2½ years later every one of them had died of silicosis and tuberculosis. Incidents such as this could be multiplied, and it may be wondered why such terrible risk to life should be allowed at all. Probably the reason is that only a comparatively small number of men are engaged on this hard ground work, and they are apt to be confounded with men who are engaged on somewhat similar work in limestone and in other ground, where dust inhalation does little harm. There can be no doubt that dry drilling in such hard ground ought to be abolished by law, as it is in South Africa, and other protective regulations ought to be introduced. For instance, a dust trap has recently been devised, in which a rubber hood is placed over the drill hole, and the whole of the dust is sucked away into a dust filter.

In the pottery industry the conditions of work have been greatly improved in the last twenty years. The chances of dust inhalation are greatly reduced by the use of exhaust ventilation for carrying away the dust produced in the various processes. Again, care is taken that the workrooms, in which dry clay is bound to get on the floors, are swept out after the potters have stopped work for the day, so that the dust raised will have time to settle before the next morning. Provided that the precautions advised are fully taken by the employers and workers, it is probable that nowadays there is not much risk of harm.

It may be wondered if the inhalation of dust could not be prevented by the wearing of a respirator. Many attempts have been made to provide a suitable apparatus, but it is a very difficult problem. It is fairly easy to stop the inhalation of the large particles of dust; but it is the extremely small particles which are the most deadly, as they pass right into the alveoli of the lungs, and such small particles are not stopped at all efficiently by respirators. Also respirators are uncomfortable to wear, especially if the work is at all heavy, and it is almost impossible to get workmen to keep them on.

The main conclusions to be drawn from the evidence which I have brought before you are two in number. Firstly, we have seen that in almost every instance where the atmospheric conditions

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were adverse, owing to high temperature or humidity or excess of dust, a great deal could be done by taking suitable precautions to render these conditions considerably less adverse. Secondly, we saw that such an improvement of conditions resulted in an increased efficiency of the workers, coupled with an improvement of health, and, in some instances, if not in all, a reduced liability to accidents. This improvement of efficiency was so marked that in most cases it would more than compensate the employers for the expense entailed by the introduction of the better conditions, so they would benefit as well as the employees. It is therefore most important that the kind of information I have been describing to you should be better known to the employers as a class. They are not wanting in humanity, and in a desire to do what they can for their workpeople, but they are, for most part, busy men who have got into certain grooves of thought and routine, and they are slow to react to new ideas. Hence the more these ideas can be forced into their consciousness by repeated iteration from various sources, such as by articles in papers and magazines, by books, and by conferences such as we are holding at the present moment, the sooner are they likely to act upon them.

WORK AND SELF EXPRESSION

BY PROF. T. H. PEAR, M.A., B.Sc.

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The problems of the relation between work and self-expression have been treated by the most varied classes of writer. Employers and workers (both these categories containing sub-divisions with different mentality, outlook and history) physiologists and psychologists, social workers and reformers, dramatists and novelists are all represented. H. M. Kallen has recently drawn up a full and variegated list of them.

Yet in many of these writings it is difficult to dissociate statements of fact or reasoned conclusions from exhortation, satire, apology, dissent or defiance. Progress towards clear thinking, however, seems indicated by the increasing number of writers who express - often uncompromisingly - their own point of view.

To attempt to treat the subject from the many angles which the word "self-expression" hints at would be impossible. I will confine myself here to an issue which is of outstanding importance and is capable of clear discussion.

Many who ask whether a particular type of work affords opportunity for self-expression are putting, in a vague way, the question. "How far does this work involve acquired skill of a high type?" For it is obvious that one of the most perfect ways of self-expression in work is through such high-grade, personal skill. The uppermost flights of this skill allow the worker to express himself uniquely and personally in his activity.

Recently in the "Journal of Personnel Research" I have attempted to classify the various grades of skill beginning from the lowest and ending with the highest. Without, however, making such discriminations here, we may consider the contribution which skill makes to one's experience.

Skill appears to its possessor as power over complex situations in the physical world. Exercising this power, either actually or in imagination, affords enjoyment of a very special kind, sought by many musicians, artists, players of games and workers.

The consciousness of added power in any direction cannot fail to widen one's personality. And to contemplate a skilled person, happy in his work, is a very high form of pleasure. Power leads to power; the skilled artist, musician, or athlete may enter social circles into which his skill is the only key. But skill also leads to financial power, becoming a bargaining asset, as in the worker, the portrait painter, the surgeon and the boxer.

There is a proverb "Knowledge is power". But the power which we call skill means also a special kind of knowledge. This knowledge is different from the ordinary types acquired through the eyes and the ears. It comes through the muscles, joints and tendons. In this way we can say that a tennis player knows

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the length and breadth of the court, the musician may know a piece of music, through the muscles.

This knowledge has the sparsest vocabulary, almost no language, and belongs, we are sometimes told, to the lower senses. That does not prevent it from existing.

Skill, then, is knowledge carried by the muscles, joints, tendons, the skin and perhaps certain inner organs. We speak in English of a cunning workman, and this word serves in our language to link up knowledge with skill. From this cunning and other factors are born the joy of work, pleasure from self-expression, expansion of personality and increased self-respect.

Now it should be borne in mind that those who oppose the minute subdivision of work often have not stated explicitly these two losses which the worker suffers if he is made to carry out one small process, repeated throughout his industrial life. Stress is often laid on the undoubted economic fact that by becoming less skilled he loses a valuable bargaining asset. But he also loses an intellectual asset, in his muscular knowledge, and a moral asset in his diminished power. Any system which takes these away should compensate generously for their loss.

The philosophy of the meaning and functions of work is nowadays not merely an academic problem. In England different concepts of work have been of great influence in beginning and continuing a five months' coal stoppage.

One view is that a man's daily task should afford him a possibility of realising this satisfaction in work which was described above. Now some employers do not and do not mean to offer such work. A few of them state this quite uncompromisingly. Where this is supported by reasons, it becomes part of a creed that work should be done as soon as possible so that the worker may express himself in his spare time, somewhere else.

Now this is undoubtedly true of some work. But this kind of work is generally the subject of much thought from inventors who try to diminish it, to make it less dependent upon personal skill, and often to abolish it. Many domestic tasks performed nowadays are quite unnecessary, e.g., the introduction of stainless steel has caused some kinds of work completely to disappear.

The important differences in philosophies of work, some mutually exclusive, are clearly described by Witte.

Might I suggest that we should not interpret this phrase merely in its economic sense? To all of us the knowledge that our skill is worth money, that its increase will raise our financial status, that its subtraction means a loss to the community, is an important means of increasing our self-estimation. And so the point of view which regards skill as a bargaining asset is nowadays of great significance.

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But during the last few years changing demands have caused some skill to become simpler in pattern. They have gradually been de-graded into simpler skill called by the same name. This is a general tendency the significance of which is not always understood. Every invention which tends to make a machine "fool-proof" replaces or de-grades a skill.

Some skills, however, are completely disappearing or rendered unnecessary by change of fashion or introduction of machinery. Thus we see that while some skills have become simplified, others have been extinguished.

There is another process which is happening to skills; they may become "fractionally distilled". The more valuable higher skills increasingly become the property of the few, while the lower skills are made even simpler by the introduction of machinery, and sometimes by deliberate simplification. Therefore as a bargaining asset such latter skills have almost completely lost their value. Where the higher skills have deliberately been segregated this loss of value of the lower skills is, of course, accelerated.

The importance is very variously estimated by different writers.

SUMMARY OF DISCUSSION

As already stated in the Preface to this Report, the following is by no means intended to be more than just a summary of those parts of the discussion which may be considered of more general interest.

In dwelling on the subject of Industrial Hygiene and Industrial Medicine, Professor Loriga gave it as his opinion that the positive side of these sciences is not yet being sufficiently developed. Except for obvious ailments, such as tuberculosis and heart diseases, still too little is known about physical tendencies which govern the disinclination or inclination for work.

Professor Pear, though agreeing with Professor Loriga, stated that progress in this direction is being made in Great Britain, where all attempts are sponsored by the Medical Research Council, and that funds have been created for medical men who are willing to cooperate with the Psychological Institute of the University of Manchester in positive medical research work. Professor Pear considered it of supreme importance that through propaganda on a large scale the interest of Anthropologists, Psychologists, Physiologists and Psychiatrists should be roused for the big field of investigation which industry offers.

Later in the discussion expression was given to the need for the Universities to get into ever closer touch with practical life, and thus bring to the service of industry the vast amount of theoretical knowledge at their disposal and their necessarily more detached view point.

An English worker wished to emphasize the necessity for considering the home-life of the worker when investigating his working capacity and willingness to work, and for realizing the great influence which insecurity of work has on the worker.

Professor Pear made here a comparison between the American and European worker, who is surrounded each by such different economic possibilities. The American worker, in scaling the firm rocks which constitute the mountain of his career, may occasionally even welcome risks and be stimulated by them. But on the European worker, whose career nowadays may rather be compared to a crumbling cliff side which he has got to climb against his natural inclinations, all uncertainty has a disabling effect.

A member of the School drew attention to the fact that much of our chosen play is actually often comparable to real hard work. Professor Pear agreed that this is an illuminating example of the inner forces at work. All play is chosen activity, whereas work is forced activity through inner compulsion, to which outer compulsion is often added.

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In discussing the introduction of new methods, mention was made of the fact that older workers in particular find it difficult to adjust themselves to these. In addition they often suffer very much under the reduced value of their skill.

Professor Pear stated that this is often a question of discrimination. Many former skills can be used in the new processes. But the ways in which these new methods are presented to the worker are often psychologically very wrong and offend the pride which man has in his skill. On the whole, of course, it will always be easier to adapt workers to new methods when the work is altogether new to them.

Professor Lipmann dwelt on the distinction between fatigue and weariness made by Prof. Pear. This distinction is also made in the German vocational psychology ("Ermüdung" und "Müdigkeit").

Dr. Miles, of the National Institute for Industrial Psychology doubted whether the worker minds being fatigued when he has done a good day's work. In Dr. Miles' opinion there are still many things in factory life of greater importance to the worker than detailed fatigue investigations. It is his impression that there is still too much to be done in the way of general betterment of conditions for us yet to concentrate wholly on such very detailed and special matters as for instance motion study. He even fears that through the over-specialisation of to-day the worker may come to serious grief, as, to a great extent, this involves the sacrifice of his personality. In Dr. Miles' opinion fatigue is much less the result of actual work than of the repression of the workers' being, and the speaker considers it possible that we have already reached the point in industry where such repression becomes unbearable. The same of course applies to all over-organisation. Dr. Miles would welcome it if Psychologists would concentrate rather on the question as to how greater freedom and better possibilities for self-expression could be given to the worker.

Mr. Piacitelli feared that Dr. Miles did not understand motion-study rightly. From his personal experience, in working under Mr. Gilbreth, he knew that the foremost aim in Mr. Gilbreth's motion studies had always been the elimination of all human waste. Suggestions from the workers themselves with regard to this were always welcomed and followed up.

An industrial welfare worker dwelt on the lack of legal minima which is still the case in Great Britain as in other countries. In her opinion scientists should be much more active in creating public opinion. Physical and mental overfatigue of Labour will entail heavy economic consequences.

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A worker from England pointed out how scientific and efficiency methods can only be of real service to mankind when they go hand in hand with social progress.

An employee stated that for thirteen years he had worked a 12 hour day and that for the past six years he had been working 7¼ hours per day. Owing to the coordinated intensive working methods he finds himself more fatigued in the shorter than in the longer period. He is therefore grateful to scientific investigators for their research work into the elimination of unnecessary fatigue.

In the discussion following his lecture on working capacity and frequency of accidents, Professor Lipmann stated that women are more subject to accidents than men, not only because of their greater emotionalism, but also because of the double burden which they carry in having the homework added to their daily job. In addition their concentration is easily lessened through the family cares which occupy their attention.

With regard to the use of safety first pictures, Professor Lipmann was of opinion that these can be helpful only when they are really well drawn and impressive, are hanging in suitable places and are often changed.

A factory inspector from Sweden urged that children should be taught in school with reference to the causes of accidents.

In answer to the question why the frequency of accidents is less in the case of older workers, Professor Lipmann replied that this may partly be due to greater experience in their work and generally also because of a decreased emotionalism.

The performance of monotonous work produces a greater liability to accidents.

During the last morning of the School a discussion on Practical Co-operation in Factory Life was introduced: from the point of view of the Employee, the Employer, the Scientific Investigator, the Welfare (Personnel) Worker, the Factory Inspector and the Industrial Social Worker.

The Employee began by pointing out that the worker must feel that the employer has a real understanding of the essentials of his (the employee's) life. The interest which the employer feels for his employees sometimes shows itself in ways which are too far removed from the worker's immediate needs. Sometimes there is good intention but wrong application. An illustration of this may be seen in what happened recently in a big English factory, where, through the initiative of the employer, a lecture on Astro-

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mony was being held for the employees. A worker happened to be present who was oppressed by the insecurity of his position in this factory and obsessed by the fear of losing his job. In the middle of the professor's lecture this man, who could never let his fears rest and who had quite forgotten his surroundings, called out: "Will they be able to give me work up there if I lose my job down here?" A happening like this speaks volumes.

The speaker further dwelt on the necessity for removing that spirit of suspicion which dwells in the workers. At the same time the employer has no real confidence in his employees. The employee does not want to be on his own little job only, he is longing to share in the work as a whole. The speaker was of opinion that the employer would get ever so much more out of his workers if he consulted them, instead of only giving commands.

The question of wages is doubtless another key to the relation between employer and employee. Work badly paid really is a bad investment. The worker has often reason to feel that his wages do not augment in the same proportion as his skill and output.

Another matter of great importance is the choice of foremen and management. In the practical factory organisation and every day routine they constitute the link between employer and worker. These persons should not be chosen according only to their knowledge and skill. Their moral character and humane sentiments should count in the first place. One often hears it stated that "there is no sentiment in business". There surely need be no sentimentality, but no good can come from the absence of humane feeling.

The speaker also dwelt on the bad feeling and lack of trust which is created through the fact that many young people, who learned and practised much in order to become skilled, are considered valueless as soon as processes become mechanised, and are discharged without delay. He urged scientists to spend part of the time and effort which now goes towards the increase of production, towards the service of Humanity. He was convinced that his co-workers would then come to feel very differently with regard to these questions of scientific management, rationalisation and efficiency methods.

When his distrust is removed the employee will realize that his interests are entirely linked up with those of the employer. As a rule it is the tempo of the machine which is first determined and man must follow. It is of the greatest importance however to adapt working processes to man.

The speaker felt that the Summer School as a whole had ap-

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proached these fundamental matters from the right angle and with real understanding. When returning to their own factory life all present should act as missionaries.

Finally the speaker would like to destroy the existing belief that the worker is not interested in Social Progress. The contrary is true. But Social Progress seems so slow in showing itself. He hoped for co-operation and for understanding of the community of interest which does exist, even though the point of view and method of approach needs must vary.

An Employer next took the word. In his opinion the employer's first duty lies with the "human beings" working in his factory. He put the question how things would be if our own children, sisters and brothers were working in our factories? Would we then not at once try to create for them the very best of conditions? But does the fact that our workers happen to be the brothers, sisters and children of someone else suddenly alter everything? That this should actually be the case shows that there is something fundamentally wrong in our attitude and that we should lose no time in changing this.

In addition to our duty towards the individual we have our duty towards the human race as a whole. We may not exhaust that, we must preserve and strengthen it.

In the second place then come output and the raising of production. Naturally interested as the employer is in these, he may not further them at the expense of all other considerations. It is necessary for the worker's feeling of self respect that he should be consulted, and it is equally necessary that the employer seeks and values this intelligent co-operation which cannot but be profitable to the works. The way in which scientific processes and new working methods are introduced to the workers is most important, the when, why and how must be made known to them. The worker may not just be treated as a cipher.

Finally the speaker wished to say a word about what would probably be regarded as his hobby, namely beauty in the factory. In factories everything is mostly as grey as grey can be. Industrialists seem to believe that factories and beauty have nothing in common. Ugliness and sordidness cannot fail to add to our feeling of weariness or fatigue. Beauty on the other hand recreates. When a mountaineer arrives tired out at the top of his mountain, the beautiful view makes him forget all feeling of fatigue.

We need in our work such moments of re-creation. We need beauty in our work-rooms, colours, flowers. This is no luxury and no sentimentality. It is just a necessity. This also is a means of conquering weariness. Modern processes of work allow the worker little personal satisfaction and few possibilities for

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emotional expression. The only thing left to him is perhaps the pleasure of mastering the process and of acquiring his quickest rhythm. But that kind of satisfaction is more mental than emotional. We must find ways in which the emotions can express themselves. The best way in which to do this is to cultivate the sense of beauty. This can be done with simple means, which nevertheless ameliorate working conditions considerably.

The contribution of the Scientific Investigator was next given as follows:

It has been the custom of the Industrial Fatigue Research Board to try and obtain the sympathy and support of the employers and the workers in the enquiries made by its investigators. A committee is formed to supervise such investigation or group of investigations, and on this committee representatives of one or more employers' associations are usually asked to serve, and representatives of associations of the workers, in addition to the purely scientific experts. Supposing that either employers or employees objected to the proposed investigation, it would, in most cases, be given up, as the Board always has many more problems submitted to it than it has time to investigate. So it is able to pick and choose what it fixes upon. Also it is realized that without goodwill on both sides it is very difficult to obtain useful results. If, in the course of an enquiry, any particular firm consulted shows the least objection to opening its factory or works to investigation, no attempt is made to press for facilities as there are plenty of other firms available who are pleased to offer a welcome. Before starting on the actual enquiry, the investigator concerned is careful to explain to the foremen or forewomen, and to representative workers in the workroom where he is going to make his observations, what he is intending to do and why he is intending to do it. In this way their co-operation is obtained and any latent suspicion is eliminated. Investigators, employers and employees are on most friendly terms. Indeed the investigators are often regarded by the workman as a subject of mild jest, or as harmless people who may do some good, and in any case will not do any harm; whilst the employers naturally take the investigators seriously, and usually are glad to avail themselves of suggestions of improvements, unless they consider the expense too great.

The next speaker introduced the co-operation of the industrial welfare (personnel) worker, of the factory inspector and of the industrial social worker. Both the former are in that position which may be described as being "in the factory yet not of it". They should be able to study matters dispassionately from all

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angles and should naturally have the unprejudiced point of view.

The speaker drew attention to the necessity for using a telescope as well as a microscope in our studies. While poring over the detailed processes which need observation and are interesting, we must not forget the crudeness with which industry in the East presents itself. There we still find night shifts of 12 hours, terribly long hours for women in the textile industry, whilst in the silk dyeing factories small children are bending hour after hour over tubs of boiling water.

Our feeling of responsibility with regard to industry must far exceed all national limits, as social progress depends on world conditions.

RÉSUMÉ DE LA DISCUSSION

Comme on l'a déjà indiqué dans la préface du présent rapport, ce qui va suivre ne prétend à rien d'autre que de former tout au plus un résumé des parties de la discussion qui peuvent être considérées comme présentant un intérêt plus général.

Parlant de l'hygiène et de la médecine industrielles, M. le Professeur Loriga déclare qu'à son opinion, l'aspect positif de ces sciences n'a pas encore reçu de développement suffisant. Sauf pour les affections patentées, comme la tuberculose ou les troubles cardiaques, on sait actuellement trop peu de choses quant aux tendances physiologiques dont dépendent le goût ou le dégoût du travail.

M. le Professeur Pear, bien que d'accord avec le Professeur Loriga, expose que des progrès ont été accomplis dans cette voie en Grande-Bretagne, où le Conseil des Recherches Médicales prend sous son patronage tous les efforts entrepris en ce sens; de plus, des fonds ont été constitués à l'intention des personnes du corps médical désireuses de collaborer avec l'Institut psychologique de l'Université de Manchester pour un travail positif de recherches médicales. M. le Professeur Pear considère comme une nécessité urgente qu'une propagande faite sur une grande échelle vienne éveiller l'intérêt des anthropologues, des psychologues, des physiologues et des psychiatres pour le vaste champ d'investigation que l'industrie pourrait leur offrir.

Dans la suite de la discussion, on a exprimé le besoin qu'il y aurait pour les universités d'entrer dans un contact toujours plus étroit avec la vie pratique, et de se rendre ainsi à même de mettre au service de l'industrie la masse considérable des connaissances théoriques dont elles disposent, de même que leur point de vue propre par définition plus dégagé.

Un ouvrier anglais a tenu à souligner la nécessité de prendre en considération la vie à la maison du travailleur, chaque fois qu'on veut examiner sa capacité et sa volonté de travailler, et de ne pas perdre de vue l'influence que peut exercer sur le travailleur l'insécurité de son travail.

M. le Professeur Pear a esquissé, à ce sujet, une comparaison entre l'ouvrier américain et l'ouvrier de l'Europe, qui trouvent devant eux des possibilités économiques si différentes. L'ouvrier américain, quant il gravit les fermes roches qui constituent ce qu'on pourrait appeler la montagne de sa carrière, peut bien, à l'occasion, se réjouir même des risques et en recevoir comme un stimulant. Mais pour l'ouvrier européen, dont il conviendrait plutôt, à l'heure actuelle, de comparer la carrière à quelque roche branlante et qu'il doit escalader sans pouvoir suivre ses inclinations naturelles, toute incertitude a pour effet de réduire ses capacités.

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L'un des membres de Cours attire l'attention sur le fait que nombre des jeux que nous choisissons librement peuvent souvent être comparés à des travaux réellement pénibles. M. le Professeur Pear déclare que c'est là un exemple particulièrement saisissant et qui permet d'entrevoir quelles forces intérieures tendent au travail. Tout jeu est une activité choisie, tandis que, par contre, le travail est une activité forcée due à une contrainte interne, à laquelle vient se joindre fréquemment une contrainte du dehors.

Au sujet de l'introduction de méthodes nouvelles dans le travail, il a été fait mention de ce que les ouvriers plus âgés ont, en ce qui les concerne, de la peine à s'y adapter. En outre, ils ont souvent à souffrir considérablement de l'amointrissement subi par la valeur de leur habileté.

M. le Professeur Pear a déclaré que c'est là souvent une question de discrimination. Nombre d'anciennes formes de l'habileté professionnelle peuvent être utilisées par les procédés modernes. Mais la manière dont ces méthodes nouvelles sont présentées aux travailleurs est fréquemment tout à fait fautive, au point de vue psychologique, et a pour effet de blesser la fierté du travailleur pour son adresse. Dans l'ensemble, il sera naturellement toujours plus facile d'adapter les ouvriers à de nouvelles méthodes lorsque le travail est également nouveau pour eux.

M. le Docteur Lipmann traite de la distinction entre la fatigue et la lassitude. Cette distinction est également faite par la psychologie allemande de la vocation. ("Ermüdung" et "Müdigkeit").

M. le Dr. Miles, de l'Institut National de Psychologie Industrielle, met en doute que ce soit égal à l'ouvrier s'il est fatigué lorsque celui-ci a accompli une bonne journée de travail. Aux yeux du Dr. Miles il y a encore, dans la vie à la fabrique, bien d'autres choses qui ont plus d'importance pour l'ouvrier que des recherches détaillées concernant la fatigue. Il a l'impression qu'il y a encore beaucoup trop à faire dans la voie de l'amélioration générale des conditions du travail pour qu'il nous soit permis de concentrer toute notre attention sur des questions aussi nettement particulières et spéciales que, par exemple, celle de l'étude du mouvement. Il craint, en effet, qu'en raison de la spécialisation excessive d'aujourd'hui, l'ouvrier n'en vienne à éprouver un malaise très grave, en tant que cette spécialisation entraîne, dans une large mesure, le sacrifice de la personnalité du travailleur. Aux yeux du Dr. Miles, la fatigue est beaucoup moins le résultat du travail proprement dit que de la répression à laquelle se trouve assujettie la personne même de l'ouvrier, et le Dr. Miles considère comme possible que nous ayons dès à présent

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atteint, dans l'industrie, le degré où cette répression devient intolérable. La même chose, d'ailleurs, s'applique évidemment à toute organisation excessive. Le Dr. Miles souhaiterait de voir les psychologues s'appliquer à l'étude de la question de savoir comment on pourrait arriver à donner à l'ouvrier une liberté plus grande et de plus grandes possibilités d'expression individuelle.

M. Piacitelli craint que le Dr. Miles n'ait peut-être exactement compris en quoi consiste l'étude du mouvement. Par son expérience personnelle, en ayant travaillé sous la direction de M. Gilbreth, l'orateur sait que toutes les études consacrées au mouvement par ce dernier tendent à l'élimination de tout gaspillage humain. Les suggestions apportées dans ce sens par les ouvriers eux-mêmes ont toujours été les bienvenues et suivies d'effet.

Une surintendante d'usine traite du manque de minima légaux (legal minima) comme cela est toujours le cas en Grande-Bretagne et dans d'autres pays. A son sens, les savants devraient être incomparablement plus actifs afin de créer une opinion publique. Le surmenage physique ou mental de la classe ouvrière risque d'entraîner de graves conséquences économiques.

Un ouvrier d'Angleterre indiqua que les méthodes scientifiques et efficaces de travail ne peuvent être d'une utilité générale pour l'humanité que si elles vont de pair avec le progrès social.

Un employé a énoncé qu'il travaillait, il y a treize ans, 12 heures par jour et que, depuis les six dernières années, il ne fait plus qu'une journée de 7¼ heures. En raison des méthodes de travail coordonnées et intensives, il se trouve être fatigué davantage par la journée réduite que par la longue journée d'autrefois. Aussi est-il reconnaissant envers les enquêteurs scientifiques dont les recherches tendent à éliminer la fatigue inutile.

Au cours de la discussion intervenue à la suite de sa conférence sur la capacité de travail et la fréquence des accidents, le Docteur Lipmann a exposé que les femmes sont plus sujettes aux accidents que les hommes, non seulement en raison de leur plus grande émotivité, mais encore par suite du double fardeau dont elles sont chargées en ayant leur travaux de ménage qui viennent s'ajouter encore à leur tâche quotidienne. En outre, leur faculté de concentration se trouve facilement amoindrie par les soucis domestiques qui occupent leur attention.

En ce qui concerne l'emploi de "Safety First" images, le Docteur Lipmann émit l'opinion qu'elles ne peuvent rendre service que si elles sont vraiment bien dessinées et impressionnantes, apposées aux endroits convenables et fréquemment renouvelées.

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Un inspecteur d'usine suédois insista sur la nécessité qu'il y aurait à instruire les enfants, à l'école, sur les causes des accidents.

En réponse à la question de savoir pour quelles raisons la fréquence des accidents est moins grande chez les ouvriers plus âgés, le Docteur Lipmann répondit que cette moindre proportion peut être due à une plus grande expérience du travail et, en général, à une émotivité réduite.

L'accomplissement d'un labeur monotone a pour conséquence d'augmenter la possibilité d'être sujet aux accidents.

Au cours de la dernière matinée du Cours eut lieu une discussion au sujet de la collaboration pratique à l'intérieur de la vie à l'usine: au point de vue du travailleur, du patron, de l'enquêteur scientifique, du surintendant, de l'inspecteur de fabrique et du travailleur social.

L'employé commença par insister sur l'importance, pour celui qui travaille, de sentir, chez son employeur, une véritable compréhension des besoins essentiels propres à la vie du premier. L'intérêt que l'employeur éprouve à l'égard de son personnel se manifeste parfois sous des aspects qui sont par trop éloignés des besoins immédiats du travailleur. Parfois, l'intention est bonne, mais la réalisation défectueuse. Un exemple de cet état de choses peut être trouvé dans ce qui s'est passé récemment à l'intérieur d'une grande usine anglaise où, sur l'initiative de l'employeur, une conférence astronomique fut donnée au personnel. Parmi les assistants se trouvait un travailleur fortement préoccupé par l'insécurité de la place qu'il avait dans cette usine, et obsédé par la crainte de perdre son gagne-pain. Au beau milieu de la conférence du professeur, l'homme en question, incapable de maîtriser ses appréhensions et ayant tout à fait oublié où il se trouvait, s'écria: "Est-ce qu'ils pourront me donner du travail là-haut, si je dois perdre le mien ici-bas?" Un incident comme celui-là en dit plus que bien des volumes.

L'orateur parla ensuite de la nécessité d'aplanir cet esprit de suspicion qui domine chez le travailleur. De son côté, l'employeur n'a pas de vraie confiance en ceux qu'il emploie. Le travailleur ne voudrait pas être confié dans les limites étroites de sa tâche particulière, il aspire à prendre part au travail dans son ensemble. L'orateur pense que l'employeur obtiendrait bien davantage de ses employés et ouvriers, s'il les consultait au lieu de ne leur donner que des ordres.

La question des salaires est très certainement une autre clé quand on veut comprendre les relations entre employeur et employé. Un travail mal payé constitue, en vérité, un fort mauvais placement. Le travailleur a trop souvent raison de penser que son

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salaires n'augmentent point dans la même proportion que son adresse et que ses services.

Un autre point de haute importance consiste dans le choix des contre-maîtres et du personnel dirigeant. Les uns et les autres, dans l'organisation pratique de l'usine et dans la vie courante, forment le lien intermédiaire entre l'employeur et les travailleurs. Ces hommes ne devraient pas être choisis uniquement en fonction de leurs connaissances et de leur adresse. Leur caractère moral et leurs sentiments humains devraient être considérés en première ligne. On entend souvent affirmer "qu'il n'y a pas de sentiments dans les affaires". Certes, toute sentimentalité serait vaine, mais l'absence des sentiments humains ne peut rien produire de bon.

L'orateur exposa également le malaise et le manque de confiance provenant de ce que nombre de jeunes gens, qui ont beaucoup appris et fait beaucoup, afin de devenir habiles, sont considérés comme dénués de toute valeur et congédiés sans délai dès que les procédés de travail se trouvent mécanisés. L'orateur exhorta les savants à mettre au service de l'humanité une partie des efforts qu'ils dépensent actuellement en vue d'accroître la production. Il a la conviction que ses compagnons de travail éprouveraient alors des sentiments bien différents à l'égard des questions d'organisation scientifique, de rationalisation et de méthodes efficaces.

Lorsque sa méfiance aura été vaincue, le travailleur comprendra que ses intérêts se trouvent liés avec ceux de l'employeur. En général, on commence par déterminer le rythme de la machine, après quoi il n'y a plus qu'à suivre cette dernière. Et pourtant, il serait de la plus grande importance d'adapter la marche du travail à l'homme lui-même.

L'orateur a le sentiment que le Cours de Vacances a abordé ces questions fondamentales en se plaçant au point de vue convenable et en faisant montre d'une véritable compréhension. Lorsqu'ils seront rentrés dans la vie industrielle, chacun des assistants devra jouer le rôle d'un missionnaire.

Enfin, l'orateur voudrait détruire la croyance selon laquelle l'ouvrier ne serait pas intéressé au progrès social. C'est le contraire qui est la vérité. Mais le progrès social semble si lent à se manifester. L'orateur met son espoir dans la coopération et dans la compréhension de cette communauté d'intérêts qu'il faut affirmer, encore que le point de vue et les méthodes de rapprochement exigent d'être transformés.

Un employeur prit ensuite la parole. A ses yeux le premier devoir de l'employeur est de penser aux "êtres humains" qui travaillent dans son entreprise. Il demande comment iraient les choses, si

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c'étaient nos propres enfants, nos soeurs, nos frères qui travaillaient dans nos fabriques? Est-ce que nous ne créerions pas alors pour eux, tout de suite, les plus favorables des conditions? Mais le fait que nos ouvriers peuvent être les frères, les soeurs et les enfants d'autrui a-t-il pour conséquence immédiate de tout modifier? Qu'il puisse en être ainsi dans la réalité démontre qu'il y a quelque chose de fondamentalement erroné dans notre attitude et que nous ne devrions pas perdre une minute pour y remédier.

Outre nos devoirs envers l'individu, nous avons aussi notre devoir envers le genre humain dans son ensemble. Nous n'avons pas le droit d'épuiser ce dernier, nous avons l'obligation de le protéger et de le rendre plus fort.

Le rendement du travail, l'accroissement de la production ne viennent alors qu'en second lieu. Quelque naturellement intéressé à ces questions que puisse être l'employeur, il ne doit pas en rechercher la solution aux dépens de toutes les autres considérations. Il est indispensable au sentiment de respect envers soi-même, chez l'ouvrier, que celui-ci soit consulté, et il n'est pas moins indispensable que l'employeur recherche et estime cette collaboration intelligente qui ne peut être que profitable au travail. La façon dont on présente aux travailleurs les procédés scientifiques et les nouvelles méthodes de travail est de la plus grande importance, il faut leur en communiquer le quand, le pourquoi et le comment. Le travailleur ne doit pas être traité comme un zéro.

Enfin, l'orateur veut dire un mot de ce que l'on considérera probablement comme son "dada": de la beauté à l'usine. Dans les fabriques, tout, la plupart du temps, est aussi gris que possible. Les industriels semblent croire que les usines et la beauté n'ont rien de commun. Or la laideur et l'aspect morne et lugubre ne peuvent manquer d'ajouter encore à nos sentiments de lassitude ou de fatigue. Par contre, la beauté refait l'âme, elle recrée. Quant un montagnard arrive, fatigué, au sommet de sa montagne, la splendeur de la vue lui fait oublier tout sentiment de lassitude.

Nous avons besoin dans notre travail, de pareils instants de re-création. Nous avons besoin de beauté dans les lieux où nous travaillons, de couleurs, de fleurs. Ce n'est point là du luxe, ni de la sentimentalité. C'est strictement une nécessité. Et c'est aussi un moyen de vaincre la fatigue. Les procédés modernes de travail ne permettent à l'ouvrier que de rares satisfactions personnelles. La seule chose qui lui reste est peut-être le plaisir de connaître à fond le procédé et d'en acquérir le rythme le plus rapide. Mais ce genre de satisfaction est plus mentale qu'émotionnelle. Il faut que nous trouvions des moyens qui permettent

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aux émotions de s'exprimer. La meilleure façon d'y parvenir est de cultiver le sens de la beauté. On peut y parvenir par des moyens très simples et qui néanmoins amélioreraient considérablement les conditions du travail.

L'exposé de l'enquêteur scientifique fut ainsi conçu: Il a toujours été dans les habitudes du Bureau d'Investigation sur la Fatigue Industrielle (Industrial Fatigue Research Board) de s'efforcer d'obtenir la sympathie et le concours des employeurs et employés dans les enquêtes entreprises par ses investigateurs. Il existe un Comité ayant pour fonction de surveiller ces enquêtes ou groupes d'enquêtes, et il est d'usage, généralement, d'avoir recours, dans ce Comité, à la collaboration de représentants d'une ou de plusieurs associations d'employeurs, de même qu'à celle de représentants des travailleurs, en plus des experts exclusivement scientifiques. Au cas où les employeurs, ou bien les travailleurs, s'opposent à l'enquête proposée, il n'est pas donné suite, généralement, à cette dernière, le Bureau ayant toujours plus de questions soumises à son examen qu'il n'y a de temps pour les étudier. Il a ainsi la faculté d'arrêter et de déterminer ce qu'il choisit. De plus, on comprendra sans peine que, sans bonne volonté de part et d'autre, il est très malaisé d'obtenir des résultats utiles. Si, au cours d'une investigation, quelque maison particulière semble faire la moindre difficulté pour ouvrir à l'enquête son usine ou ses ateliers, on ne fait aucune tentative tendant à aplanir l'opposition, vu qu'il reste toujours assez d'autres firmes aussi importantes et qui ne demandent qu'à ouvrir leurs portes. Avant de commencer l'enquête décidée, l'enquêteur a soin d'exposer, dans l'atelier, aux contre-mâîtres et contre-mâîtresses, de même qu'aux représentants des ouvriers les endroits où il va prendre ses observations, ce qu'il compte faire et pourquoi il compte le faire. De cette façon on obtient la collaboration des travailleurs et on écarte toute trace éventuelle de soupçon. Enquêteurs, employeurs et employés sont entre eux dans les termes les plus cordiaux. A vrai dire, les enquêteurs sont souvent regardés par les ouvriers comme des sujets de douce ironie, ou comme des gens inoffensifs qui peuvent faire quelque bien, ou en tout cas qui ne peuvent pas faire de mal, tandis que les employeurs prennent naturellement les enquêteurs au sérieux, et sont généralement heureux d'entendre les suggestions d'amélioration qu'on leur soumet, encore qu'ils considèrent la dépense comme excessive.

L'orateur suivant parla de la collaboration du surintendant, de l'inspecteur d'usine et du travailleur social industriel. Les deux premiers occupent une situation qu'on pourrait définir en disant "qu'ils sont à l'usine sans être de l'usine". Ils devraient être à

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même d'étudier sans passion les problèmes en en examinant tous les aspects, et ils devraient naturellement avoir un point de vue impartial.

L'orateur attira l'attention sur la nécessité de faire usage, dans nos études, aussi bien d'un télescope que d'un microscope. Tout en examinant le détail des procédés et des méthodes qui exigent notre observation, nous ne devons pas oublier la crudité brutale avec laquelle l'Industrie se présente en Orient. Aujourd'hui encore, il a des travailleurs astreints à une tâche nocturne de douze heures, des journées affreusement longues pour les femmes dans l'industrie textile, tandis que dans les teintureries pour la soie de petits enfants sont penchés, pendant des heures entières, sur des tubes d'eau bouillante.

Le sentiment de notre responsabilité, en ce qui concerne l'Industrie, doit largement dépasser toutes les frontières nationales, car le progrès social dépend des conditions faites à l'homme sur la terre.

ZUSAMMENFASSUNG DER DISKUSSION

Im Vorwort ist bereits gesagt worden, dass der folgende Bericht nur eine Zusammenfassung derjenigen wesentlichen Teile der Aussprache bringt, die von allgemeinem Interesse sein dürften.

Professor Loriga betonte, dass die positive Seite der Gewerbehygiene und Gewerbemedizin noch zu wenig gepflegt werde. Ausser von Krankheitserscheinungen, die die Leistungsfähigkeit beschränken, wie Tuberkulose und Herzkrankheit, wissen wir wenig über die körperlichen Ursachen, die Arbeitsunlust oder Arbeitswillen bestimmen.

Professor Pear teilt diese Ansicht, sieht aber einen Fortschritt in der Richtung zur Pflge der positiven Medizin in der Tatsache, dass in Grossbritannien alle Bestrebungen und Institute auf dem Gebiet der Gesundheitsforschung dem Medical Research Council unterstellt und Stipendien geschaffen worden sind für Mediziner, die in Verbindung mit dem psychologischen Institut der Universität Manchester positive Medical Researches vornehmen. Er hält es für dringend wünschenswert dass Anthropologen, Psychologen, Physiologen und Psychiater durch eine grosszügige Propaganda für das ungeheure Forschungsgebiet, das die Industrie bietet, interessiert werden.

Im Laufe der Aussprache wurde die Notwendigkeit betont, die Universitäten in stärkeren Kontakt mit dem praktischen Leben zu bringen und die reichen Ergebnisse der Wissenschaft und objektiven Forschung in erhöhtem Masse für die Industrie nutzbar zu machen.

Ein englischer Arbeiter sagte mit Nachdruck, dass die häuslichen Verhältnisse der Arbeiter sowie der starke Einfluss, den die Unsicherheit der wirtschaftlichen Lage auf den Arbeiter ausübt, bei Beurteilung der Arbeitsfähigkeit und Arbeitsfreudigkeit berücksichtigt werden müssen.

Professor Pear antwortete mit einem Vergleich des amerikanischen mit dem unter ganz anderen wirtschaftlichen Bedingungen stehenden europäischen Arbeiter. Während der aufstrebende amerikanische Arbeiter mit dem Bergsteiger vergleichbar ist, der auf festem Gestein zielsicher zur Höhe klimmt und Unsicherheit und Gefahren zuweilen sogar als Ansporn begrüsst, gleicht der europäische Arbeiter dem Mann, der gegen seinen Willen gezwungen wird abbröckelnde Felsen zu besteigen und dem Unsicherheiten zum Willen lähmenden Hemmnis werden.

Eine Teilnehmerin wies darauf hin, dass die Grenzen zwischen Spiel (Sport) und Arbeit oft fliessend seien. Professor Pear definierte das "Spiel" als eine Reihe von Handlungen, die nur des Vergnügens wegen getan werden, während bei der "Arbeit" ein

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Zwang von innen her wirksam wird, zu dem oft ein Zwang von aussen hinzutritt.

In der Aussprache über die Einführung neuer Arbeitsmethoden wurde von verschiedenen Rednern auf die Schwierigkeiten hingewiesen, die die Umstellung besonders älteren Arbeitern bereitet - sie leiden oft psychisch stark unter der Entwertung ihres fachlichen Könnens durch Rationalisierung bezw. Mechanisierung der Arbeit.

Professor Pear erwiderte, dass die Umstellung verhältnismässig einfach ist, wenn Fertigkeiten und Fähigkeiten, die für die alte Arbeit notwendig waren, bei der neuen Arbeit Verwendung finden können. Die Form, in der ihnen neue Arbeitsmethoden beigebracht werden, wäre oft psychologisch falsch und verletze den Berufsstolz der Arbeiter. Allerdings müsse man allgemein sagen, dass neue Methoden am besten Menschen beigebracht werden, für die die Arbeit ganz neu ist.

Dr. Lipmann ging auf die im Anschluss an die englischen Definitionen von "fatigue" und "weariness" von der deutschen Berufspsychologie geprägten Begriffe "Ermüdung" und "Müdigkeit" ein.

Dr. Miles, Leiter des National Institute for Industrial Psychology, bezweifelte, dass den Arbeiter die Ermüdung stört, wenn er ein gutes Tagewerk hinter sich hat. Ihm läge viel mehr an der Ausschaltung andere Dinge, die ihm wichtiger sind. Wir müssen bei dem Arbeiter die Ueberzeugung befestigen, dass wir sein Interesse wahrnehmen und seine Arbeitsbedingungen verbessern wollen. Erst wenn der Boden so bereinigt wäre, könnten wir in Einzelheiten gehen. Heute sei die weitgehende Arbeitsteilung für den Arbeiter noch verhängnisvoll. Er muss seine Persönlichkeit zum grossen Teil aufgeben. Nach Dr. Miles Ansicht entsteht weniger Ermüdung durch die aktuelle Tätigkeit, als durch die Unterdrückung seines Wesens. Es sei sehr wohl möglich, dass in der Industrie in dieser Beziehung über das Mass des Erträglichen hinausgegangen wird. Das Gleiche gelte von der "Ueberorganisation" - der Arbeiter ist oft nur ein Rad an einer Maschine. Es wäre besser, wenn die Psychologen sich mehr mit der Frage beschäftigen würden, wie dem Arbeiter grössere Freiheit und Möglichkeiten der Auswirkung seiner Persönlichkeit gegeben werden könnten, statt auf die Beschränkung der Persönlichkeit, z.B. im Wege der Bewegungsstudien, soviel Arbeit zu verwenden.

Herr Piacitelli fürchtete, dass Dr. Miles das Wesen der Bewegungsstudien nicht kenne, wenn er glaube, dass sie nur im Interesse des Arbeitgebers erfolgen. Aus seinen persönlichen Er-

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fahrungen im Zusammenwirken mit Gilbreth wisse er, dass Gilbreth's Bemühungen besonders darauf gerichtet waren, die Vergeudung menschlicher Kraft zu verhüten. Anregungen von Seiten der Arbeiter würden immer begrüsst und beachtet werden.

Eine englische Betriebswohlfahrtspflegerin bedauerte das Fehlen der gesetzlichen Festlegung von Mindestschutzbestimmungen in Grossbritannien und verschiedenen anderen Ländern. Die Wissenschaft sollte weniger zurückhaltend sein und die öffentliche Meinung mehr zu beeinflussen suchen. Physische und geistige Uebermüdung haben für den Arbeiter eine schwerwiegende wirtschaftliche Bedeutung.

Ein englischer Arbeiter betonte, dass Betriebswissenschaft und Rationalisierung erst dann einen Fortschritt für die Menschheit bedeuten könnten, wenn sie Hand in Hand mit dem sozialen Fortschritt gehen.

Ein Angestellter berichtete, er hätte dreizehn Jahre täglich 12 Stunden und seit sechs Jahren täglich $7\frac{1}{4}$ Stunden gearbeitet. Infolge der intensiveren Arbeitsmethoden empfinde er bei der kürzeren Arbeitszeit mehr Ermüdung als früher bei der 12 Stunden-Arbeit. Er begrüsst es, dass im Betrieb ein auf betriebswissenschaftlicher Grundlage arbeitender Organistator tätig ist, der die Arbeit nach menschlichen Gesichtspunkten zu beurteilen und zu gestalten sucht.

In der Aussprache, die auf den Vortrag von Dr. Lipmann über "Arbeitsleistung und Unfallhäufigkeit als Symptome der industriellen Leistungsfähigkeit" folgte, führte der Vortragende die grössere Unfallhäufigkeit der Frauen nicht nur auf die stärkere Emotionalität, sondern auch auf ihre Doppelbelastung durch berufliche Arbeit und die häuslichen Aufgaben zurück. Ihre Konzentrationsfähigkeit würde herabgemindert, weil ihre Gedanken durch Familiensorgen abgelenkt werden.

Nach Ansicht von Dr. Lipmann können Unfallverhütungsbilder nur wirksam sein, wenn sie gut und eindrucksvoll sind, am richtigen Platz hängen und öfter gewechselt werden.

Eine schwedische Fabriksinspektorin hob die Notwendigkeit hervor, die Kinder in den Schulen über Unfallgefahren aufzuklären. Auf die Frage nach dem Grund der geringeren Unfallziffer älterer Arbeiter, gibt Dr. Lipmann an, dass die älteren Arbeiter durch ihre Berufserfahrung und ihre im allgemeinen geringere Emotionalität vor Unfällen bewahrt werden. Monotone Arbeiten erhöhten die Unfallaffinität.

Am letzten Tage der Studienwoche wurde eine Aussprache über

ZUSAMMENFASSUNG DER DISKUSSION

Formen des Zusammenarbeitens in Fabrikbetrieben eingeleitet, durch Referate über die Zusammenarbeit vom Standpunkte des Arbeitnehmers, vom Standpunkte des Arbeitgebers, des betriebswissenschaftlichen Prüfers, des Betriebswohlfahrtspflegers, der Gewerbeinspektion, der Sozialbeamten.

Zuerst sprach ein Arbeitnehmer:

Der Arbeiter müsse fühlen, dass der Arbeitgeber wirklich Verständnis für die den Arbeitern lebenswichtigen Bedürfnisse haben. Das Interesse, dass der Arbeitgeber für seine Arbeiter an den Tag legte, kommt zuweilen in Massnahmen zum Ausdruck, die den Augenblicksnöten der Arbeiter durchaus nicht gerecht werden. Oft ist guter Wille vorhanden, aber es werden falsche Mittel angewandt. Um dies zu veranschaulichen, schilderte er einen Fall, der sich kürzlich in einem grossen englischen Werk zugetragen hat, in dem auf Veranlassung des Arbeitgebers ein Vortrag über Astronomie für die Arbeiter gehalten wurde. Unter den Teilnehmern war auch ein Arbeiter, der sich über die Unsicherheit seiner wirtschaftlichen Lage grosse Sorgen machte und in ständiger Angst vor der Entlassung lebte. Mitten in den Vortrag des Professors drang die Stimme dieses Mannes, der unter dem Druck der Furcht vor Arbeitslosigkeit seine Umgebung vollständig vergessend, in den Ruf ausbrach: "Kann ich da oben Arbeit bekommen, wenn ich meine Arbeit hier unten verliere"? Solch eine Vorkommnis spricht Bände.

Der Arbeiter geniesst aber auch nicht das Vertrauen des Arbeitgebers. Er möchte gern an der Arbeit im Ganzen teilnehmen. Wenn der Arbeiter öfter um seinen Rat gefragt würde, würde der Unternehmer besser mit ihm fertig werden als wenn er nur Befehle gibt.

Die Lohnfrage ist auch ein Schlüssel zum Verhältnis von Arbeitgeber und -nehmer. Eine schlecht bezahlte Arbeit ist auch für das Unternehmen eine schlechte Kapitalsanlage. Oft fühlt der Arbeiter mit Recht, dass sein Lohn nicht in dem Mass wie seine Arbeit steigt.

Werkmeister und Leute in leitender Stellung sollen nicht nur nach Klugheit und Tüchtigkeit ausgewählt werden, sondern man sollte auch darauf sehen, dass sie Charakter und menschliches Empfinden für die Arbeiter haben.

Oft hört man: "Für Sentimentalität haben wir nichts übrig". (there is no sentiment in business) Es sollte aber Raum für menschliches Gefühl bleiben.

Die gelernte Arbeit gilt nicht mehr viel und trotzdem verlangen die Arbeitgeber, dass die jungen Leute jahrelang in die Lehre gehen, um etwas zu lernen, was nachher doch nicht als gelernte Arbeit (skill) gewertet wird.

ZUSAMMENFASSUNG DER DISKUSSION

Es sollte dafür gesorgt werden, dass ein Bruchteil der Zeit, die jetzt von der Wissenschaft im Interesse der Produktionssteigerung verwandt wird, in den Dienst der Frage der Menschlichkeit in der Industrie gestellt wird. Sicher würden die Arbeiter dann auch eine ganz andere Stellung zu den Fragen der Rationalisierung und Betriebswissenschaft einnehmen.

Wenn das Misstrauen beseitigt ist, wird der Arbeiter einsehen, dass seine Interessen eng mit denen des Arbeitgebers verbunden sind, und umgekehrt. Meist wird das Tempo der Maschine bestimmt, und dann muss der Arbeiter sich ihr anpassen. Man muss die Arbeit aber dem Menschen anpassen.

Der Redner war der Ansicht, dass die Sommerschule die Grundprobleme mit richtigem Verständnis erfasst und gut zum Ausdruck gebracht hätte. Nach der Rückkehr zu ihrer Arbeitsstätte hätten alle Teilnehmer eine Mission zu erfüllen.

Der Redner äusserte den lebhaften Wunsch, die Auffassung zu zerstören, dass der Arbeiter nicht am industriellen Fortschritt interessiert sei. Er ist im Gegenteil sehr daran interessiert. Es sei nur bedauerlich, dass die Ideen des menschlichen Fortschrittes sich so langsam verwirklichten. Wir dürfen auf eine Zusammenarbeit und die Anerkennung der Gemeinsamkeit der Interessen, wenn wir auch die Dinge von verschiedenen Seiten ansehen, hoffen.

Dann ergriff ein Arbeitgeber das Wort:

Die Notwendigkeit der Zusammenarbeit ergibt sich für den Arbeitgeber vor allem aus seiner Pflicht gegenüber den Menschen, die in seinen Betrieben arbeiten. Wie würde es sein, wenn unsere Kinder, unsere Schwestern und Brüder in unseren Fabriken arbeiteten? Würden wir dann nicht sofort versuchen, die Arbeitsbedingungen so gut wie möglich zu gestalten? Nur weil es zufällig die Kinder und die Brüder und Schwestern anderer Leute sind, versagen die Gefühle plötzlich? Das ist eine falsche Einstellung, von der wir so schnell als möglich loskommen müssen. Der Unternehmer hat aber auch eine Pflicht gegen die Allgemeinheit und die menschliche Rasse. Wir dürfen mit unserem Volk keinen Raubbau treiben, wir müssen mit für seine Ertüchtigung sorgen.

Als weiterer Grund kommt das Interesse des Unternehmers an der Produktionssteigerung hinzu. Dieses Interesse darf aber nicht alle anderen Rücksichten verschlingen. Das Gefühl der Selbstachtung verlangt, dass der Arbeiter zu Rat gezogen wird, aber auch dem Arbeitgeber muss an der verständnisvollen Mitarbeit der Arbeiterschaft gelegen sein, wovon der Betrieb im übrigen nur Vorteil ziehen wird. Es hängt ausserordentlich viel davon ab, wie neue Arbeitsmethoden und Rationalisierungsmassnahmen durchgeführt werden. Der Arbeiter muss erfahren, wann,

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warum und wie eine neue Sache eingeführt wird. Er darf nicht als Nummer behandelt werden.

Der Redner bat dann, ein paar Worte auf sein "Steckenpferd" sagen zu dürfen: Schönheit in der Fabrik. In den Fabriken ist meist alles grau in grau. Die Schönheit wird vor den Fabrikatoren ausgeschlossen. Der Bergsteiger vergisst über der schönen Aussicht, die sich ihm auf dem Gipfel eröffnet, mit einem Male alle seine Müdigkeit. Wir brauchen in der Arbeit solche Leuchtpunkte. Wir brauchen schöne Räume, Farben und Blumen. Das ist kein Luxus und keine Sentimentalität. Das ist einfach eine Notwendigkeit. Auch dies ist ein Weg, Ermüdung zu überwinden. Die heutige Arbeitsweise gewährt dem Arbeiter wenig innere Befriedigung und Möglichkeit, sein Gefühlsleben irgendwie auszu-drücken. Es bleibt ihm höchstens die Freude an der Beherrschung seiner Arbeit und der Schnelligkeit die er darin erreichen kann. Das ist aber eine mehr verstandesmäßige Art der Befriedigung. Wir müssen Möglichkeiten finden, um den Emotionen, die die Menschen bewegen, Raum zu geben. Der beste Weg ist aber die Pflege des Schönheitssinnes. Man kann dies mit einfachen Mitteln tun und die Arbeitsbedingungen dadurch doch wesentlich verbessern.

Ein Leiter für betriebswissenschaftliche Untersuchungen äusserte sich folgendermassen:

Das Amt für Ermüdungsforschung in der Industrie (Industrial Fatigue Research Board) versucht stets, das Vertrauen und die Mitwirkung der Arbeitgeber und Arbeitnehmer für die von den Prüfungsbeamten (investigators) vorzunehmenden Untersuchung zu gewinnen. Zur Kontrolle solcher Untersuchung bzw. von Reihen solcher Untersuchungen ist ein Ausschuss gebildet worden; Vertreter einer oder mehrerer Arbeitgeberorganisationen und Arbeitnehmerorganisationen werden jeweils um ihre Mitarbeit zur Unterstützung der wissenschaftlichen Facharbeiter gebeten. Wenn von Arbeitgebern oder Arbeitnehmern Bedenken gegen eine geplante Untersuchung geltend gemacht werden, so wird sie in der Regel aufgegeben, da die Zahl der dem Amt vorgelegten Fragen die tatsächlichen Möglichkeiten der Durchführung von Untersuchungen meist übersteigt. Das Amt kann daher unter den vorgeschlagenen Untersuchungen eine Auswahl treffen.

Erfahrungsgemäss ist ohne guten Willen auf beiden Seiten wenig zu erreichen. Wenn im Laufe einer Untersuchung sich eine befragte Firma nicht geneigt zeigt, ihre Fabrik oder Werkstätten für die Untersuchung zu öffnen, so bemüht man sich nicht den Zugang auf irgend eine Weise zu erreichen, weil es genug Firmen gibt, die die Leiter einer solchen Untersuchung willkommen heissen. Ehe mit der eigentlichen Untersuchung begonnen wird, hat der

ZUSAMMENFASSUNG DER DISKUSSION

Untersuchungsleiter den Werkmeister und Werkmeisterinnen (bezw. Vorarbeitern) sowie den Vertrauensmännern der Arbeiterschaft in den Räumen, in den die Beobachtungen angestellt werden sollen, eingehend zu erklären, was er zu tun beabsichtigt, und warum er es tun will. Auf diese Weise wird ihre Mitwirkung gewonnen und latentes Misstrauen beseitigt. Untersuchungsbeamte, Arbeitgeber und Arbeitnehmer stehen auf durchaus freundschaftlichem Fusse. Oft schlagen die Arbeiter gegenüber den mit der Untersuchung betrauten Persönlichkeiten einen scherzhaften Ton an, betrachten sie als harmlose Leute, die etwas nützlich tun, oder doch jedenfalls nichts gegen die Interessen der Arbeiter unternehmen wollen, - während die Arbeitgeber die Untersuchungsbeamten ernst zu nehmen pflegen und in der Regel gern Verbesserungsvorschläge aufnehmen, wenn die Ausgaben nicht zu gross sind.

Die nächste Rednerin behandelte das Zusammenwirken des Betriebswohlfahrtpflegers (oder Personalbeamten), des Gewerbeinspektors und Sozialpolitikers. Die beiden ersteren befinden sich in der Lage, die man etwa charakterisieren könnte: "im Betrieb arbeitend aber nicht zum Betrieb gehörend" (in the factory yet not of it). Ihnen ist die Möglichkeit gegeben die Fragen von verschiedenen Gesichtspunkten aus objektiv beobachten und vollkommen unvoreingenommen beurteilen zu können.

Die Rednerin betonte, dass man nicht nur die Dinge durch ein Mikroskop sondern auch dann und wann durch ein Teleskop betrachten müsste. Wenn wir über die Verfeinerung der Arbeitsmethoden im einzelnen diskutieren, sollten wir uns bewusst bleiben, dass sich die Industrie im fernen Osten noch in den grössten Formen vollzieht, dass wir dort noch Nachtschichten von 12 Stunden haben, entsetzlich lange Arbeitsschichten für Frauen in der Textilindustrie und dass in den Färbereien, in denen die Seide zu unseren Kleidern gefärbt wird, sich kleine Kinder stundenlang über Kübel mit kochendem Wasser beugen.

Das Gefühl der Verantwortlichkeit sollte sich über nationale Grenzen hinaus erstrecken, da die Arbeitsbedingungen der ganzen Welt Voraussetzung des Sozialen Fortschrittes sind.

Ein Unfall kann verursacht sein :

- I. durch ein unvorhersehbares Naturereignis.
- II. durch mangelhafte oder fehlende vorgängige Schutz- und Aufsichtsmassnahmen.
- III. durch mangelhaftes Verhalten eines Menschen im Augenblick der Gefahr.

Das mangelhafte Verhalten des Menschen kann bestehen darin, dass

1. die Gefahr nicht oder zu spät bemerkt wurde.
2. die Abwehrbewegung gar nicht oder zu spät erfolgte.
3. dass eine falsche Abwehrbewegung ausgeführt wurde.

Das mangelhafte Verhalten kann verursacht oder mitverursacht sein

u. durch besondere Eigenschaften des Arbeiters,

A. mangelhafte Berufskenntnisse, mangelhafte Kenntnisse von den Berufsgefahren und von den Unfallverhütungsmassnahmen.

B. mangelhafte körperliche Beschaffenheit des Arbeiters (Herzkrankheit, Schwindel, schlechte Hör- oder Sehschärfe usw. v.)

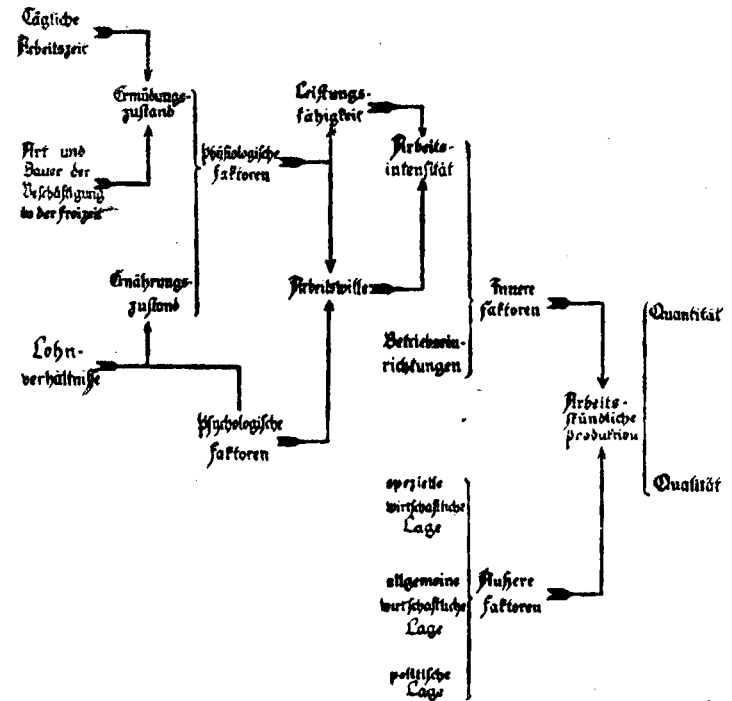
C. mangelhafte psychische Beschaffenheit des Arbeiters (allgemeine Sorglosigkeit, Mangel an Pflichtgefühl, Kaltblütigkeit, Umsicht, Geisteszugewandtheit, körperlicher Gewandtheit, Mängel des Gedächtnisses, der Aufmerksamkeit usw., abnorme Ermüdbarkeit)

b. durch besondere Umstände, wie Hitze, schlechte Beleuchtung, Übermüdung, besondere Affekte des Arbeiters (Sorgen u. dgl. v.), Arbeitshast., Fühlhol, plötzliche Erkrankung.



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Die Faktoren der Arbeitsleistung.



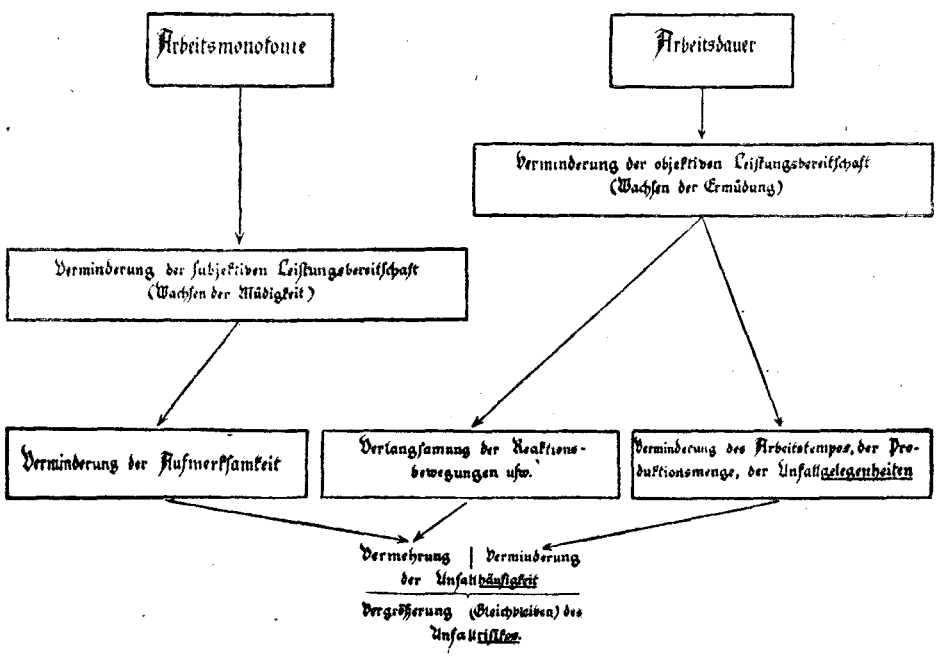
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Don je 100 Unfällen sind verursacht:

	32	10	15	15	
Allgemein (Frankreich)	durch Unvollkommenheiten der Maschinen, Mangel an Schulung vorrichtung	durch falsche Maschinen, Irthümer ungeschulter Arbeiter	durch körperliche Mängel (Hörsehvermögen, Schwäche, Schwerhörigkeit, Kurzsichtigkeit ufm. der Arbeiter	durch schlechte Aufmerksamkeit, Mangel an Reaktionsfähigkeit ufm. der Arbeiter	Freis
Montiers-Arbeiter (Amerika)	durch Unvollkommenheiten der Maschinen, Mangel an Schulung vorrichtung				Bezahlte Maschinen-Werker-Gewerkschaft
Baumholz-Industrie (Amerika)				78 durch Unachtsamkeit der Arbeiter	florierende
Streifenbahn (Dortin)		35 durch unvorsichtige Auf- und Abfragen 38 durch unvorsichtige Schritte der Fußgänger			
Flieger (Bayern)		6 durch mangelhafte Prüfung der Führer	51 durch mangelhafte Bewandlung der Führer		Erstarrt
Eisenbahn (Deutschland)			14 durch unachtsamere Verhalten der Beamten		Sag

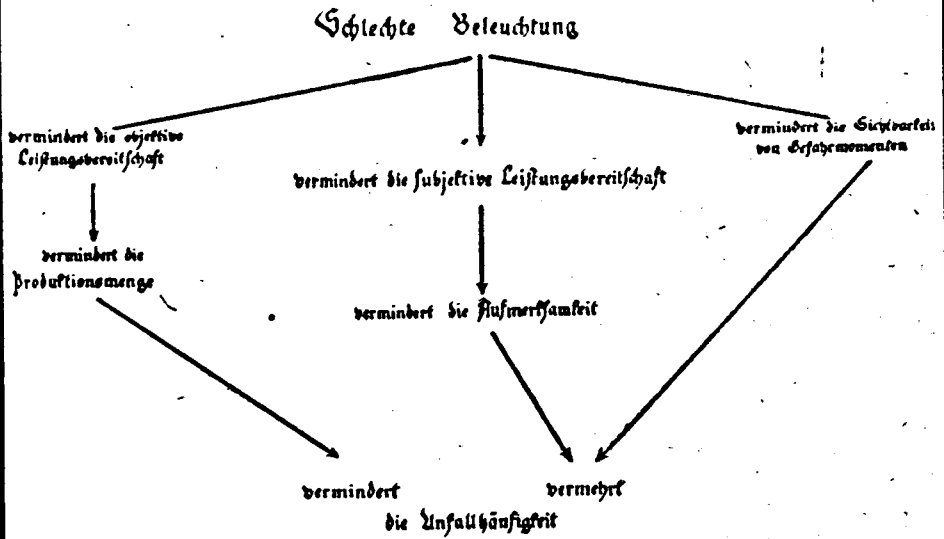
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Wirkung fortgesetzter monotoner Arbeit auf die Unfallhäufigkeit.



IV
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Wirkung der Beleuchtung auf die Unfallhäufigkeit.



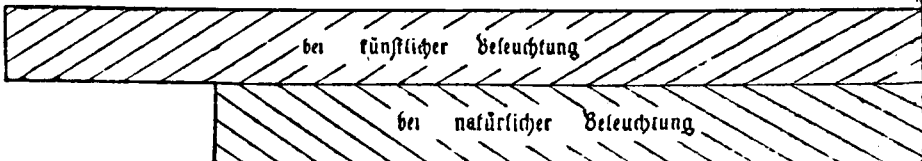
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Relative Häufigkeit von Augenverletzungen



Relative Häufigkeit von Unfällen

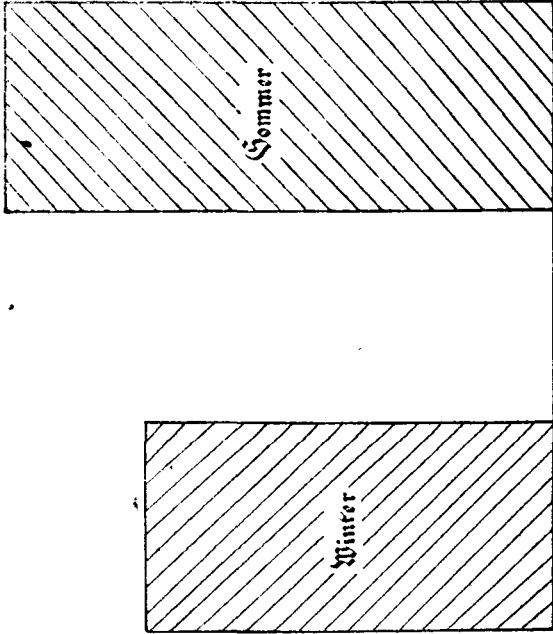


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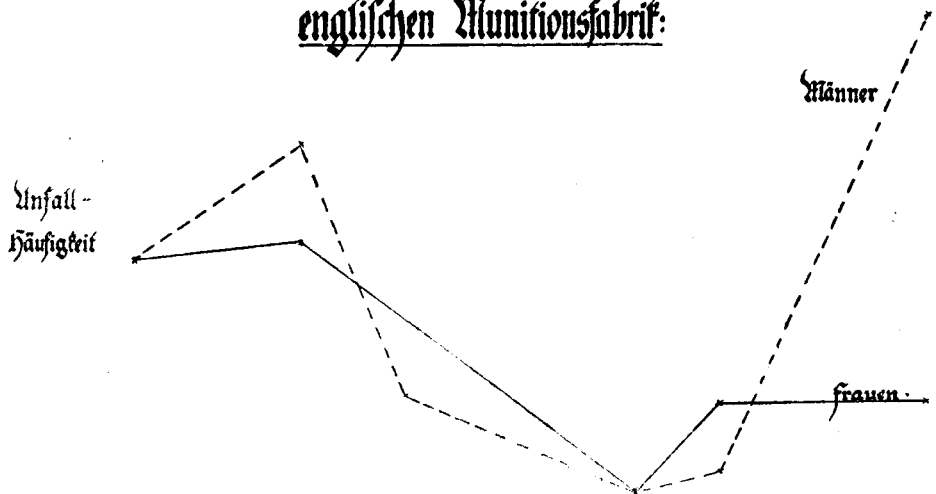
Authe. Lee und Lorenson.

Vergleich der Unfallhäufigkeiten im Sommer und im Winter in einer amerikanischen Stahlfabrik.



VII
 Institut für angewandte Psychologie, Berlin.
 Direktor Dr. Otto Lipmann
 Quelle: Teich

Die Unfallhäufigkeit bei verschiedenen Temperaturen in einer englischen Munitionsfabrik:



VIII
 Institut für angewandte Psychologie, Berlin.
 Direktor Dr. Otto Lipmann
 Quelle: Verano

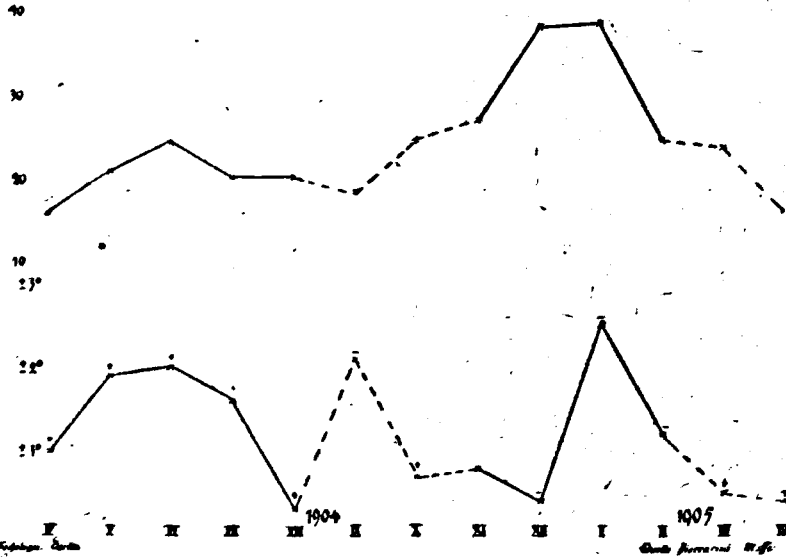
Die Unfallhäufigkeit wächst im Sommer, wenn die Monatstemperatur höher (+) ist als die normale, und im Winter, wenn sie niedriger (-) ist als die normale.

Anzahl der Unfälle
auf je 10000
Arbeiter-Arbeits-
Stunden in den
Eisenbahn-
Werksstätten
Flormig

Abweichung der
Durchschnitts-
Temperatur
des Monats
von der
normalen
Temperatur
des betr.
Monats

IX

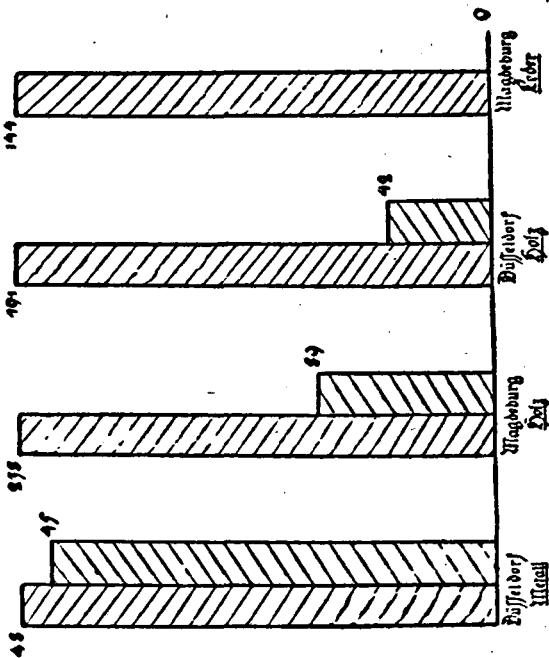
Ergebnis für entsprechende Zeitpunkte, Berlin
Berliner B. d. d. d. Eisenbahn



Das Pfundvergleichssystem
als solches wirkt nicht unfallgefährdend.

Zeitlohn-Arbeiter
Stücklohn-Arbeiter

Anzahl der Unfälle auf je 1000 Arbeiter

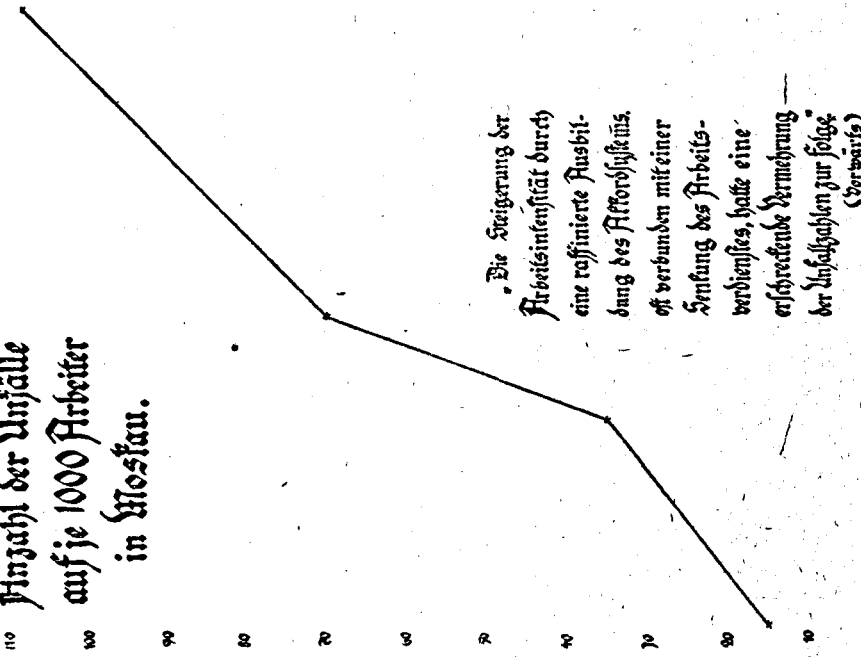


IX

Ergebnis für entsprechende Zeitpunkte, Berlin
Berliner B. d. d. Eisenbahn

Quelle: Gesamtverfassungsbereich
für 1922.

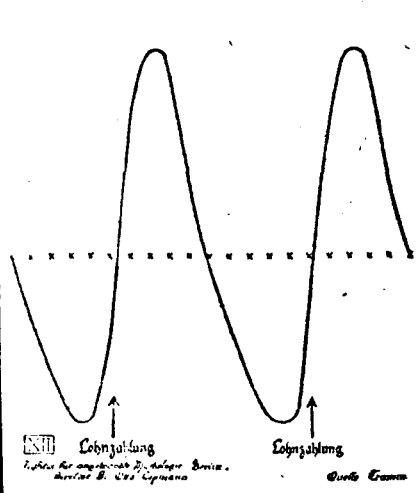
Anzahl der Unfälle auf je 1000 Arbeiter in Moskau.



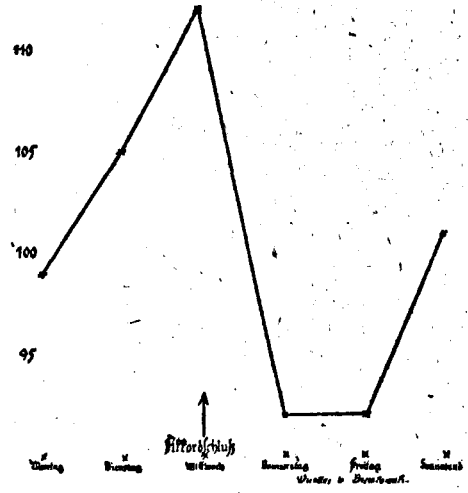
Die Steigerung der Arbeitsintensität durch eine raffiniertere Ausbildung des Akkordsystems oft verbunden mit einer Senkung des Arbeitsverdienstes, hatte eine erschreckende Vermehrung der Unfallschäden zur Folge (Vorwärts)

1910
 1897
 1898
 1899
 1900
 1901
 1902
 1903
 1904
 1905
 1906
 1907

Verlauf der Unfallhäufigkeit während zehntägiger Lohnperioden bei der Berliner Straßenbahn
(Schematisch)



Verlauf des Unfallrisikos während der Arbeitswoche in einer Berliner Kabelfabrik



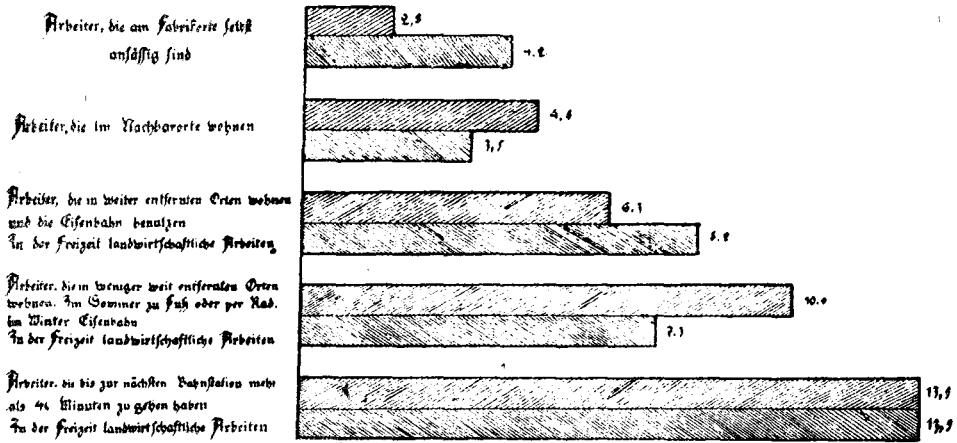
1897
 Lohnzahlung
 Lohnzahlung

110
 105
 100
 95

Montag
 Dienstag
 Mittwoch
 Donnerstag
 Freitag
 Samstag

Einfluss der Entfernung zwischen Wohn- und Arbeitsstätte auf die Unfallhäufigkeit.

(Arbeiter einer Waggonfabrik in Kirchheim b. Heidelberg.)



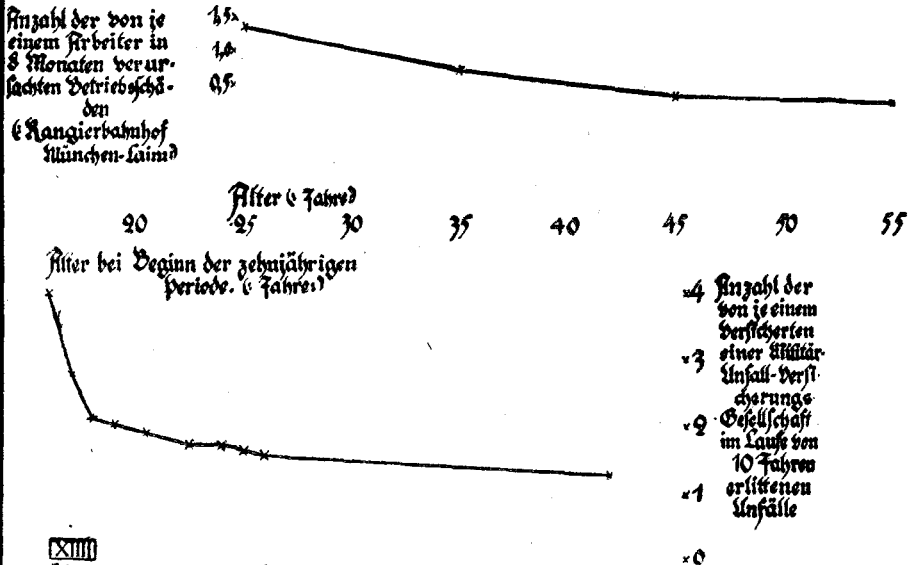
Unfallhäufigkeit } im Sommer // // // // //
 im Winter // // // // //

XIII

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Quelle: Hoff-Ortha

Jüngere Personen verursachen und erleiden mehr Unfälle als ältere.

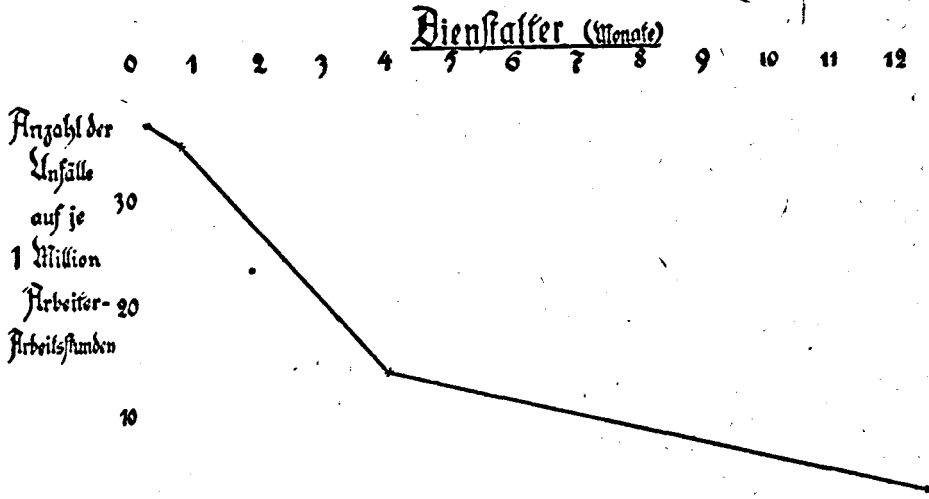


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Quelle: Harn.

Anzahl der Unfälle bei Arbeitern verschiedenen Dienstalters



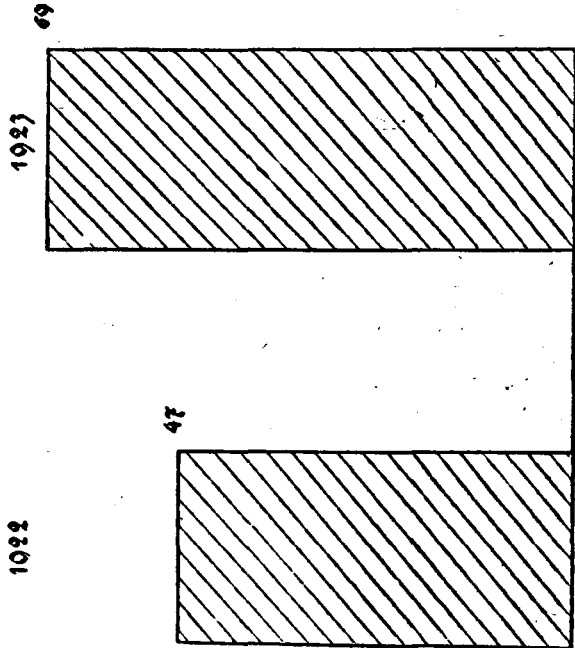
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Quelle: Gmelin

Lange Arbeitslosigkeit bewirkt einen Verlust an Sicherheit und Geschicklichkeit und vermehrt daher bei Wiederaufnahme der Arbeit die Unfallgefahr.

Anzahl der Unfälle auf je 1000 Mitglieder der Berliner Eissterimungs-Krankenkasse.



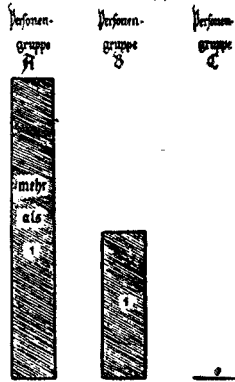
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Nachweis der „Unfallaffinität“.

Manche Personen sind - unabhängig von ihren Verufe- ein für allemal mehr (Gruppe A) oder weniger (Gruppe C) dazu veranlagt, Unfälle zu erleiden als die Personen einer mittleren Gruppe (B).

Anzahl der Unfälle während
der ersten 5 Jahre



Durchschnittliche Anzahl der Unfälle
während der zweiten 5 Jahre



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Quelle: Warke.

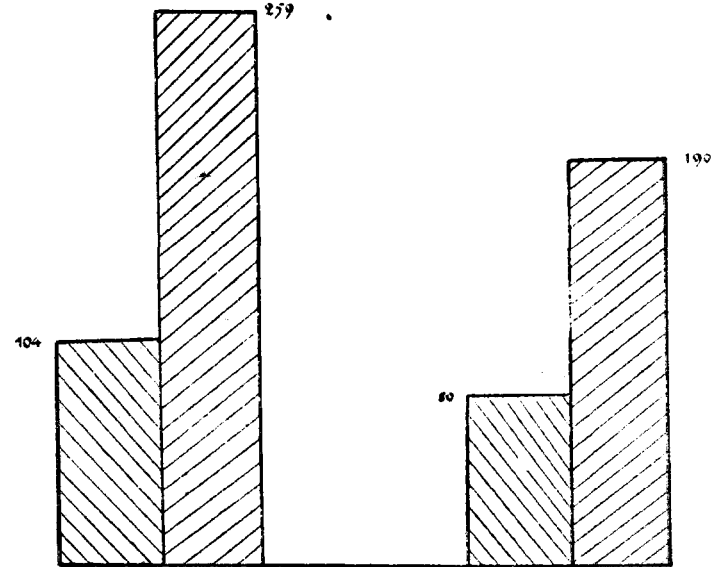
Abhängigkeit der Unfallhäufigkeit von der Prozentzahl neu- gestellter Arbeiter. Möbelfabrik.

Prozentzahl der Neueinstellungen:

Anzahl der Unfälle auf je 1000 Arbeiter:

1. Halbjahr 1919

2. Halbjahr 1919

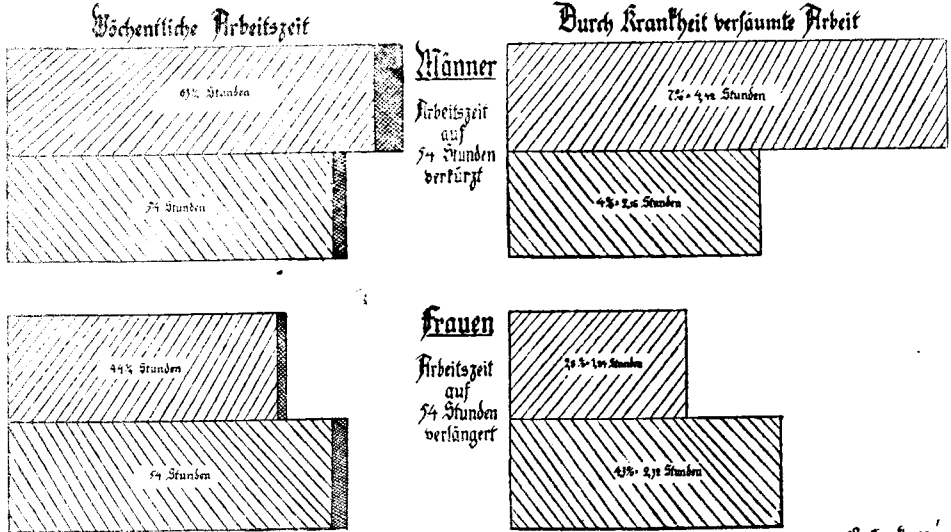


XVII

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Quelle: Lipson - Campbell

Arbeitszeitverlust bei verschiedenen langen Arbeitszeiten in englischen Munitionsfabriken.

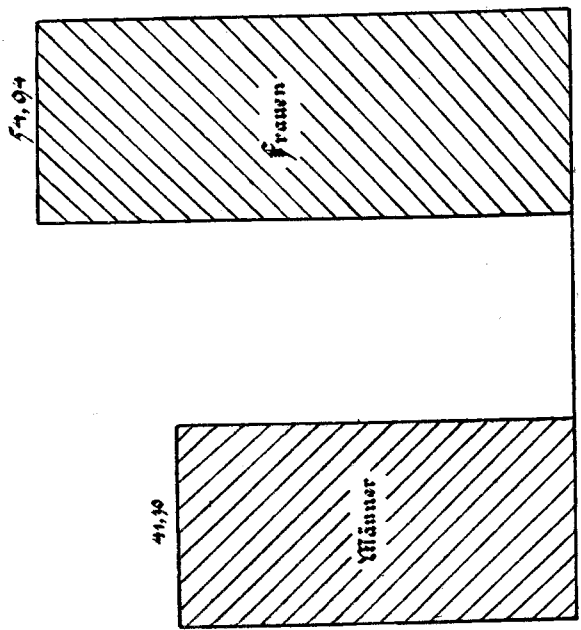


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XIX

Quelle: *beram.*

**Bei der Arbeit an Handpressen
erleiden die Frauen mehr
Unfälle als die Männer.**

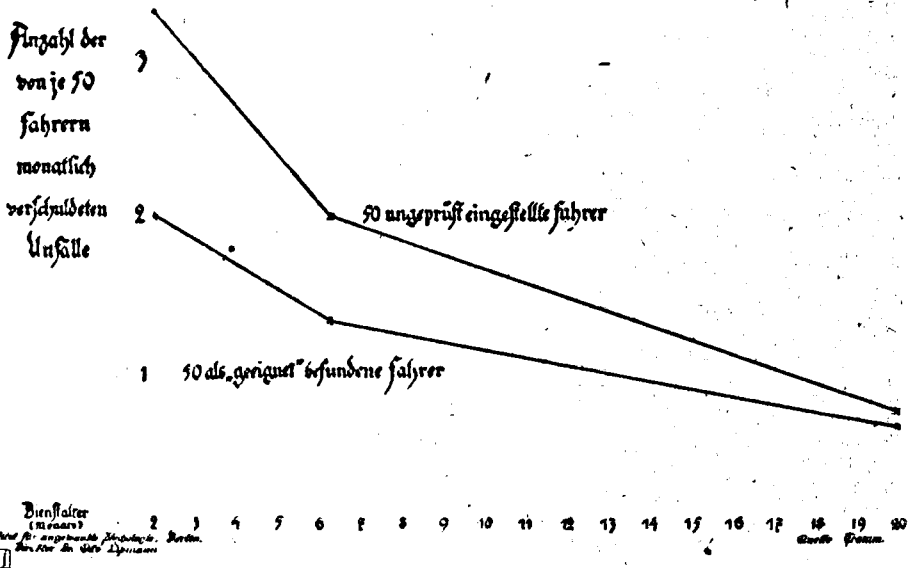


Quelle: *Baumig*

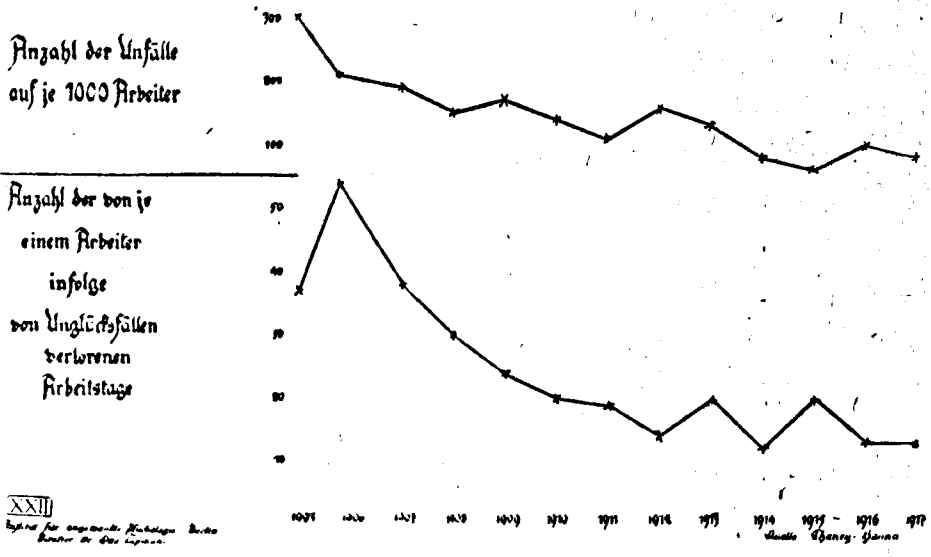
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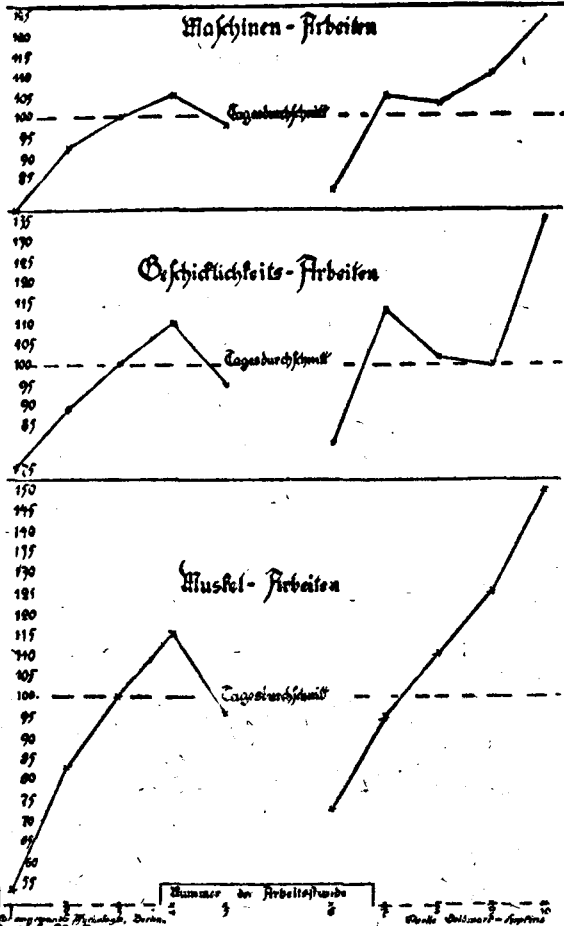
Die Anzahl der von geeigneten und von ungeprüften Straßenbahnfahrern verschuldeten Unfälle in Abhängigkeit vom Dienstalter.



Wirkung umfassender Unfallverhütungs-Maßnahmen in einer amerikanischen Stahlfabrik:

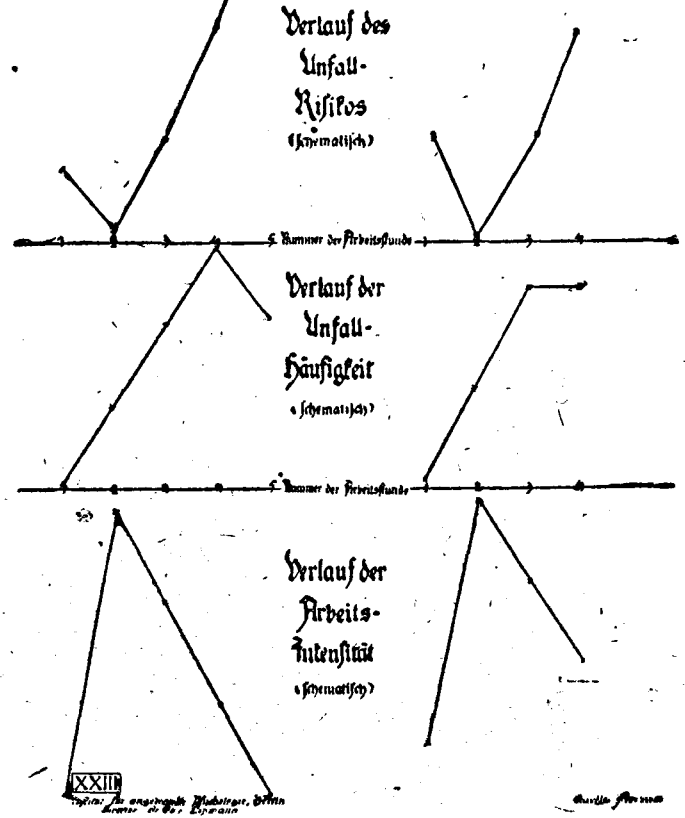


Verlauf des Unfallrisikos während des zehnstündigen Arbeitstages in 3 Abteilungen einer amerikanischen Liniationsfabrik.

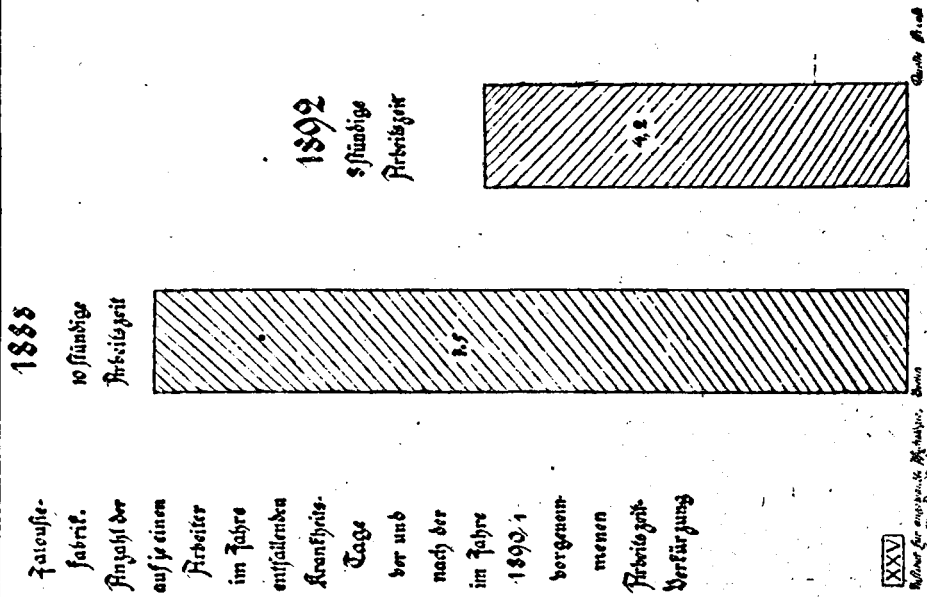


10stündige Halbtagstarbeitsperiode

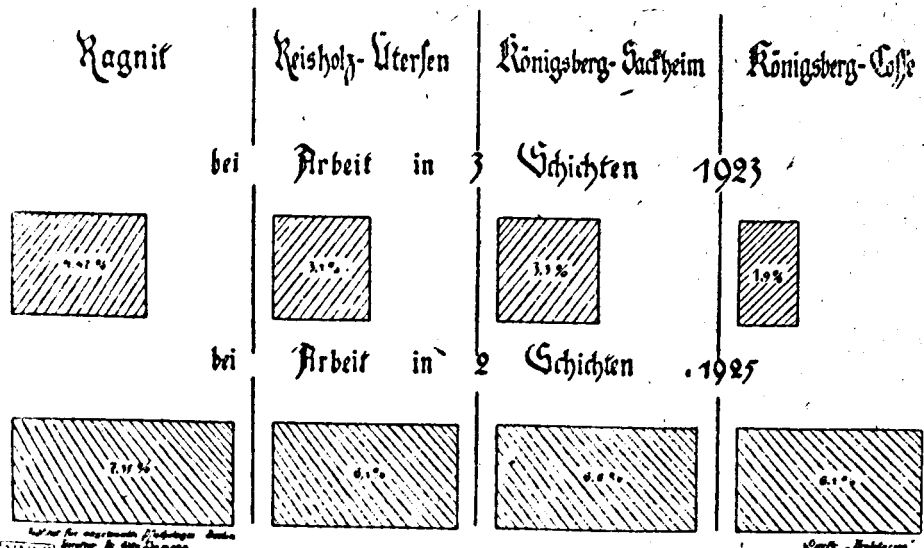
8stündige Halbtagstarbeitsperiode



Quelle: Dr. ...

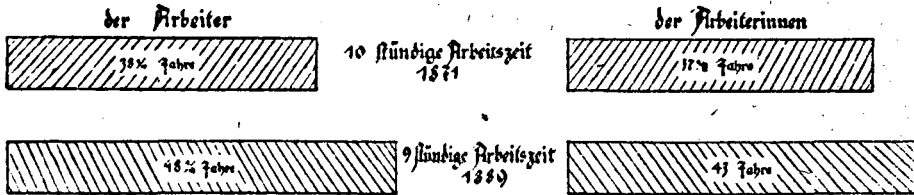


Krankenstand im Verhältnis zur Belegschaft beim Drei- und Zweischicht-System in deutschen Papierfabriken:



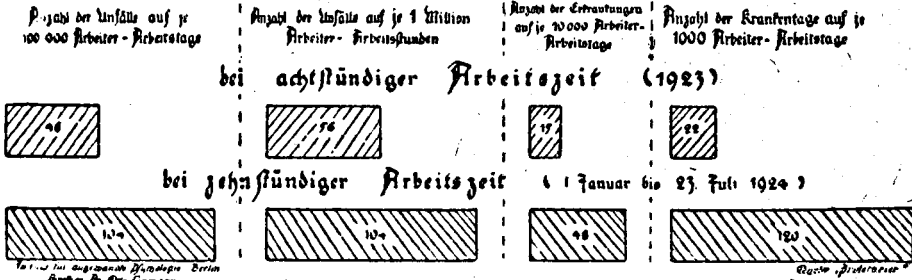
Sterbealter, Anzahl der Erkrankungen und Unfälle bei verschieden langer Arbeitszeit.

Vergleich des im Jahre 1872 in England durchgeführten Verkürzungs der Arbeitszeit auf das Sterbealter,



Quelle: Statistik der Gewerkschaften - Berlin

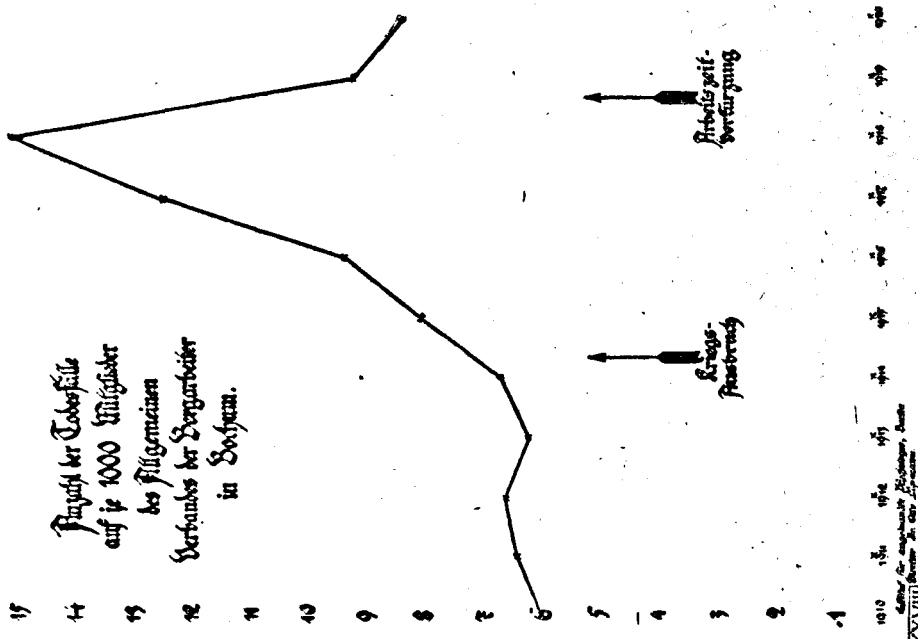
Krankheits- und Unfallhäufigkeit bei verschieden langer Arbeitszeit in einer Generatorenanlage Mitteldeutschlands



1.1.1924 bis 23. Juli 1924
Quelle: Dr. Otto Lohmann

Quelle: Arbeiterzeitung

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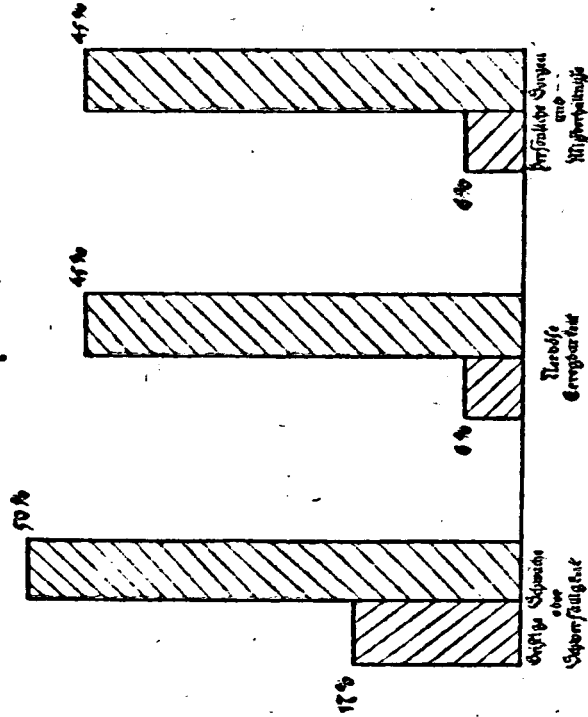
Quelle: Bergbauamt Bochum, Bochum, 1924

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Einfluss der allgemeinen und der jeweiligen städtischen Verfassung auf die Verursachung von Unfällen.

Strafgebühren, die Unfälle verursachen haben

Strafgebühren, die keine Unfälle verursachen haben

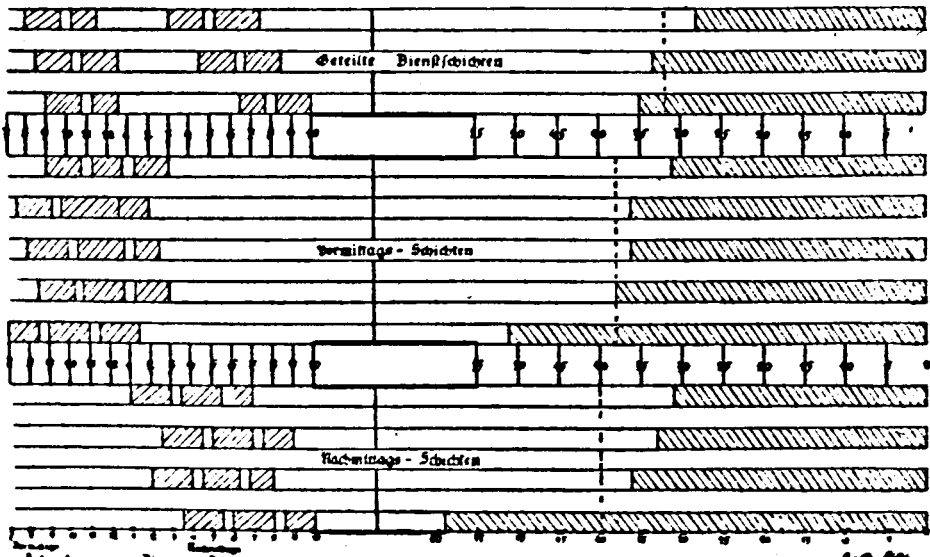


Schlüssel für die verschiedenen Städte und Vorkommnisse

Quelle: C. v. ...

Abwankungsfehler der Fernsprechbedientinnen bei verschiedenen Dienstzeit-Einteilungen

Arbeitszeiteinteilung | Anzahl der Abwankungsfehler auf je 1000 Verbindungen



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