Progress Report
1950–1953
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1. GENERAL OBJECTIVES.

The aims of this Unit are to observe and measure human behaviour in order to establish general principles about healthy human performance. It is believed that such principles should be of general scientific interest, and also of practical value when applied to men working either in Industry or the Services. The investigations usually consist of experimental studies of individual human activity. Most projects are aimed at devising measures of human achievement which will allow people to work more effectively with less fatigue and fewer accidents.

2. MAIN LINES.

The researches can conveniently be grouped under eight main headings.

I Unusual environments.
II Vigilance tasks and skill consistency.
III Information presentation.
IV Information measurement.
V Training.
VI Motor performance.
VII Sickness and accident studies.
VIII New devices and procedures.

3. FUTURE TRENDS

In the future, work will continue along all these lines with special attention to:

(a) studies of vigilance tasks and skill consistency
(b) researches on information presentation
(c) new experiments on information measurement
(d) the experimental analysis of training.

On the practical side, most of the problems come in from the Services, usually from the Royal Navy or the Royal Air Force. More work however now being done on civilian and industrial problems. There is also an increasing tendency for questions to appear with a medical background.

1. UNUSUAL ENVIRONMENTS
The researches on the effects of abnormal environments can be considered under four sub-headings:-

1. Cold
2. Heat
3. Noise
4. High CO2

1. Cold.
The numbing effects of cold winds have been assessed by a two-point tactile discrimination test under field conditions. Slight differences in wind speed and air temperature could be detected by this means. The stronger were the winds, the lower were the skin temperatures and the greater was the risk of minor frostbite. Field studies in Canada have also shown that a two-point tactile discrimination task can demonstrate the presence of acclimatisation due to natural cold, but very high levels of wind chill over come this acclimatisation. Laboratory cold-room studies in this country have shown that a similar acclimatisation effect can be developed in un-acclimatised men by daily exposure to artificially produced cold. (Mackworth)
An attempt is now being made to relate tactile numbness readings to finger blood flow and skin temperature readings under circumstances which normally produce acclimatisation changes. (Mackworth and Batts)

Pepler has now completed his researches at the Royal Naval Tropical Research Unit at Singapore into the effect of high atmospheric temperatures on the performance of skilled tasks by young European men living under tropical conditions. Reduced working ability was found in tasks as different as pointer alignment, Morse code reception and prolonged visual watch keeping. The results agree in general with the results obtained from hot room experiments in Cambridge. Pepler has also drawn attention to the importance of factors such as the subject's level of skill, the difficulty of the task and the subject's level of motivation in determining the effects of high temperatures. The results of these studies are now being analysed in detail, and the Climatic Physiology Committee has suggested that these Singapore results on human performance should eventually be published together with the physiological evidence in the Special Report Series.

Many investigators have previously failed to demonstrate any measurable changes in human performance due to prolonged high intensity noise. Recent research by Broadbent has however given definitely positive results. The subjects were asked to do a visual watch-keeping task for a period of 1 & 1/2 hours at a time. They were exposed to the noise during the whole of this working spell. Previous investigators have tried the effects of long spells of noise on performance at short tests (or the effect of short bursts of noise on performance at long tests) - but they have not used long spells of noise given throughout long tests. With this arrangement Broadbent has demonstrated that the same subjects can find the same visual signals more quickly under quiet conditions (70 db.) than they can in noise at the 100 db. level.

It is important that some men are more susceptible to noise than others. Many stress studies are done on a specially selected group of volunteer subjects consisting of either keen undergraduates or scientists specially
associated with the investigations. Such subjects were mostly used in previous noise studies with negative
results, whereas Broadbent obtained this decrement when he used a random sample of subjects drawn from a
Naval population. Performance results taken from undergraduate-scientist subjects may well underestimate
stress effects for two related reasons; Firstly, this undergraduate-scientist type of subject is likely to do well
on the experimental task without stress. These noise experiments, as in the heat studios, showed that men
who learned the task quickly without noise were less likely to deteriorate either with prolonged work or with
noise. Secondly, stress decrement is less likely with such subjects because those with good academic
qualifications are known to have a personality feature which enables them to do well under prolonged stress.
To obtain an assessment on this personal characteristic each subject is asked on a separate occasion to do a
special tracking task and also to predict his future achievement score. The index used is the difference,
regardless of sign, between this estimate and the previous achievement score on the tracking task. This index
can be termed an independence index since it assesses, as it were, an ability to free oneself from the present
circumstances. Subjects with low independence scores show a greater decrement in visual watch-keeping
accuracy with noise than those with high independence scores.
Subjects with low independence scores also usually have a marked decrement between the first ten-minute
period and the second ten-minute period in the number of correct responses made on a choice-reaction test.
This result was found when scores for quiet and noise were pooled. In these other studies the subject worked
as fast and accurately as possible; he set his own pace and every time he made a response a fresh stimulus
was presented. Broadbent showed that with this unpaced arrangement the same men made fewer wrong
choices in quiet conditions (70 db.) than in 100 db. noise. The importance of providing a long enough test was
again underlined by the fact that these results were obtained in a task lasting half an hour. The noise
conditions would apparently have produced no effect had the test lasted for only five minutes.
Broadbent is now comparing the performance effects of noises of different spectra - and high frequency noise
appears to be more detrimental than low frequency noise of the same intensity. This is of practical importance
from the point of view of jet noise in aircraft carriers and in light coastal craft. Further work is planned on
intermittent noise from recordings of rockets, especially the effect on a more intellectual task involving
immediate memory. This task will also be tried in prolonged noise.

4. High CO2
A new method of escape from a submarine involves the hazard of a high CO2 concentration in the atmosphere
for a period of several hours,. The Royal Naval Physiological Laboratory has therefore constructed a model of
some of the apparatus that survivors would have to operate to effect an escape. Gregory has demonstrated in
pressure chamber tests that trained Naval ratings can continue to operate this equipment without mistakes
even in such highly abnormal atmospheres.

II. VIGILANCE TASKS AND SKILL CONSISTENCY

1. Vigilance Tasks.
In a theoretical paper on Pavlovian conditioning and vigilance tasks Broadbent has developed the analogy
drawn initially by Mackworth between the conditioning situation and human watch keeping duties. Broadbent
has re-interpreted some phenomena found in conditioning experiments in the light of evidence drawn from vigilance studies. He mentions how only certain aspects of the total stimulus situation can lead to complex responses at any given time. Three principles of perception selection are discussed. The stimulus is selected if it is of high intensity or of biological importance or if it is highly novel. This discussion of the phenomena of classical conditioning includes a new explanation of extinction in terms of competing stimuli rather than, competing responses.

There are important connections between the nature of perceptual selection and the phenomena found during the periodic momentary neglect of information in a vigilance task. Such momentary failures cannot be redeemed by a spurt in performance when the task is paced by the environment at a moderate speed. It may be that the pacing of factory work by the speed of the machine prevents occasional shifts perceptual selection and so increases apparent fatigue by breaking the novelty principle, (Broadbent).

Fraser has shown in the laboratory that fast environmental pacing can lead to a decrement in performance; the same visual watch keeping task was changed from one which showed a fatigue decrement to one which did not when he increased the length of time during which the signal remained visible. Fraser has also made it clear that the presence of the experimenter during a prolonged visual task can raise accuracy at that task. The less skilled the subjects, the greater the loss of accuracy when the experimenter was absent.

Fraser has also devised a new form of visual vigilance task for a study of aircrew fatigue. The subjects looked at a vertical opal glass screen up which were moving small spots of light. At long internals chosen at random during the one hour of each test a rather larger spot of light appeared and passed slowly up the screen taking 5 seconds to do so. The subject had to watch for these larger circles and to photograph them by pressing a camera button when each large circle was estimated to have travelled exactly half way up the screen. The measure of performance was the scatter of these subjective estimates of position about the average estimated position of the circles for that particular subject. There were three main results in this investigation which was undertaken on R.A.F. navigators. Most men showed an increase in the scatter of these judgements during the second half-hour of a watch keeping spell compared with the first half-hour. Nearly all the subjects showed a smaller scatter in their estimates when they were tested fresh than they did when they were tired after flying. Another effect of flying fatigue was a reversal of the trend from the first half-hour to the second half-hour; most men when tired after flying showed a larger scatter of readings during the first half-hour than they did during the second half-hour of their test.

The effort of prolonged work on intellectual performance is also being studied by Shaw on Ministry of Civil Aviation controllers giving outward clearances to aircraft leaving the London area. Those men were being tested on arrival for work, at the beginning of an eight-hour spell of duty and, on another occasion, at the end of eight hours of work. The task provided is on exact imitation of their own duties. The times required to give the instructions, and the margins of safety these instructions would allow are the measures being used.

2. Skill Consistency.

Lewis has noted with the experimental car that highly skilled drivers show a remarkable consistency in performance when cornering, whereas less skilled drivers are much less consistent. The index of driver performance found most useful in this investigation is based on acceleration and deceleration readings. A
period of six weeks elapsed between test and re-test. This result has been found in Police drivers and also in keen rally drivers who have not had any special training. The general importance of this finding lies in the fact that this may lead on to methods of assessing levels of skill in forms of work where there are a large number of ways of achieving the same end result - i.e. in the many tasks where error and output scores are hard to obtain. To discover how general is this tendency, Lewis is now studying consistency of pilot performance on landing. This will show whether the better pilots give a more standard response pattern on test and re-test. A further extension of his work will be a study of the effects of prolonged car-driving on consistency of performance over a 500-mile journey consisting of six laps of 50 miles each.

A new project has been proposed in view of these developments. The idea is to investigate consistency in watch keeping tasks, in particular, to determine the disadvantages of lack of sleep on performance and the advantages of providing knowledge of results.

In collaboration with Miss Davis of Professor Russell’s Unit at University College, Gibbs has suggested a factory investigation where production figures will be compared in two situations: (a) where the workers are given frequent information of the piece work bonus they have earned - and (b) where this knowledge of results is delayed until the end of each week.

III. INFORMATION PRESENTATION

A large proportion of the work of the Unit during the three years under review has been devoted to studies of ways in which the display of signals could be improved to make perception easier. This section of the work can best be considered under three sub-headings;

1. Speed and load stress
2. Visual display
3. Auditory display.

1. Speed and load stress.

Attempts have been made to discover some of the main reasons for measurable inaccuracies in perception. A distinction has been drawn between speed stress and load stress. Speed stress is regarded as ‘the difficulty arising from a simple lack of time to complete the task as a whole. Load stress, on the other hand, is a difficulty due to the number of potential sources of demand for instant action that are present in the environment - i.e. the number of possible action points in the situation. (Mackworth)

In studies of speed stress Conrad has shown that in addition to the stressful effect of general shortage of time, speed stress leads to momentary crises in a continually changing task. Pour sources of signal were simultaneously watched and the distribution of the time intervals between signals closely resembled the exponential. The sequence of signals was considered side by side with the sequence of responses produced by the subject. Then it became clear that the making of a response could easily momentarily reduce the probability of signal detection. Such missed signals were just as likely to occur before the response as after it. The stressful effect of a general shortage of time was also demonstrated by Conrad because he noted that the probability of a signal being detected (when it occurred a given time interval from a response) decreased linearly with the mean speed of signal presentation. Prom studies of this kind, Conrad has made the important
definition of timing that this is the creation of the most favourable temporal conditions for response. (Conditions for response are considered to be favourable when the response can be made with the least hurry, at the best moment whilst leaving the organism in a satisfactory post-response state.) Much further work is needed on the problem of the nature of the immediate mental load, although already it is clear that doubling the number of potential sources of demand for action in the environment and halving the speed stress does not necessarily maintain the status quo. Such experiments would probably be along four main lines. Errors can arise from crisis, disorder, increased memory load and increased irrelevancy level. Obviously any increase in the number of potential action points in a continuously changing environment will raise the chances of a moment occurring in which many signals will overlap in time. Increased difficulty of this kind can be created without any obvious speed stress. The reason for this is that the crisis is due to a marked irregularity in the spacing along the time scale of the signals for action. This irregularity bunches some signals too closely together although other signals arrive at intervals which seem inordinately long. Subjects usually try to avoid such crises by dealing with each of the signals a long way ahead of the moment at which the answer has to be ready.

Unrestricted anticipation, however, is less effective in dealing with the effects of excessive mental load due to disorder. In this difficulty the subject has to determine the sequential order in which signals should be selected. Searching for the best sequence is a difficulty which gives a steadily increasing error as the mental load is increased over the range from 5 to 50 items. (Mackworth) The effects of this form of mental load are intensified by increasing the speed stress. In studies of the effects of increased memory load Poulton has shown that new items could not be memorized effectively while previous items were being recalled in a continuous choice reaction task.

On the effects of increased irrelevancy level, studies have been started with verbal material to try to assess the obscuring effects of greater and greater amounts of irrelevant facts. In problem-solving as much as half of the material can be irrelevant without any effect. Some trouble is experienced when two-thirds of the material is irrelevant and considerable difficulty is found when five-sixths of the facts are irrelevant. (Mackworth)

The main developments in these studies of immediate mental load will be to determine further the influence of anticipation, especially from the point of view of procedures by which it might be possible to make greater use of anticipation by reducing limitations normally set on this by difficulties in remembering. The ways in which emphasis can be given, to the display to encourage selective perception from a mass of presented facts also seems well worth further study. This work is being undertaken in association with the Controller Training School of the Royal Navy.

In conjunction with the R.A.F. Institute of Aviation Medicine and Fighter Command, laboratory and flying trials have been done by Lewis and Simmonds on a practical problem of speed and load stress, the extent to which fighter pilots can be expected to think out successful interception routes.

2. Visual Display.
A new indicator of machine tool travel has been devised by Gibbs. Skilled lathe operators can do the same work in two-thirds of the time previously taken with the more conventional indicators. The main reason for the difference is that many fewer stoppages are required with this new method than with the old to make micrometer readings.

Gibbs has also undertaken further problems in visual display related to the visibility of car turning signals. The trafficator signal gave a quicker response than the flashing light, but the flashing light signal was seen at greater distances than the trafficator under conditions of bright sun glare. The trafficator signal was noticed more often than the flashing light at night. An interesting general finding requiring development was the point that quicker reactions were found when each light had only one meaning. Relatively slower responses were found when a light source had one meaning when it burned alone and an entirely different meaning when lit in combination with some other light.

Lewis and Cunningham have made a study of hand signals versus a turning indicator for motor cyclists, at the request of the Road Research Laboratory. Hand signals were very much better by day but useless by night. Another form of turning indicator was devised and tested.

Blinking has been suggested as a possible cause of accidents, and Poulton and Gregory have therefore undertaken laboratory studies of the effects of blinking on tracking. The normal blink rate was found to be reduced during tracking, especially when the course was difficult, and in particular when anticipation was not possible. Blinking cannot be excluded as a possible cause of errors in visual tasks in which anticipation is not possible. It is believed, however, that a more important potential cause of accidents is reduced visual vigilance and temporary lapses of attention of which blinking may be the earliest objective sign. Blinking thus appears to be a possible index of attention.

3. Auditory Display.

Gregory has followed up this result by a study of variations in blink rate during non-visual task. The subjects listened to a series of single digit numbers and mentally added these. Fewer blinks were recorded during these trials compared with the number of blinks per minute between the trials.

A similar result was obtained with a tactile task, and in these circumstances it was found that the normal resting blink rate for the subjects lay between these two extremes of the incidence during the trials and between the trials. There was a tendency for subjects who showed the greatest reduction in blink rate during the trials to make the fewest errors on this stylus maze task.

A number of interesting papers have been published by Poulton and Broadbent on problems associated with listening to more than one voice speaking at the same time. Poulton also showed that having select relevant information from one continuous stream presented some difficulty. The similarity of relevant information to irrelevant made selection more difficult, especially when similar elements occurred close together in time.

Horizontal separation of two speakers presenting information simultaneously not only reduced physical interference between them but also helped the subject to listen to the right one. When two relevant messages were presented simultaneously about half of them were not apprehended correctly.

Broadbent has shown that the difficulty of listening to two messages at once is not only a matter of difficulty in hearing such as might arise from peripheral auditory masking. The interference is apparently caused by a
central selective mechanism and this has been studied as a function of certain variations in the voices, and, again, in the localisation of the speech sources. Changes in the localization were found to be particularly important, and even apparent localization was sufficient to help perceptual selection of the relevant messages from a mass of speech. Recently it has become clear that the temporal characteristics of the stimulus are likely to prove interesting: the time for a double shift of attention, for instance, appears to be between one and two seconds. Further work is planned on this phenomenon. Broadbent is also to follow up the result obtained in these investigations that spatially separated sounds presented simultaneously in the form of short messages seem to pass through the perceptive mechanism successively rather than simultaneously. This was discovered by an experiment in which lists of digits were arranged to arrive simultaneously half on one ear and half on the other. Under these circumstances all digits given to one ear were normally written down before any digits on the other.

Poulton will be developing his studies of the differences between verbal extrapolation and verbal interpolation. A particularly interesting finding here was the point that there is an increased range of choice in verbal interpolation when the second piece of information is in conflict with the first, i.e. when the subject is given two pieces of information and has to fill in the gap between them under conditions where the meaning of the second piece of information is in conflict with the meaning of the first.

Further auditory display studies are being undertaken by Carpenter on problems arising from the choice of a stethoscope. At present these investigations are concerned with the physical behaviour of the stethoscope, e.g. the responses of existing stethoscopes and the effects on these of changes in the contact pressure and effects of imperfect sealing at ear or chest. More information is needed on the frequency spectra of the various sounds for which stethoscopes are used, especially the sounds occurring in blood pressure estimation. Carpenter is also constructing electronic equipment for human performance tests on listening to tape recordings of normal and abnormal heart sounds. Attempts will be made to record the heart sounds and accompanying murmurs separately so that their relative intensity may be varied independently. A study will then be possible of the effects on audibility of a sharp cut filter with adjustable upper and lower limits. Tests can be made of the claims put forward for the diaphragm type of stethoscope that its lessened response to low frequency heart sounds make it more sensitive to any accompanying high-pitched diastolic murmurs.

Intelligibility studies have been made by Mrs. Roberts at the request of the Ministry of Civil Aviation on alternative phrases that are necessary for ground to air communication. These phrases have been recorded on tape by men of five different nationalities. Satisfactory forms of message had to be heard clearly through a loud aircraft noise background by English, American, Dutch, French and Spanish subjects. More errors arose from foreigners mispronouncing English than from foreigners mishearing B.B.C. English. Speech training is therefore likely to be well worth considerable attention in avoiding confusion between pilot and controller. Some words, especially those familiar to most nationalities are however easier to hear and phonetic alphabet comparisons favour name words like Charlie, George and Peter on experimental test. Then again imperatives
such as "Remain on this frequency" are definitely mere intelligible if preceded by an alerting throw-away word such as "Please".

IV. INFORMATION MEASUREMENT

Information theory is a potentially important new approach especially in the quantitative treatment of skill. Certain facts have been established but the precise fields of psychology in which this mathematical system can be useful and appropriate remains ill-defined. Even where the analysis is mathematically tractable special difficulties arise when concepts are developed which cut across more traditional formulations in psychology. The fact that human behaviour is not completely predictable is however one reason for the importance of this subject. Future actions obviously depend to some extent on past actions. Psychology is often concerned with the questions of the predictability of a given course of action and here information theory has a definite place since it measures the degree of organisation of systems. Information has been communicated when the number of possible alternatives in a choice has been reduced. For example, there is often little doubt on the possible alternative answers when only the last word in a sentence is missing. But this kind of analysis of a sequence of behaviour need not necessarily be restricted to studies in verbal behaviour. Miss Cane is particularly interested in devising mathematical models suitable for various forms of sequential behaviour, and these are likely to be important developments both for theory and for practice. The consistency measurements adopted in the studies previously mentioned on test-retest of car drivers were suggested by Miss Cane.

Hick was the first to point out that in choice reaction experiments with various numbers of alternatives up to ten it could be demonstrated that on the average the amount of information extracted by the subject by his choice is proportional to the time taken to extract it. Later Hick extended this finding to cover the case in which there is a loss of information between the stimulus and response due to the subject reacting more quickly at the cost of errors. The loss of information due to errors was compensated for by a reduction in the average reaction time so that the information per second remained the same. A number of possible explanations have been considered, the most promising of which expresses quantitatively, in a restricted sense, Bartlett's view that "even the most elementary-looking perceptual processes have the character of inferential construction". Hick's experiments were undertaken in circumstances in which all the relevant possibilities were equiprobable. But as he himself pointed out, this is seldom the case in real life - either subjectively or objectively. Crossman has however now demonstrated that the law also applied when the probabilities were unequal, provided this was taken into account on computing the display information. A further extension of Hick's work has been made by Crossman in his card sorting experiments, i.e. with a serial task rather than with isolated reactions. Leonard has also been considering the extension of Hick's original, studies to serial situations. Leonard has given his subjects a choice reaction task in which the situation presented is in the form of a progressive classification process in three stages. At first there are six alternatives, then there are only three alternatives (the warning signal), and lastly the final signal is given for one of these three choices. Leonard is studying the effects of reducing the time interval between warning and final signal which he has termed the warning period. The point is to determine the minimum warning period necessary for effective use of advance information. This can be remarkably short and a warning period of about 0.3 seconds gives a reaction time to the final signal of
a progressive six-choice which is about 0.35 seconds. This lies between the six-choice and three-choice reaction times.

Gregory has devised a speculative account of brain function in terms of probability and induction and in this he had the help of Miss Cane. This work is related to Hick’s comment that the objective frequencies with which events occur do not exactly correspond to the subjective or psychologically effective probabilities. Gregory has started experiments in which various events occur with different objective frequencies during a series of presentations. The subject has to guess the next event. It will be possible to determine how different these frequencies must be before people begin to select one of the alternatives more frequently than any of the other possible choices. Gregory’s interesting paper is in fact a plea for more experiments on human learning in which the subjects have to form hypotheses and make definite predictions from a growing series of data. He has made the further suggestion that eye movement recordings could identify the sources of visual data that are providing crucial information in deciding between rival hypotheses. Another particularly stimulating idea also ready for experimental analysis is the proposal that studies should be made of inductive thinking to discover more about the ways in which people decide when they have enough data to support a definite conclusion.

V. TRAINING

Problems related to the design and use of synthetic training devices have been considered by Hick and Crossman, mainly at the request of the Plying Personnel Research Committee of the R.A.F. Some of the work mentioned on Information Measurement has a bearing on the fundamental approach to this matter. Hick and Crossman have been working on the pre-flying training of ab initio pupil pilots by means of photographs, films and special devices including one to simulate the kinematic perspective appearances during a glide approach. This aspect of training has certain advantages and in particular provides a means of testing principles with a view to their application to the more complicated flight simulators used for crew training.

The work of Lewis previously mentioned on the devising of measures of pilot performance, especially for landing ability, is also likely to be useful here in providing ways of measuring actual achievement so as to try to apply various yardsticks to assess the benefits of synthetic training in the handling of real aircraft. Similarly Mackworth and Poulton have attempted to devise scoring methods, based mostly on passenger delay, for the synthetic equipment used in the training of railway controllers by British Railways at their training school at Derby.

Gibbs has studied the transfer of manual skill between various tracking tasks. The interesting general result was that an unfamiliar and difficult version of a task which goes against everyday experience can give a training of value to a more familiar and easy version of the work, but practice on the easy task is not usually such a useful training for the more difficult task. Gibbs has suggested that there is probably an optimum level of difficulty for the training task in relation to that of the real task. More work is needed on this valuable idea.

VI. MOTOR PERFORMANCE

Hick has prepared a summary of the main variables to be considered when man is regarded as an element in a control system. Gibbs has shown, in studies of the optimal characteristics of control levers, that isometric
contraction of muscle gives a more rapid and accurate manual control than isotonic contraction; that is, a pressure control lever is better under certain circumstances than a displacement lever. The findings have indicated a possible theory of the way in which manual movements are controlled - in fact, how visual and proprioceptive data are used and integrated in the control of manual movement. The importance of kinaesthetic feedback in the continuous regulation of skilled response has been emphasised. Further investigations are planned to develop this new theory and also to give guidance on practical problems of machine design in the Services and Industry. The effects of time lags between visual and proprioceptive sense data are being investigated by Gibbs, and Shackel is comparing the relative advantages of finger, hand and arm movements in tracking. These researches are also of practical importance for the design of manual controls for aircraft and for guided missiles.

A start has been made at St. Mary’s Hospital, Colchester, on some investigations of motor performance during recovery from upper limb injury; Colles fractures are being studied in which patients in this preliminary work are being provided with progress records to see whether this affects the rate and extent to which they recover full movement at the wrist. (Mackworth)

VII. SICKNESS AND ACCIDENT STUDIES

At the request of the Treasury, Buzzard and Shaw have undertaken an analysis of absence under a scheme of paid sick leave introduced for Government industrial employees. After this scheme was introduced there was a sharp increase in sick absence and indeed the increase was greater than had been expected; absence more than doubled and reached an average level of about 12 days per annum. This analysis shewed that the increase was due mainly to longer absences of four weeks or more, which accounted for two-thirds of the whole. The rise in sickness absence was marked in all age groups. A distinct and striking difference was found between workers who received incentive payment and those who did not. Workers on piece work and other incentive systems had a relatively lower sick absence rate. Shaw has suggested one possible modification of some such sick pay scheme. Under this proposal the workers would contribute throughout the year a sum equal to one week’s sick pay. The employer would contribute an equal sum. The panel doctor’s certificate would be adequate for this contributed sick pay, but sick pay after the first two weeks would be dependent on the opinion of the factory doctor. (in an establishment of 1,000 workers it is estimated that this would work out at an average of little more than one such case per day.) The authority of the factory doctor would be confined entirely to the issue of sick pay, and the opinion of the sick worker’s own doctor would be final on the question of whether or not he should return to work. Once a sick worker had exhausted a fortnight’s pay within the year he would have a two week’s gap to bridge in any later illness in that same year before he again drew benefit - subject again to the factory doctor’s assent.

Shaw is now undertaking an analysis of accident returns of some 4,000 accidents notified to the Port of London Authority during 1951-52. The intention is to provide some basic data on the main factors leading to dockside accidents from observations taken on actual cargo handling process. Shaw has prepared a new method of coding these records in order to indicate, for example, the dock areas, processes, equipment and types of
This accident survey will draw attention to any particularly dangerous situations in cargo handling and may lead on to more detailed experimental studies of particular processes and equipments.

VIII. NEW DEVICES AND PROCEDURES

Several equipments have been produced for the timing and recording of events. Gregory has devised and constructed a multichannel printing chronograph with the help of Cunningham. Each channel is identified by a letter of the alphabet which is printed on the recording paper every time a signal arrives. This time of arrival is itself also printed directly in numerals on the record paper to the nearest 0.1 seconds. A small portable six-channel version of this device has been built by Cunningham and Gregory and is now being produced commercially.

For more accurate reaction-time measurements, Davidson and Gibbs have developed an instrument capable of measuring time intervals to the nearest 0.001 seconds. The apparatus consists of three cold cathode counting tubes (Dekatrons) and a Post Office counter and it will count pulses from a 1000 cycles per second oscillator. Hick has designed an electronic device which automatically gives a series of randomly distributed time intervals of a given average length. This average duration can readily be altered within a wide range.

Davidson has built a cardiochronograph which presents in a series of vertical lines the time intervals between successive heart beats. Davidson is using this equipment to study startle effects from gun blast at H.M.S. Excellent.

Davidson and Carpenter have designed a standard variable speed equipment for experiments requiring a variable speed drive. This has been of particular value in the construction of equipment for speed and load studies by Conrad and Mackworth.

Cunningham has built two large multiple-belt equipments for the presentation of quickly changing visual data and many special devices for the experimental car.

Considerable progress in photographic methods of recording human performance has been achieved by Simmonds in the experimental car researches, in studies of patients with limb injuries and also in recording factory workers on light manual tasks as well as in eye-movement photography. Simmonds has, in addition, worked on procedures to study the expected visibility range of the batsman on an aircraft carrier under various weather conditions.

Bilney has devised a pressure control lever using carbon piles to give zero voltage output in the central position and positive or negative voltage output to left or right. Bilney has also produced a free-moving control lever in which two potential meters differentially connected on coixion spindles will give a large change in resistance for small radial movement. Both these types of control can be operated by arm, finger or head movements, Bilney has also designed an apparatus to sample quickly changing voltages as rapidly as four times per second. This will automatically summate the squares of these readings.
Publications.

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