FACTORIAL ANALYSIS AND ITS BEARING ON 
SELECTION AND PLACEMENT OF WORKERS IN 
THE TATA IRON AND STEEL FACTORY, 
JAMSHEDPUR (INDIA) - FIRST SURVEY. 

By

BAUSBH DHR.

MAIN LIBRARY

April, 1947.
## CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Development of Factorial Analysis and its Bearing on Industrial Selection and Placement</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>The Tata Iron and Steel Company, Jamshedpur.</td>
<td>28</td>
</tr>
<tr>
<td>III</td>
<td>Classification of Jobs</td>
<td>79</td>
</tr>
<tr>
<td>IV</td>
<td>Sampling Human Traits</td>
<td>116</td>
</tr>
<tr>
<td>V</td>
<td>Tests: Their Formulation and Try-Out</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>(A) A Critical Estimate of Data and Constructive Plan for Second Survey</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td>(B) Interview</td>
<td>159</td>
</tr>
<tr>
<td>VII</td>
<td>Training</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Bibliography</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Planning an Intelligence Test for Adults</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Group Intelligence Test Forms A. and B., Draft I and Draft II</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Facility Value of Test Items Forms A. and B. (Draft II) and Selection of Test Items</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Group Tests - Verbal Intelligence, Modified Beta, and Aptitude</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Histograms and Rotation of Axes</td>
<td></td>
</tr>
</tbody>
</table>
I am most grateful to Professor C.H. Thomson for the encouragement I received from him while in India, and to both him and Mr. B.D. Misselbrook for advice and suggestions during my residence in Edinburgh.

My thanks are also due to Professor J. Dreyer for the interest he took in my research, to Mr. W.C. Emmett for training me in Statistical work during the summer vacation of 1946, and to the staff of the Department of Psychology.

BANSI DHAR.
I.
DEVeLopment of factorial analysis
AND ITS BEARINGS ON INDUSTRIAL SELECTION AND PLACEMENT

"There is no search for timeless, spaceless, population "less truth in factor analysis; rather it represents a simple "straightforward problem of description in several dimensions "of a definite group functioning in definite manners, and he "who assumes to read more remote verities into the factorial "outcome is certainly doomed to disappointment." - Truman L. Kelley.

The credit for initiating the mathematical treatment or "rationalization" of the results of tests administered to a fairly large group so as to subsume them under certain heads, in terms of loadings, goes to Professor Spearman. These heads were designated Factors and were supposed to enter in varying measure in the different tests of the battery. It was further believed that the mental reaction, occasioned by the tests, could be described in their terms. This is undoubtedly a good mathematical device. The crux of the problem is: Do the factors have any psychological significance? It is this aspect which has occasioned a long drawn out controversy among the psychologists.

The position of Spearman may be summed up thus:
If we take a number of "sufficiently dissimilar" tests and administer them to a large population, the intercorrelations can be arranged into a hierarchical order and the tetrad differences will be or tend to be zero. According to Spearman this tendency is universal and points to the invariable presence of a general factor which runs through all the cognitive tests. When this general factor has been taken out what is left in each test is specific factor.

In /

1. Factor Analysis - Holzinger & Harman - Univ. of Chicago. 1941. p.3.
3. In this system of coefficients the values steadily diminish from top to bottom and from left to right.
In an article which he contributed to the British Journal of Psychology before his death, he reviewed the
the measure of recognition that his theory had gained from
different quarters. The following were the chief sources of confirmation:

(1) Brown and Stephenson tested about 300 subjects and administered no less than 20 tests. Their finding was:
"The whole of this immense material - with two small and
explicable exceptions - was found to satisfy the hierarchical
conditions admirably." Brown who was sceptical of Spearman's theory in 1910, remarked: "The main purpose of our research
has been achieved, namely to establish Prof. Spearman's theory
of two factors on an adequate statistical basis."

(ii) Then came the contribution of Alexander in 1935.
He wrote: "In Spearman's tests of 'g' we have measures of the
"common factor, not merely of a battery of tests, but of the
"whole cognitive sphere. That being so, we are more than
"happy to accept the existence of 'g' as meaning the existence
"of 'the common intellective factor'."

(iii) In 1942 Holzinger and Swineford showed the factor 'g'
to possess the desired stability and consistency in full measure.

Spearman concluded by saying: "It ('g' factor)
"presents at least the cardinal statistical characters -
"definiteness, comprehensiveness and stability which are
"indispensable for the purpose of science,"

The next important step was to interpret this
statistical entity 'g'. Spearman had studiously avoided
describing it in the early stages of his investigation. He
interpreted /


5. In conclusion, it may be stated that the results of the
present research, so far as they have been yet worked out, are in some conflict with Spearman's theory and
to some extent confirm Thorndike's view upon the nature of psychical correlation.

6. Intelligence, Concrete and Abstract.
interpreted the 'g' in 1904 thus: "All branches of
'intellectual activity have in common one fundamental function
(or group of functions), where the remaining are specific
'elements seen in every case to be wholly different from that
'in all the others." 7  Reviewing his work in 1927 he critically
examined the various proposed explanations, psychological and
physiological, and was unwilling to bracket it with intelligence.
"This bare title, indeed, carries us no great way, seeing that
'the word intelligence has no definite meaning."
8 The recourse
to power of attention, as advocated by Burt9 and Garrett,10 was
rejected as the expression was ambiguous. It may mean "some
conation or effort of will" or its meaning may be taken as akin
to that of mental energy as advocated by Woodrow. But conation
or effort of will may imply intensity of conation, that is,
success is very closely connected with volitional control, i.e.
"The most successful testee is he who can most effectively dis-
pel all distraction caused by other matters."11 Altogether
Spearman was disposed to reject the conative explanation of 'g'
but was favourably inclined towards the interpretation of 'g'
as mental energy. He discussed at length this hypothesis in
Chapters VIII and IX, in its philosophical, physiological and
psychological aspects, and came to the conclusion that it fitted
the facts "as a glove does the hand."12 And to the
dissentients his rejoinder was that they should salve their
conscience "by only saying that the mental phenomena behave
'as if' such an energy existed."12 The engines through which
this energy made itself felt he described as S's.

In

10. Ibid. 1919, x. p.156
11. The Abilities of Man, p.89.
12. Ibid. p.135.
In his article published posthumously in 1946 he reviewed his earlier interpretations and added that "the presence of the spatial factor and that of a high 'g' tend to go together."\textsuperscript{12a} And he came to the conclusion that in spatial perception two psychological processes are intrinsically involved, viz., synthetic and analytic. In the synthetic operations "figures (or their constituents) are mentally grasped" in larger units (sometimes called wholes). In the analytic, occurring simultaneously, the attention is directed from one element of the figure to the other. And this latter, being a noogenetic process, that is, the process of discovery or educing relationship can be attributed to 'g'. And the greater this analytic capacity the greater the possession of 'g'.

His final conclusion, his swan song, is that "'g' is essentially characterized by the combination of noogenesis and abstractness."

We may sum up the interpretation of 'g' by Spearman thus:

1. 'g' is mental energy.
2. This energy is operative in noogenesis which consists in:
   a. The apprehension of one's own experience, that is the power to observe what goes on in one's mind;
   b. The Eduction of Relations - when a person has in mind any two or more ideas (using this word to embrace any items of mental content, whether perceived or thought of) he has more or less power to bring to mind any relation that essentially holds between them. - This is what is presumably meant by abstractness as a characteristic of 'g'.
   c. The Eduction of Correlates - "On the presentation of an item, together with a relation, a person tends to conceive the correlative item."

\textsuperscript{12a} Intellectual Status at Maturity as a Criterion for Selecting Items in Pre-School Tests. By Katherine M. Maurer. Minnesota University Press, London; Geoffrey Cumberlege.

"... The best predictors are those tests involving perception."
He illustrates these three laws thus:  

I. Awareness of Experience.  
II. Reduction of Relations.  
III. Reduction of Correlates.  

The dotted lines indicate the contribution of "Neoegenesis".

We may now proceed to a discussion of the method employed by Spearman to work out the 'g' factor.

(i) The intercorrelations (see p.1) are arranged into a hierarchical order;

(ii) The tetrad differences of such correlations, if they are not zero, are explained as being due to sampling error. Spearman gives the following formula for it:

\[
P_E = \frac{1.349 \left[ r^2 (1-r)^2 + (1-R)s^2 \right]^{\frac{1}{2}}}{n^{\frac{1}{2}}}
\]

when \( R = 3r \frac{n-4}{n-2} - 2r^2 \frac{n-6}{n-2} \)

(iii) His next step is to analyse the matrix of correlations into a general factor and as many specific factors as there are tests. The loadings of 'g' factor in each test are used to obtain the correlation matrix thereof, which when subtracted from the original should give residues that are zeros or almost zeros. Whether it is invariably so or not we shall discuss later.

Spearman subsequently found that the tendency to zero tetrad differences was not so universal as he had hoped it to be, and the residuals were too large to be explained away by the formula of probable error. Hence group factors, "The very pucker of psychology," were brought in to account for deviations from the strict hierarchical order. These were the factors that ran through many but not all tests.

---

that is, they arose from an overlap of specific factors. He defined them as "those which occur in more than one but less than all of any given set of abilities; and were thus in fact the specific factor of an ability which was included in the same set with some other ability which also contains this element." However, Spearman and his school would resist their incursion as far as possible. And the remedy, in the words of Holzinger, was "we should seek tests that do not have an apparent degree of common specificity because the Su in one test is pretty sure to be correlated with the Su in a similar test."16

We can now proceed to a critical examination of the theory of Spearman.

(1) He insists on the homogeneity of the population, to which the tests are administered, with respect to age, training or sex for "only in such a manner, it would, it would seem, can any adequate explanation be afforded for the occasional occurrence of appreciable negative correlations."17

(2) Besides the three qualitative laws of Noogenesis, he enunciates five quantitative ones. The first qualitative law (see pp.4-5) working against the homogeneous environment of the material tested ensured similarity of approach by the group. And the tests, though "sufficiently dissimilar" were not drawn from fields beyond the ken of the average. If they were completely dissimilar the correlations among them in every case be zero or very nearly zero. In the correlation matrix at page 145 of The Abilities of Man there is only one figure that is nearly zero, and this relates to correlation between "completed /

"Completed Words" and "Drawing Length". In fact Spearman is indirectly pleading for the proper selection of what is described by modern logicians as the Universe of Discourse; and in spite of insistence on sufficient dissimilarity of tests they have a solid core of similarity in the sense that it is not incompatible for an average person in the group tested to perform varying combinations of the tests. The next step in the assessment of 'g' factor which is already assumed is to discover individual differences and the justification for the possibility of these differences is based on the quantitative laws:

(i) The Law of Spar?, according to which "every "mind tends to keep its simultaneous output constant in "quantity, however varying in quality."

(ii) The Law of Retentivity, involving the law of inertia, the law of dispositions, the law of associations, makes for differentiation among individuals.

(iii) The Law of Fatigue, that is, the tendency opposed to the occurrence of a cognitive process afterwards.

(iv) The Law of Conative Control which makes for control of the intensity of cognition by conation.

(v) The Law of "Primordial Potencies" which implies that age, health, heredity, the effects of drugs, etc. have all their effect in varying measure in each individual.

These laws are universal, but their combined operation produces results which vary from individual to individual. They enable us to measure quantitatively the qualitative differences of Hecogenesis.

In conclusion, both the philosophy which almost unconsciously actuates Spearman's investigations and the technique /

18. Like Spearman, Bradley and Bosanquet also hold that "knowledge is inherently confined to relations and "that neither relations nor their terms could stand "by themselves". - Bernard Bosanquet, 1848-1923: Proceedings of the British Academy, Vol. XI.
technique that he evolved made for the supposed discovery of a Common Factor. To the extent that some specifics in a bunch of tests tended to have something in common, after the contribution of 'g' had been removed and allowance made for sampling errors, Spearman grudgingly admitted the possibility of a few group factors.

This position of Spearman is open to certain serious objections. As Thomson is the most representative and the most consistent critic of Spearman, we shall state his criticism and then express our own views. He does not question the laws enunciated by Spearman, nor does he disfavour the insistence on the homogeneity of the material to be tested. He too favours the dissimilarity of tests, within the framework of the environmental background of the subjects. His criticism is directed against the exaggerated claims that Spearman makes for his technique and to the interpretation that his unconscious philosophical prepossessions led him to place on his results. He takes Spearman's Correlation Matrix of "sufficiently dissimilar" tests and proves statistically that what is supposed to be the loading of 'g' can be accounted for equally well by the group factor theory or even by Chance overlapping among the tests.

As for the potentiality attributed to 'g', he contends that an equally satisfactory hypothesis is to suppose that it resides distributively in the brain cells which operate through the formation of certain constellations. Thomson's approach is an extremely objective one. He would not posit a mental entity the presence of which is after all speculative. He relies upon the physiological study of the human brain and suggests that the possible explanation of the zero tetrad differences when they occur is that "each test "calls upon a sample of the bonds which the mind can form and "that some of these bonds are common to two tests and cause their /
"their correlation." To Spearman's contention that "all abilities involve more or less g" his answer is, "with this view, the present author has always agreed, provided that 'g' is interpreted as a mathematical entity only, and judgment is "suspended as to whether it is more than that." And this is the most reasonable position to take. Spearman has not been able to establish his mathematical technique as the only one in the field and to disprove and discredit the other technique which resolves the same correlation matrix into group factors. In the circumstances the safest view to take is that g is a possible mathematical entity.

Another plea put forward in support of Spearman's theory is that of Parsimony of Hypotheses. If 'g' alone can account for the correlations among tests, there is no point in bringing in group factors. But we overlook these important facts, -

(1) The better opinion among the physiologists is that the brain does not respond to the stimuli as a whole and that there is functional autonomy among groups of brain cells. This is in accord with the theory of group factors as expounded by Thurstone.

(2) The positing of a universal 'g' factor is an addition to the widely accepted findings of the physiologists and the hypotheses based thereon. Parsimony of Hypotheses demands that a sweeping hypothesis like that of 'g' or Lashley's about the unitary functioning should not be accorded acceptance till the present hypotheses have been disproved.

(3)


20. Ibid. p.240.

21. Lashley's investigations seem to discountenance this view, but his work is not advanced enough to disprove the earlier hypothesis. The principles of 'equi-potentiality' and 'mass function' await verification which may be scientifically convincing.
(3) The magnitude of specific which we get when we use Spearman's technique as against that obtained when the date is analysed with the help of Thurstone's method.

In practice, the difference between Thomson and Spearman is this. Spearman admits group factors only when all other probable explanations, based upon his technique, have failed. He was driven in 1926 to the conclusion that "Among the exceptional cases where specific correlations and "group factors do become of appreciable magnitude, the four "most important have been in respect of what may be called the "logical, the mechanical, the psychological and the arithmetical "abilities." To these he tacked on "the ability to appreciate music" and the list went on swelling till his death on the 17th September 1945. In the words of Thomson, "the "theory of Two Factors has gradually extended the 'two' to "include, in addition to 'g' and specifics, a number of other "group factors, still, however, comparatively few." Thomson would use both the techniques, and as group factors are more helpful for purposes of classifying the Battery he would prefer them. But even then group factors are mathematical abstractions and, though they provide a signpost to the psychologist for further investigation, should not be identified with abilities residing in the mind. He warns us against the anthropomorphic tendency to reification. This is in conformity with the practice in scientific research.

The fact of the matter is that we must judge the interpretation of 'g' by Spearman in the light of his biographical details. He was dissatisfied with the idealistic solutions to the great philosophical problems mainly because they were entirely subjective. But he was anxious to arrive at some sort of solution about the mental substance.

And /  

23. The Factorial Analysis of Human Ability: p.15.  

Dimensions of Personality by H.J. Eysenck, Kegan Paul, London - 1968. Our position is very similar to that of Eysenck (1968) who regards factors as principles of classification.
And he did so with the help of objective tests and the evolution of an elaborate statistical technique. Yet he was carried away by his philosophical leanings, predominantly idealistic in his time, when interpreting the mathematical entity. Thomson would wish us suspend judgment and await the results of further investigation in testing and physiological psychology.

The latest position which is rather nebulous is that of the organismic psychology of Lewin and Allport. It stresses the unique nature of human personality which colours all human thought, feeling and performance. But the exact nature of this unique personality is a thought construct like $g$ and awaits further research. Murray's explorations are commendable adventures but are far from being conclusive.

On the statistical side Thurstone has been led to bring in a second order general factor in his interpretation of Factors in two of his latest investigations - Factorial Studies of Intelligence (1941) and A Factorial Study of Perception (1944). His conclusion in the first study was, "Each of the primary factors can be regarded as a composite of an independent primary factor and a general factor which it shares with other primary factors. The psychological interpretation of the general factor must be only tentative at the present time."25 In his second study he analysed the results of sixty tests and described one of the eleven factors as one which represented "the variance that is common to the primary mental abilities." Commenting on his interpretation he says: "This is probably a second-order general factor common to the primary abilities and it may be interpreted as Spearman's G."26 The expression "second-order" is significant. It denies 'G' the status it occupies in Spearman, but concedes the possibility of the group /

25. P.38.
group factors, some or all, coalescing in functioning. It may be argued that this concedes the main contention of Spearman, regarding the universality of 'g'. There is nothing to suggest this in the discussion of Thurstone. All that it implies is that group factors have a tendency to be cooperative in varying measures when tests are administered to a homogeneous group as the University of Chicago undergraduate volunteers. The snag about Thurstone's interpretation of group factors is that he considers them as constellations in the human mind. This is a position which is indefensible according to Thomson. We reserve a detailed discussion of this till we come to "Sampling Human Traits" (Chap. IV). However, as said at page 9 Thomson has no objection to investigating the possibilities of a mathematical entity like 'g'. But Thurstone is exceeding the bounds of objective knowledge when he speculates about the physiological counterparts of group factors.

This cautious attitude of Thomson has been the subject of criticism by Cyril Burt. He says "there is no mathematical difference between assuming only a single factor, varying continuously, and assuming an infinite (or indefinitely large) number of unit-factors forming a single homogeneous 'pool'. A bushel of wheat is still a bushel, whether we call it corn or insist that it is composed of innumerable grains."27 This criticism proceeds from a misunderstanding of Thomson's position which comes temptingly near Spearman's and yet ends in reservations which are tantalising to the speculative minds.

Thomson as stated at page 9 holds that the correlation matrix can be analysed in two ways, one of which enables us to get a 'g' factor and another to get group factors. Expressing his leanings for group factors as mathematical entities, he suggests that the functioning of the mind is more satisfactorily explained /

---

explained in terms of the formation of bonds\textsuperscript{28} than by any other speculative hypothesis about the mind as a whole. Burt's contention in effect is that if Thomson thinks of mental organization from below (i.e. cells), why not from above. And answering the question his way votes for the technique which would give us 'g' factor. Thomson holds that organization from above is not quite an established fact in physiology; and as mathematical technique is only a handmaid to working out certain hypothesis in order to obtain verification, he would prefer the group factor technique. It is an objective statement of facts, extremely non-committal. Using the phraseology of Burt's metaphor, we can say that Thomson's position is that whether an infinite (or indefinitely large) number of unit-factors would form a single homogeneous pool is a proposition he would not commit himself about. Perhaps some of them may, and in highly developed minds quite a few. The analogy of "a bushel of wheat" used by Burt is logically untenable for the simple reason that the cell in the brain is a unit in a sense which is very different from a grain of wheat. The grain does not tend to form bonds with other grains as the cells do. The organization of mind is a process which probably proceeds from below and is not imposed from above as the two-factor theory would suggest. Of the two probabilities this is the safest for purposes of further investigation.

Thomson sums up his difference with the two-factor theory thus: "The difference between the sampling theory and the two-factor theory is that the latter looks upon 'g' as being "part of the test, while the former looks upon the test as being "part of 'g'." Burt rephrases this:\textsuperscript{29} "If we take a set of "tests (or rather a set of processes tested by cognitive tests) and consider them in extension, we shall say that each of these processes /

\textsuperscript{28} See p.9.

\textsuperscript{29} The Factors of the Mind: by Burt. Univ. of London Pres 1940, p.160.
"processes is included in a wider class which is defined as "being cognitive; i.e., the special test-processes are included "in the same general class, labelled 'g.' If we consider the "same processes in intension, we shall say that the concept of "any particular cognitive process is a complex concept, which "contains as its generic constituent the notion of being "cognitive, i.e., the generic quality of 'g' is included in the "specialized concept of each tested process." Burt here makes two assumptions:

(a) 'g' means the same thing in both places in the statement of Thomson.

(b) The denotative and connotative interpretation of the predicate are the same and equally acceptable.

Thomson has not defined it and hence we have to interpret it with reference to the content in which he uses it. The statement occurs at page 281 of "The Factorial Analysis of Human Ability" in the section relating to the "Interpretation of g and the specifics in the Sampling Theory" and sums up his own views and those of E.L. Thorndike. Thomson's hypothesis is:

"If the hierarchical battery is composed of extremely varied "tests, which cover very different aspects of the mind's "activity, this fraction may be taken as being of the whole "mind - of the whole mind, that is, of an ideal man who can "perform all of these tests perfectly, and all others which can "extend their hierarchy. When we estimate a person's 'g' from "such a battery, we are deducing a number which expresses how "far that person is above or below average in the number of "these bonds which his mind can form." This, he goes on to say, "accords with Thorndike's view that "one mind is more intelligent "than another simply because it possesses more interconnections "out of which it can make patterns." Ostensibly 'g' is used here in a more restricted sense than in Spearman. It is not something which imposes organization from above, but is the symbol /
symbol to describe the range of interconnections which have developed and would enable a particular person to form varied patterns. The interconnections that would cover the whole mind can be conceived to exist in an ideal mind alone. And the ideal is always in advance of achievement. Thomson is using the first 'g' in his statement in the sense of Spearman, as a universal quality of the cognitive process, and the second in his restricted sense - that is, each test may enter into a group of interconnections with other tests and thus become a sharer in one or more groups.

Hence the first assumption of Burt is unwarranted. As regards the second assumption, the denotative view is too crude when scientific statements regarding qualities are concerned. And cognition is a quality. It is rather misleading to say that each of the processes tested is included in a wider class defined as being cognitive. This is a roundabout way of saying that each one has a cognitive quality. We may ask what is this cognitive quality. Burt would say Spearman's 'g' to which Thomson would demur. As discussed above he is using the expression 'g' in a restricted sense. As cognition, i.e. capacity to know, has a wide range and may extend from partial organization of things perceived to an all-round one in an ideal one. Thomson would say judge each man or group according to his or its performance. Thus the second assumption of Burt has no justification in the statement made by Thomson.

The expression 'g' as made out in the foregoing pages is used for the synthesis of certain group factors and stands for a mathematical entity, the real nature of which is a matter of merest surmise. We have discarded the notion of a universal synthesising capacity imposing itself from above. How many of the group factors can be combined, rather contribute towards the articulation of a whole, will depend upon /
upon the gravitation of the bonds\textsuperscript{30} involved and the degree of gravitation will depend upon the innate strength of neurones and the environmental influences which make varied interconnections possible. Some of these bonds, says Thomson, "may be inherited, some may be due to education."\textsuperscript{31} We do not posit any constellations in the brain as the physiological counterpart of group factors.\textsuperscript{32} What we mean is that the group factors are symbols for describing what, from the physiological point of view, would be interconnections of bonds. The expression 'gravitation' is used to describe the potentiality in the bonds to interconnect. Thomson warns his readers against a swing to the other extreme - brain atomism. "There is no implication that the combined action of a number of them is the mere mean of their separate actions. There is no commitment to mental atomism."\textsuperscript{32} The possibility of the mind working as a whole is accepted, but its universality is disputed. The phenomena of multiple or double personality, dissociation in dreams or obsessions, testify to the correctness of our position. One of the important bearings of Thomson's hypothesis on our thesis is that in the formulation of tests for the factory and the treatment of the scores, we need have no prepossessions about discovering an all permeating 'g'. No test, if it is found effective, is to be thrown out for negative correlation with the supposed test of 'g' by which we often mean a verbal or non-verbal test of intelligence. In fact we have a field in industry where the validity of the two views can be discovered in the most profitable manner. If we could assemble a battery of tests which correlate highly among themselves and relate to verbal, spatial and certain other outstanding abilities largely needed and /

\textsuperscript{30} In Thomson's usage they stand for neurone arcs on the bodily side.

\textsuperscript{31} The Factorial Analysis of Human Ability: p.271.

\textsuperscript{32} Ibid. p.271.

\textsuperscript{32} See p.25 but as the counterpart of attitudes, symbolically represented by group factors.
and developed in the factory and could validate it. We could later attempt an expansion of it. We go on adding tests which have a high correlation with proficiency in different grades and then determine how many of them would correlate significantly positively with the original battery. The process is bound to be a long drawn out one, but is the best empirical way of verifying the two theories in a practical field.

We have accepted 'g' as a symbol of synthesis of abilities, in varying measure the physiological hypothesis of Thomson regarding the formation of bonds which the tests sample. 33 "Development", says Brooks, "consists not only in the modification of traits, but also in their integration." 34 and this succinctly sums up our view. Having indicated what we mean by 'g', we may now profitably discuss some of its characteristics. It is rather unfortunate that 'g' has been confused, in spite of Spearman's earlier disclaimation 35, with Intelligence. And as the confusion still persists we shall use the expression intelligence in the discussion that follows in our sense of 'g'. Even Spearman tended to mix up the two. Writing his autobiography in 1932 in "A History of Psychology in Autobiography" Vol. I, he says, "the 'g' which is more or less accurately measured by every hothopotch of the tests (whether those of Binet or any others) reveals itself to consist really in our noegenetic ability to educe relations and correlates." 36 According to Dr. Meili and Mlle.Schapira 37 the

---

33. See page 9.
35. "In the last act, the truth stands revealed, that the name (Intelligence) really has no definite meaning at all; it shows itself to be nothing more than a hypostatized word, applied indiscriminately to all sorts of things.' The Abilities of Man, p.24.
36. Ibid. p.326.
the four principal factors of INTELLIGENCE are Plasticity, Complexity, Fluency and Globalization. These characteristics are such as can easily be applied to the integrative process of the neural bonds. Without plasticity integration would be difficult, and integration implies complexity. To the extent that the mind attains synthesis of its abilities there is globalisation, that a certain mental set which emerges from integration and influences all subsequent thinking. The authors are well advised in describing the process of intelligence as "the ease with which relatively separate data can be united to form a single whole." This whole is not necessarily all comprehensive. Even Lewin, though an organismic psychologist, does not subscribe to this: "We have to do not with a single unitary system but with a great number of strong configurations, some of which stand in "communication with others, and thus form component parts of a "more inclusive weak configuration." Each of the configurations has the qualities of Plasticity, Complexity, Fluency and Globalization; and these configurations may themselves integrate into a higher unity in some persons. The quality of Fluency is described as "the ease with which one can abandon and discard a certain idea." And this is very important for purposes of adaptation.

We can now sum up our position thus:

(i) Test results can be correlated and mathematically analysed, according to the technique of the Two-Factor theory or the Multiple-Factor Theory.

(ii) We prefer the technique of the Multiple-Factor theory for group factors are more helpful as pointers in a psychological investigation of traits than the philosophical g Factor Theory.

(iii) /

(iii) These group factors are mathematical entities but enable us to frame hypothesis regarding the mental processes or human traits which could be asssessed by the tests in respect of a particular group and environment.

(iv) The possibility of a 'z' factor in a limited sense is not ruled out.

(v) The best method to verify the two hypotheses (generally described as theories) is to begin with a highly correlated battery of tests for some fundamental traits needed in the factory workers of a particular class and to validate it. This battery should be enlarged by adding other tests which correlate highly with proficiency and then to find out their intercorrelations with the nucleus of tests we started with. We may now proceed to a discussion of the broad methods used in Factor Analysis and indicate the reasons for our choice of the one proposed to be employed by us.

The following methods deserve mention:

(i) The Methods of Spearman and Holzinger. They aim at reproducing the original correlation by one general factor. This factor is adequate only when the tetrad difference criterion is satisfied. As stated before, the tetrad differences are not always within the chance range of zero. The device adopted or advocated by Spearman was that of "purifying" which, at its best, is a dubious one and may, hints Cureton, be better described as "purging". Consequently Tyron in 1932 and Emmett in 1936 came to the conclusion "that there was no statistically satisfactory evidence for the absence of group factors from any large battery of tests described in the literature." The attempt of Brown and Stephenson.

---


Stephenson described at page 2, is flawed by introducing the device of purging. They dropped two tests out of 22 "because 20 is a sufficiently large number for our present purpose." And later on one other test was dropped because it was responsible for large tetrat differences, the facile justification being "at worst it is no sin to omit one test from a battery of so many." However, Spearman himself paved the way for the recognition of multiple factors by making increasingly greater allowance for group factors.

Holzinger's bi-factor technique is an improvement on Spearman's method inasmuch as it retains a large general factor but places a greater emphasis on group factors. His method is to remove the general factor and then to find out the tests which have significant residual intercorrelations among themselves and zero correlation with other tests. Such a cluster is analyzed mathematically to get a group factor. Thus Holzinger's technique helps us to obtain a general factor, group factor or factors, and factors specific to each test. Such a technique makes it imperative to make as happy a choice of variables as possible. Here experience and technical insight alone can guide us aright. In the words of Holzinger and Harman, "these should be chosen so as to measure the aspects of the group which are significant for a particular problem, i.e. the set of variables should be valid as a whole." This method helps us later in identifying the underlying factors. Where technical experience is not rich enough to hit upon such a hypothetical design of variables, the authors suggest the employment of "B- Co-efficient or Coefficient of Belonging." It is defined as times the ratio of the average of the intercorrelations of a subset or group of variables.

43. Factor Analysis to 1940; by Dael Wolfle. Univ. of Chicago, 1940, p.9.

variables to their average correlation with all remaining variables. These group factors may be considered to be fractional factors.

This is also in effect the technique of Alexander. He makes use of the Centre of Gravity Method of Multiple Factor Analysis as expounded by Thurstone in "A Simplified Method of Multiple Factor Analysis" (1933). His variables have been deliberately selected with a view to bringing into operation certain abilities which he wants to assess. When the factors have been obtained, he rotates the factorial matrix with certain definite assumptions based upon the planning of his tests. He picks out the test which has the highest loading in 'g' factor and zero in the others, say F.II Verbal and F.III Performance. The factors are rotated in pairs, say I ('g' Factor) and II (Verbal). The loading in Factor II (Verbal) is made zero and then the highest possible loading for 'g' is obtained by finding the square root of the communality for the Test. This test is then brigaded with other tests and the loadings of 'g' obtained.

Next he picks out the test with a high loading of V and by subtracting from the communality the square of the loading of 'g' factor, previously obtained, he gets a remainder the square root of which gives the loading for V factor. Other tests are then brigaded with it, after deductions have been made for the new 'g' factor loadings in both the tests. Thus he obtains loadings under Factor II(V) for all the tests. It is then an easy transition to work out the third factor. The communality due to the new loadings of 'g' and 'v' is then subtracted from the communality for the whole test and the remainder gives the loading for the third factor. Thus Alexander obtains a rotated set of loadings in which all the tests have 'g' saturation, but of the Verbal and Performance Tests.

Tests the Verbal ones have zero or low loadings under F.III (Performance) and the Performance ones under F.II (Verbal).

But both Holzinger and Alexander proceed with the assumption that 'g' is omnipresent - a postulate we do not subscribe to.

(ii) Next in order, according to Dael Wolfe, are the methods of Hotelling for discovering principal components by working up to the actual communalities and Thurstone's method of Principal axes. Thurstone's method consists in so locating the first axis or coordinate that "it accounts for the maximum possible fraction of the variance of the distribution of scores." The second axis is then placed at right angles to the first" and is made to account for the maximum amount of the remaining variance. The process is repeated till all the scores have been accounted for by the new method.

(iii) This last method of Thurstone is a prologue to his present method of using the centroid method and then obtaining a simple structure. He makes use of guessed communalities or reliabilities in the diagonal cells of the correlation matrix, not that they are very satisfactory but because they make the process of analysis faster. Perhaps the method of Principal Components, but for its tedious length, would be more satisfactory. The genesis of Thurstone's method may be traced to Burt, who first employed it to obtain a single general factor. But Thurstone gave it a complete form; and developed an after process.

47. Burt's Group-Factor Method & Kelly's method, assuming the existence of general, group and specific factors may be placed under this class.
48. Factor Analysis to 1940. Univ. of Chicago, 1940, p.10.
49. i.e. Centroid Method as opposed to Averoid. The Averoid method consists in employing the average correlation for each variable as the estimate of communality.
process by which the Centroid Factors could be rotated so as to get rid of the negative loadings and obtain simple structure. By simple structure is meant a configuration of the rotated factors which gives to each one an independent setup in the sense that it has the highest loadings in a particular cluster of tests, the other factors having zero or negligible loadings. Thus certain well marked constellations stand out. By Constellation, Thurstone means, "a grouping of trait victors" i.e. some trait which is predominantly assessed by the test vectors which form the cluster for the trait in the simple structure. But a simple structure is not unique if the clusters along the arcs are thin, e.g. along BC.

In the words of Thurstone, "there are no test vectors along the arc AC or along the arc BC. The five test vectors near C may be regarded as identical except for experimental errors. It is for this reason that the primary traits A, B, C, cannot be inferred with certainty." To be unique we should have "a more extensive test battery which includes tests along AC and along BC." The great mathematical contribution of Thurstone was to develop a technique for obtaining a unique structure which makes the factors obtained psychologically significant inasmuch as they provide a clue for investigation in the laboratory to isolate certain traits, so far as human traits can be isolated, and then to devise suitable tests. This is what Thurstone himself suggests: "the rough factorial map of a new domain will enable us /

52. Ibid. p.169.
53. Ibid.
"as to proceed beyond the factorial stage to the more direct "forms of psychological experimentation in the laboratory." 54

We therefore propose to adopt Thurstone's technique of factorial analysis and rotation as the latest in the field and psychologically most helpful as suggestive of hypothesis. Nor does this procedure preclude us from inferring the possibility of a 'g' factor if we have good reasons to name one of our factors as concerned with generalization of certain abilities. We plan to start our survey by devising our tests in a manner that, having regard to their texture and the subjects to whom they are administered, they should tend to overlap. The results of these tests would lead on to a second survey in which we shall widen the scope of the battery and have "sufficiently dissimilar tests" which correlate high with proficiency. We would then be in a position to find out whether the tests which correlate high with proficiency, meaning thereby above 60, would correlate high or low or partly high and partly low among themselves. It would then be possible to state empirically whether Spearman or Thurstone's theory is most helpful to a testing programme in the factory.

The usual plan, as recommended by Hull and others, is to assemble a battery of tests with low correlations among themselves and then to administer it to a group of workers and to correlate each test with proficiency. Only such tests as correlate low among themselves and high with proficiency should be retained. This, to our mind, is rather a tedious process and we know of no case in which this ideal has been achieved in an industrial concern. We therefore place a nucleus round which to build up a battery which includes only such tests as correlate high with the proficiency of workers who are accepted by the management to be efficient. Whether some /

some of these tests would correlate low among themselves we
leave an open question.

One of the objections against tests which correlate
high among themselves is that all of them measure the same
traits, or much the same traits. We submit that this is
correct only to a measure, for psychologically if the tests
cover all the important aspects of an occupation and are
administered to a select group marked out for its proficiency,
most of them would intercorrelate high. This would only
show that the subjects are persons who have assimilated all
the important requisites of their job and integrated them
with reference to the needs of their occupation. It should,
however, be borne in mind that tests in such cases would be
drawn up with special reference to a particular environment.
An atomistic treatment of the traits is possible, though not
always desirable, even in an industrial concern. If a test
relates as exclusively as possible to one particular trait
which, though needed in some degree in occupation X, is not
very much in demand for the efficient discharge of duties
(e.g., fluency in writing English for Furnace Foreman), the
chances are that its intercorrelation with other tests, like
manual dexterity or reaction tests would be low. We see no
reason why we should administer such tests in a factory where,
given a certain minimum of intelligence and aptitude, it is
the qualities of personality, as developed as possible, which
are most needed.

There are two aspects of human activity as we find it
in the Tata Iron and Steel Co., Jamshedpur.

(1) Activity on the part of the worker to get on
successfully. The first requisite for this is the possession
of a certain amount of mental alertness and capacity for
adaptation /

X See "Intelligence, concrete & abstract" by W.P. Alexander,
p.148 - "..... These tests are measuring what may be
called a functional ability, a unity in a sense, but not
in the sense that these factors are unities .......... The
abilities so found are not independent of one another."
adaptation as we find it in the most efficient hands of the particular grade for which a person is an applicant. Tests, performance, verbal or non-verbal, are devised and validated with reference to a select group to determine the degree of their qualities in an applicant within a short time.

(ii) The capacity to develop a behaviour pattern which would promote profitable working of the factory. This will minimise internal conflicts and enable the management to increase the output and improve its quality to face competition in the markets of India and abroad. The first step to this is occupational analysis (see Chapter III) against a sketch of the actual operations in the factory. The second is to find out some important qualities of personality in the efficient workers which the management would expect the new entrants to develop. We have used the word "develop" and not "possess" because the qualities of personality are the result of environmental influences in the factory and certain dispositions, partly inborn and partly acquired in the course of upbringing. While the psychologist has to diagnose the disposition of an applicant as well as he can, the management cannot absolve itself of the responsibility to foster the qualities of personality, acceptable to it, by creating the necessary environment. Thus training within industry and social and health services are as important as psychological testing. As in the cognitive sphere so here we hope to discover certain factors which may enable us to investigate the nature and the process of development of the personality qualities considered desirable by the management in the different grades of workers.

These two aspects of human activity in the factory must click together. Kelley very aptly describes them as

(a) /

55. i.e. i and ii.

(a) a constellation of capacities and traits, and (b) a constellation of environmental stimuli; and it is in the harmonious functioning of these two that the success of the undertaking lies. The problem of personnel selection is a great experiment in analyzing and predicting about human nature. Little work has been done in this direction so far in the Tata Iron and Steel Company. The few tests employed have not been validated. Nor is there any plan in the gradation of jobs. And so a lot of spade work has to be done in the first survey before we can make a profitable use of Factor Analysis and discover the cognitive and affective factors which will enable us to describe different grades of workers in psychologically meaningful terms. However, a beginning has to be made and this thesis is an attempt in that direction; and it would have its sequel in the evolution of the most predictable criterion which consists in discovering what combination of the former (the individual with his endowments and attainments) and what combination of the latter (the social milieu with its requirements and tolerances) leads to the highest correlation for each individual, and further, what other independent combinations of the former with the combinations of the latter are correlated? 57

Genesis and Development of the Factory

The factory owes its beginnings to Sir J.N. Tate (1829-1904). Jamsetji Nusurwanji Tata was born in 1839, joined the Elphinstone College, Bombay, and passed out as "Green Scholar". His eldest son, Dorabji, was born in 1859; and the second, Ratanji, in 1871. Jamsetji Nusurwanji rose from humble beginnings and came to have large shares in the Alexandra Mill, the Swadeshi Mill and Advance Mill. Adventure was in the blood of the Tatas; and when in 1882 he saw a "report on the financial prospects of iron working in the Chanda district" by Ritter von Schwarz, a German expert, his curiosity was aroused and gradually he evolved a plan for the exploitation of the iron ore resources of India. In 1899 General (then Major) R.M. Mahon's report was published. He contended that Calcutta or its neighbourhood would be the best site for iron and steel works and he laid down three principles for the guidance of would-be enterprisers:

1. The plant of the works must be thoroughly modern in every detail;
2. The management should consist of persons "combining expert knowledge with local experience";
3. Economy in collecting and assembling the raw material would have to be insisted upon in order to secure a return upon initial outlay.

This year Lord Curzon issued revised rules for mining and prospecting. In 1900 Sir Jamsetji was in England and discussed the question of prospecting with Lord George Hamilton. Consequent upon this, prospecting work was started in the Chanda district, under the direction of Mr. Shapoorji Saklatwala, a nephew of Sir J.N. Tate. Dorabji was now forty and was taking an active part in his father's trade ventures. He went
to see the Chief Secretary of the Government of Central Provinces in 1903; and while waiting for an interview stepped into the Nagpur Museum. Here he happened to examine a geological map of India and found that the Drug district near Raipur, about 140 miles from the Chanda area, had large deposits of ore. He then discovered the report of Mr. F.K. Bose which said that the area suffered from one handicap - the difficulty of obtaining coal. Mr. Bose had retired from the Department of Geological Survey and was in the employment of the Maharaja of Mourbhanj. The Maharaja extended an invitation to the Tates for prospecting and they responded to it. And thus, through chance and coincidence, the Tates fixed upon the present site of the factory. Mr. Bose's survey revealed the possibilities of vast iron ore deposits in the Gurnmaishini Hills (2964 ft. above sea level - 23°17' Lat., 83°16' Long.). An agreement was arrived at between the Maharaja and the Tates. The Maharaja allowed them to take ore for the first three or four years without any royalty and then to pay a royalty beginning at half an anna (about 1/2) per ton and gradually rising to eight (about 8d) per ton. The average royalty worked out to 3½ annas (about 3½d) per ton over a term of fifty years. The lease covered an area of 30 square miles. Such were the humble beginnings of the factory. The Tates got access to two important mines, Okampad (22° 10' Lat., 86° 7' Long.) and Badampahar (22° 4' Lat., 86° 6' Long.). Messrs Julian Kennedy, Sahlin and Co. were appointed construction engineers. Mr. Sahlin landed on January 31, 1903. The site chosen was Sakchi. The coal was to be brought from Jherria. The water supply was assured by the close proximity of the Rivers Khorkai and Subarnrekha. The first stake was driven on a plateau on February 27, 1903; and the actual construction of the plant was begun in the autumn of 1908. The first iron was made on December 2, 1911.
Within these 35 years the factory has grown into huge dimensions; and today the iron and steel works at Jamshedpur is one of the biggest works of its kind in the world. The following table shows the various products of the works during the year 1936-37:

<table>
<thead>
<tr>
<th>Products</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphuric Acid</td>
<td>8,158</td>
</tr>
<tr>
<td>Coal Tar</td>
<td>25,063</td>
</tr>
<tr>
<td>Sulphate of Ammonia</td>
<td>5,763</td>
</tr>
<tr>
<td>Coke</td>
<td>778,360</td>
</tr>
<tr>
<td>Pig Iron</td>
<td>327,077</td>
</tr>
<tr>
<td>Ferro Manganese</td>
<td>10,124</td>
</tr>
<tr>
<td>Steel Ingots</td>
<td>850,591</td>
</tr>
<tr>
<td>Steel Blooms</td>
<td>701,793</td>
</tr>
<tr>
<td>Steel Billets</td>
<td>244,216</td>
</tr>
<tr>
<td>Steel Slabs</td>
<td>61,734</td>
</tr>
<tr>
<td>Steel Sheet Bars</td>
<td>136,042</td>
</tr>
<tr>
<td>Steel Tin Bars</td>
<td>73,822</td>
</tr>
<tr>
<td>Steel Hoe Bars</td>
<td>2,497</td>
</tr>
<tr>
<td>Steel Sleeper Bars</td>
<td>19,896</td>
</tr>
<tr>
<td>Steel Heavy Rails</td>
<td>84,029</td>
</tr>
<tr>
<td>Steel Light Rails</td>
<td>1,660</td>
</tr>
<tr>
<td>Steel Heavy Structures</td>
<td>77,475</td>
</tr>
<tr>
<td>Steel Light Structures</td>
<td>46,709</td>
</tr>
<tr>
<td>Steel Heavy Bars</td>
<td>3,455</td>
</tr>
<tr>
<td>Steel Light Bars and Ties</td>
<td>103,334</td>
</tr>
<tr>
<td>Steel Fish Plates</td>
<td>2,880</td>
</tr>
<tr>
<td>Steel Plates</td>
<td>50,499</td>
</tr>
<tr>
<td>Steel Black Sheets</td>
<td>116,960</td>
</tr>
<tr>
<td>Steel Plain Gold Sheets</td>
<td>92,190</td>
</tr>
<tr>
<td>Steel Corrugated Gold Sheets</td>
<td>70,295</td>
</tr>
<tr>
<td>Steel Sleepers</td>
<td>12,118</td>
</tr>
<tr>
<td>Steel Crossing Sleepers</td>
<td>1,071</td>
</tr>
</tbody>
</table>

High though these figures, there is room for considerable improvement. The products are hardly enough to meet the needs of the India of today which is getting industrialised fast. To make this improvement possible, the Tates will have to recruit a staff that is as capable as the wide choice, open to them, can make it possible. As it was, the lower ranks were filled by people lacking in abilities for higher duties. Seniority being one of the most important grounds for promotion, the intermediate, and some places in higher, ranks are occupied by people who do not pull their weight. The two factors that have hampered the most efficient working of the factory are: (i) lack of an organized plan in its development; (ii) putting a premium on the length of service /
service and patronage of the dependents of the employees. The number, therefore, does not imply proficiency of the workers,
particularly in the lower and intermediate ranks. We give below figures for 1937-38 as the emergency arising out of the
War (1939-45) made it imperative not to disclose facts and figures about the factory which was declared a protected area -
a very likely target of the Japanese bombing.

| Superior Supervisory Staff | 115 |
| Other | 679 |
| Total | 794 |
| Clerks | ... | ... | ... | 1,425 |
| (Men) | 23,797 |
| Work People | (Women) | 2,478 |
| (Children) | 180 |
| (Office boys only) | ... |
| Total | 28,674 |

To improve the quality of work of such a large body of workers we have to develop a well informed technique of selection and promotion; and as an aid to it must introduce cumulative records for deciding cases of promotion and making provision for the general and technical education of those already in employment. A detailed discussion of these must await the conclusion of this first survey.

The Plant and its Operations

Our immediate concern is to take stock of the existing jobs from the technical and psychological points of view, i.e. attempt occupational analysis and then devise some sort of tests to make a first survey. Now occupational analysis presupposes a general acquaintance with the main features of the plant and its

1 It must be borne in mind that the Tatas enjoyed the benefit of Protection - the Steel Industry (Protection) Act, 1924, and Act No.III of 1927.
Cf. Sir Jehangir Ghandhy's (Agent, Tata Iron & Steel Co.) warning: "The first factor is the possibility that we may have to meet competition from some of the foreign countries whose iron and steel capacity has considerably expanded during the war, and which in their search for outlets for their surplus capacity may be constrained to turn to India." - Tisco Review, June 1945, p.45.
its operations. And this we attempt in broad outline. We confine ourselves to those principal departments which smelt iron ore, convert pig iron into steel and manufacture blooms to be rolled or moulded into different kinds of finished products. These are (i) blast furnaces; (ii) open hearth and the Bessemer plant; and (iii) the blooming mill. We illustrate the interconnection among them below.

Department of Blast Furnaces
- Iron ore, coke and limestone. (Brought from the quarries and stocked in stockyard, hoisted to the top of the furnace with hoist.
- Sections concerned Highway Line and Stockyard)

Blast Furnaces (Stack, boshes, crucible.
- Shaft
- Section concerned Cast House) — Pig Iron

Iron to Foundry
- Pig Iron to Open Hearth. Converted Pig Iron to Bessemer Plant. Use of Converters into ingots.
- Under a Superintendent. Superintendent.

Ingots
- To Stripper yard. They are taken out of the moulds by electric cans and then placed into Soaking Pits — furnaces which are heated by Producer Gas. — Ingots are then taken to Blooming Section where ingots are made into blooms by a process of cooling and pressing or rolling.

Each Department for finished products is under a Superintendent. We leave them out.

Two things are needed to make this diagram self-explanatory. — (i) The hierarchy of workers in the Blast Furnaces, the Steel Making Shops and the Blooming Mills. (ii) Their function in the actual operation. It is in the light of (i) and (ii) that we shall proceed to a discussion of the technique of job analysis (see Chapter III) and then formulate our tests of the cognitive ability of the workers of the highest grade to obtain a norm for our selection (see Chapter /
(i) The following is the hierarchy of workers on the operation side in the three departments under discussion here:

**Blast Furnace**
1. Superintendent
2. Asst. do.
3. General Foreman
4. Shift do.
5. Furnace do.
6. Keeper
7. 1st Asst., Keeper
8. Cinder Snapper

**Open Hearth**
1. Superintendent
2. Asst. do.
3. General Foreman
4. Shift do.
5. First Hand
6. Third Hand
7. Fourth Hand
8. Spoonman

**Bessemer Plant**
1. Superintendent
2. Asst. do.
3. General Foreman
4. Shift do.
5. First Hand
6. Third Hand
7. Fourth Hand
8. Spoonman

**Blooming Mill**
1. Superintendent
2. Asst. do.
3. General Foreman
4. Shift do.
5. Asst. Mill Foreman
6. Sheer Recorder
7. Number Taker

**Converter**
- General Foreman
- Shift Foreman
- Steel Blowers
- Converter Regulator
- 1st Converter
- 2nd Converter
- 3rd Converter
- Converter Khalasi Foreman
- Converter Khalasi Foreman, do.
- Converter Khalasi Foreman, do., Special
- Converter Khalasi Foreman, do., Special, do.
- Converter Khalasi Foreman, do., Special, do., Recorder
- Transferman

**Soaking Pit**
- Head Heaters
- Asst. do.
- Spare do.
- Soaking Pit Recorders
- General Foreman, Bottom Making
- Foreman, Bottom Making
- Bottom Makers
- Khalasís (Bottom)
- Ash Pit Khalasís
- Matiné
- Coggers
- Manipulators
- Control Drivers
- Spell Hands

Each
Each of these departments has a mechanical side as well. This is responsible for general maintenance and repairs and works in cooperation with the operational staff. Besides these services, each department has a number of auxiliary services which help it in its running. These are as important as the operational side. We give below a tabular statement of these:

### Mechanical Side

<table>
<thead>
<tr>
<th>Department</th>
<th>S.M.S. I</th>
<th>S.M.S. II</th>
<th>New Blooming Mill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast Furnace</td>
<td>Mechanical Foreman</td>
<td>General Foreman</td>
<td>General Foreman</td>
</tr>
<tr>
<td>Asst. Mech. do.</td>
<td>Asst. to General Asst. Foreman</td>
<td>Foreman</td>
<td></td>
</tr>
<tr>
<td>Side Car Mistry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rolling Stock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift Foreman</td>
<td>Shift Foreman</td>
<td>Shift Foreman</td>
<td></td>
</tr>
<tr>
<td>Head Rigger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift Mistry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitters</td>
<td>Fitters</td>
<td>Fitters</td>
<td>Fitters</td>
</tr>
<tr>
<td>Fitter Helpers</td>
<td>Fitter Helpers</td>
<td>Fitter Helpers</td>
<td>Fitter Helpers</td>
</tr>
<tr>
<td>Relief Helper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Tender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material Chaser</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rigger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spare Riggers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welder</td>
<td>Welder (gas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welder Helper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blacksmiths</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spare do.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oilers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hammerman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spare do.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Checker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mochi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>S.M.S.I</td>
<td>S.M.S.II</td>
<td>New Blooming Mill</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------</td>
<td>----------</td>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Blast Furnace</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine Driver</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drillers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mistries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>24. Splasher Mistry</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>25. Gas Burner do.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>26. Moulder</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>27. Pyrometer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>28. Stove Cleaner</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stock House &amp; High Line</strong></td>
<td>I. Pitside</td>
<td>Bottom House</td>
<td></td>
</tr>
<tr>
<td><strong>29. Stock House Foreman</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>30. Lorry Driver</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>31. Control man</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>32. Stock Ho Khalaasi</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>33. Ingot Delivery Man</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>34. High Line Foreman Steel Pourers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>35. Asst, High Line Casting Mates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>36. High Line Khalaasi</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>37. Relief Man</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>38. Traffic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>39. Traffic Foreman</strong></td>
<td>L. Crane Chargeman</td>
<td>GAS HOUSE</td>
<td>GAS PRODUCER</td>
</tr>
<tr>
<td><strong>40. Yard Foreman</strong></td>
<td></td>
<td></td>
<td>Shift Foreman</td>
</tr>
<tr>
<td><strong>41. Head Ladle Chaser II</strong></td>
<td></td>
<td></td>
<td>Gas Makers</td>
</tr>
<tr>
<td><strong>42. Stock Yard Foreman</strong></td>
<td></td>
<td></td>
<td>Coal Khalaasi</td>
</tr>
<tr>
<td><strong>43. Shunter</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>44. Diesel Loco. Driver</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>45. Diesel /</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blast Furnace</td>
<td>S.M.S.I</td>
<td>S.M.S.II</td>
<td>New Blooming Mill</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>----------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Diesel Loco. Cleaner</td>
<td>Stockyard Recorder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slag Dump Mate</td>
<td>Weighment Recorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slag Dumper</td>
<td>Stockyard Mates</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tar Mixer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shunting Jamadar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III. Gas Plant</td>
<td>General Foreman</td>
<td>Pit side</td>
<td></td>
</tr>
<tr>
<td>General Foreman</td>
<td>Shift do.</td>
<td>General Foreman</td>
<td></td>
</tr>
<tr>
<td>Coal Pit do.</td>
<td>Sample man</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal Pit Mates</td>
<td>Steel Pourers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Khalasies</td>
<td>Stopper Maker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash Mates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage Cleaners</td>
<td>Gen. Khalasies Foreman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV. Cal. Plant</td>
<td>Stripper Yard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.P. Foreman</td>
<td>Gen. Foreman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.P. Mates</td>
<td>Shift do.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number Takers</td>
<td>Recorders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour Force Mates Khalasies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steam Crane Jamadar</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traffic Staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General Foreman</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shift Foreman</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gunners</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jamadars Loco. &amp; Cranes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coupling Porters</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L. Crane Charge man</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L. Crane Khalasies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traffic Recorder &amp; Pointsman.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Workers: Their Function in Operations

(a) Blast Furnace. The Traffic section referred to at p.35 is under the charge of the Traffic Superintendent whose principal duty is to be in touch with the station staff of the B.N. Railway Station at Tatanagar and to arrange for the despatch of wagons bringing raw material to the stockyard. His position is that of a liaison officer and he therefore acquires a working knowledge of the railway rules, particularly with relation to traffic of goods and the tact to get things moved as quickly as possible by inducing the railway staff to offer the best and heartiest cooperation. He gets the raw material sent on to the factory and here the High Line Foreman (see under Blast Furnace p.35) on duty takes charge of the wagons; and it is his duty to see that they are emptied at the earliest in the appropriate bins and returned to the railway station for being sent on to the quarries with promptness. The raw material obtained is distributed to the stockyards of five blast furnaces. The High Line Foreman is assisted by an assistant in his shift. The actual emptying of the wagons is done by the High Line Khalasies who get into the mundas (open trucks), open the bottom and let the raw material run out, shoving it off from the corners to the centre. They are clever with the movement of their feet and where an inexperienced person would slip into the openings they go about their job with sangfroid. They are provided with relief hands who assist them and in course of time learn the jobs themselves. The raw material, iron ore, coke and flux, having been stored in the bins, the next step is to get it moved in the necessary proportions to the top of the blast furnace. The Stockhouse Foreman (see p.35 under Blast Furnace) is responsible for this during his duty hours 2400-0300; 0800-1600; 1600-2400. He has under him the Control man, stockhouse khalasies and the lorry driver, and is responsible /
responsible for the coordination of their work. The lorry
driver takes the lorry under the bin and draws the required
amount of raw material, gets it weighed, and then delivers it
to the skip hoist. He has the stock indicator fitted in his
cabin and knows the amount of material that is already in the
furnace. The proportions of the raw materials are received
from the Sales Department or the Steel Making Plant. The
General Foreman of the blast furnaces sends the specifications
both to the Cast House and the Stockyard for action.

The most important section is the Cast House which is
under the charge of Shift Foreman, whose duty hours are
0800 to 1600; 1600 to 2400; 2400 to 0800 in rotation. A
Shift Foreman (see p.33) is a necessity for the Tatas because
the activities of five blast furnaces have to be coordinated;
and he is the person who possesses both expert knowledge and
experience and is present at the time of tapping. But the
actual hour to hour work at each furnace is in the charge of the
furnace foreman. He is responsible for the maintenance and
repair of the furnace, is to keep himself informed about the
condition of the stores, the amount of the material in the
furnace, the hour when the charge is likely, and has to
regulate blast and thereby temperature according to the quality
of the pig iron to be manufactured. To the chemical knowledge
needed for the job - and he is a graduate in Chemistry or
Metallurgy - he must add power of quick observation. It would
be a great help to the understanding of the duties and
responsibilities of the furnace foreman and his subordinates if
we describe the mechanism of and the operations in a Blast
Furnace. It has generally three parts - the stalk (or shaft),
the boshes, and the crucible. The raw material is dropped at
the top and passes into the shaft through a bell and hopper
arrangement. This prevents the gases from escaping into the
atmosphere and they are conducted by offtake pipes to the
combustion stores where they are burnt, cleaned of the dust
particles /
particles and then past a refractory checker work. Air is passed through this checker work and is heated to the temperature needed for the blast and is then blown into the crucible of the furnace. The furnace foreman has to see that of the four stoves attached to his furnace, three are on gas and one on blast. These stoves are in charge of the stove tender who arranges, through the khalasies under him, for the combustion of gases. This is done through an automatic arrangement and does not require any special skill. Experience gives him the necessary training in regulating the flow of air into the checker work. He then blows it out at the temperature required by the furnace foreman. One of the most important duties of the furnace foreman is the regulation of the temperature of the blast when there is a change over from one stove to another. But this does not require the exercise of any special gift or talent. The stove tender should not be either slothful or slovenly in his performance. In short he must be quick to react to varying conditions of temperature requirements and energetic in the discharge of his duties.

The furnace foreman keeps himself informed both of the temperature of the stoves and that in the furnace. The latter is measured by the Pyrometerman.

The raw material charged on the top descends through the shaft in the course of nine hours to two or three days to the furnace. Its movement downward is calculated by the furnace foreman and the record is kept on a prescribed form to enable the relieving furnace and the shift foreman to keep track of it. In the course of descent, the oxide of iron is reduced to the metallic state by COA in the ascending hot gases from the charge in the crucible. Limestone serves as a reducing agent.

A. CO is liberated from limestone which is charged along with iron ore by the skip hoist. The third substance charged is coke which generates heat to melt both limestone and iron ore.
reducing agent. In the course of the descent carbon, silicon, manganese, phosphorous, sulphur, etc., get into the metal. When
the charge arrives in the vicinity of the tuyeres the consumption of coke begins in an appreciable measure. Here
the oxygen of the air blown (the blast rushes at a speed of
200 to 400 miles per hour) combined with the carbon (of the
coke) and produces CO, and the resulting heat causes the fusion
of the metal. From now onward the furnace foreman has a very
special responsibility - the regulation of the heat of the
blast, and the determination of the degree at which the molten
metal and slag could be tapped. This gas CO, plus the nitrogen
of the air and hydrogen from the water vapour in the air blown,
become the reducing and carbonizing agents. As the material
in the lower strata melts, the upper strata with a temperature
of 400° to 500° C., descend. When the charge reaches a
sufficiently high temperature zone the reduction of iron begins.
Finally the slag comes to the top and blankets the pig iron.
It is then drained off through the notch cinder by the cinder
snapper whose skill lies in boring the hole which has been
sealed with bricks. The furnace foreman is of course present
and supervises the operation. The shift foreman and the
general foreman may also be present. The slag runs down the
runners to the ladles on bogies which are hauled to the tip, and
is discharged when molten by turning over the ladles - a job for
khalasies. When the molten metal is in a condition to be
tapped

B. By reducing agent is meant the chemical substance which
has the property to liberate metal from chemical
combination.

C. Tuyeres are hollow pipes. Ten to sixteen of them are
distributed symmetrically above the upper circumference
of the hearth, and their function is to provide passage
for the blast. They also determine the height to
which the slag in the furnace may rise.

D. See p.39 for the blast from the stove.
tapped the furnace foreman, along with the shift foreman (consultation between the two in the matter of the farthest limit of reduction possible in the furnace is desirable), directs the keeper to open the tapping hole with the iron bar, hammer and gas cutter. Proper provision has to be made for the protection of hearth jacket at this point with a water cooled plate, called the Dam Plate. In the course of tapping, the metal structure directly above the tapping hole is protected with a splasher. Any lack of cooperation between the maintenance and the operation sides would be detrimental to efficiency; and hence the furnace foreman should be persuasive enough to obtain the willing and unstinted cooperation of the Mechanical side. The runner-men get the runners ready and the molten metal is run into the ladles on bogies for transport to the foundry or Open Hearth or the Bessemer plant. The runners are metal castings in the form of deep troughs. They are so buried that their top edges are flush with the surrounding floor of the Cast House. As the cinder hole is at a higher level than the tapping hole, the runnersmen have to keep the runners for the slag elevated and the passage from the cinder hole to the slag ladle is uninterrupted. The runners for the metal are at a lower level. Beginning as a deep trough at the tapping hole, they are interrupted at a distance of about ten feet by the skimmer, which is a device for separating the metal from the slag that comes near the end of a cast. Thus the runner-man has quite a busy time when the metal is running out. He has to keep the flow on proper lines. He has also to give the troughs a heavy coating of a loam or clay wash which acts as an insulator, protecting the trough from the hot metal and facilitating the subsequent cleaning up.

The

2. Technical qualification and training at the Institute give them the necessary equipment. The most important thing about them is the possession of the qualities of industry, coolness of mind (emotional stability), self-confidence and Leadership on all occasions and during breakdown in particular.
The Traffic Section (see p.35 under the Blast Furnace) arranges for the movement of ladles on bogies to either the slag dump or to the foundry or the steel making shops. The Traffic Foreman receives the necessary instructions from the Shift Foreman who is instructed by the Superintendent, through the General Foreman, where the metal is to go. The drivers are engaged in working the locomotives. As the ladles have to travel back and forth from one department to another, there is a head ladle chaser with ladle chasers under him. The Head Ladle Chaser works in the general shift 0070 to 1130; 1330 to 1700; and the ladle chasers in shifts 0030 to 1600; 1600 to 2400; 2400 to 0800. Their job is to keep track of the ladles and have them in readiness to receive the slag or the metal at the different cast houses, and there are five of them in this department (Blast Furnace).

This completes the description of the Cast House and its accessories. But the furnaces must be maintained in good working condition; and it is the mechanical section which does it. It works in collaboration with the Operation Section. The dividing line between the two is often very thin; and it is inevitable when the distinction is more a matter of administrative convenience than one based on the intrinsic difference in the nature of jobs. Men on the Mechanical Side are mostly capable of work on the Operation Side, but practice has given them greater proficiency in their own jobs. The same might be said of the people on the Operation Side. The Mechanical Foreman (see p.34 under Blast Furnace) is responsible for the maintenance and repairs of the furnaces and works in the general shift. He gets the plant examined almost hour-to-hour through his subordinates and arranges for repairs when there is a fear of breakdown or is a breakdown. His principal function is to supervise the routine work of his subordinates.
subordinates, arrange their duties and make a detailed report of the repairs to the breakdown to the Engineering Department to which he is subordinate. The charge being large and heavy he is assisted by one or two assistants according to the variation in the volume of work. As on the Operation Side so here there are shift foremen working in different shifts 0000 to 1600; 1600 to 2400; 2400 to 0800, and their duties change from week to week. The shift foreman arrives a little before the beginning of his duty hours and takes over charge, making note of any special repairs needed for the efficient working of the plant, and takes stock of the situation by going round. He contacts the shift foreman in the Cast House and the traffic foreman. On the Rolling side, his duties are performed by the rolling stock foreman who arranges for the repair and maintenance of the rolling stock. There are mistries, i.e. mechanics, under him who repair the bogies and the cars which carry the scales falling from the ladles. The principal staff under the Mechanical Foreman consists of: riggers, fitters, water tender, welder, blacksmith, hammerman, time checker, cobbler, splasher, mistry, gas burner mistry, moulder, pyrometer-man, and stove cleaner (see p.34 under the Blast Furnace).

Riggers have the nimbleness to climb the chimney or any structure at a very high altitude to do ordinary repairs and cleaning. They do not possess any technical skill worth special mention, unless we consider the steadiness of feet and the coolness of mind as skill. Sometimes there are casualties, but their number is very small. These men are generally drawn from the Province of Bombay where they had occasion to do similar jobs on big boats, cargo and otherwise. There is a man at the head of each group, and the Mechanical foreman passes his instruction to him.

Another important subordinate rank is that of Shift mistry who is responsible for the repairs and maintenance of the /
the plant. He must see during his shift hours that bolts are not loose, that dam plates are not overheated, etc. He has under him fitters whose job is to screw up bolts, fix up plates and beat other articles into shape. His tools are the shifting spanner, boilmaker's hammer, boring machine and drills, steel punches, a brass or steel measuring rule, spirit level, a number of cold steel chisels, square and compass, files, green pumps, hacksaw, blades and callipers. The work requires the assistance of some other persons in the manipulative operations and so there are fitter helpers. The material chaser assists them by getting the necessary parts with which he is expected to have a fairly close acquaintance. There are welders in each shift to weld and blacksmiths to shape material with the help of hammermen. Besides these the moulder attends to the ladles which carry the ingots and is responsible for providing runners; the splasher liner cools the moulds of ferro-manganese, the gas burner mistry attends to the repairs of the combustion chamber in the stoves, and the stove cleaner removes the dust of the furnace gas after it has been cleaned and burnt. The oiler oils the various machines, the cobbler provides leather washers and mends the boots of the workers, the pyrometer man fixes and removes the charts of the temperature and the load of the furnace; and the time checker records the hours of the arrival and departure of the lower staff in the shift. This completes the picture of the mechanical section of the Blast Furnace.
We may now sum up the main features of the Blast Furnace in a diagram:

(b) Steel Making Shops

We now proceed to the discussion of human factor in relation to the operations in the Steel Making Shops (II). It is necessary to have a general idea of the composition of pig iron before we can discuss with understanding the different operations in the S.M. shops. In addition to iron, pig iron contains varying qualities of carbon, silicon, manganese, sulphur and phosphorous. These constitute about 10% of the weight and 25% of the volume of the pig iron. Carbon may be present to the extent of 3.0 to 4.5 per cent, having been dissolved into the iron from coke. Silicon, got from the earthly matter, ranges from 0.4 to 5.0 per cent, phosphorous from 0.02 to 2.0 per cent. Sulphur enters the iron from the ore and the coke and must be kept as low as possible, 0.02 to 0.2 per cent, being the usual limits. Steelmaking iron must be made low in sulphur. The amount of manganese varies from 0.2 to 2.0 per cent.

The principal concern of the steel making shops is to reduce the impurities to the measure needed for the manufacture of different grades of steel. "Steel is essentially
"essentially an alloy of iron and carbon .......... steels for structural purposes contain up to 0.65% of carbon, while from 0.65 to 1.7% is used in springs and tool steels. Above 1.7% carbon the metal is no longer steel, but is approaching the composition of cast and pig iron." This process of elimination is attempted in the Tatas in the Open Hearth and the Duplex Plant.

Open Hearth: The Department is under a superintendent who, as the discussion of the chemical processes above would show, is an expert in metallurgy and has both training and experience in the process of eliminating the impurities in the pig iron to convert it into the steel of the desired grade. He is in the general shift 0730-1130 and 1330-1700 and is liable to be called upon any moment if his presence is necessary because of breakdown or some other unexpected happening. He is responsible for the effective organization of the work of the department in a manner that the output is the greatest possible, labour is contented and well cared for, and the general foremen are active in their supervision. He must have the adaptability to adjust himself to varying situations, e.g., shortage of men or breakdown at an hour when he would ordinarily go for his midday meal.

The superintendent is also acquainted with the necessary and relevant principles of Engineering. He has an assistant to help him and to him he delegates the preparation of returns in the office. The assistant himself is an expert and is consulted by the general foreman regarding the composition of baths and the problem of absentees in different shifts. Both of these superior officers are expected to go round the department on their arrival, if possible together, and take stock of the situation. They go round at the end of the duty hours in the evening and leave the necessary instructions with the shift foreman for any particular specification.
specification of steel to be made at night and assure themselves that the furnaces and their accessories are in proper condition and there is no likelihood of any trouble at night. They are expected to send every day the figures of output to the General Superintendent who, through the Statistical department, keeps a check on the diminution of output.

The General Foreman is mainly responsible for organizing shifts. He works in the general shift 0730-1130, 1330-1700, and must acquaint himself with the situation of the department on his arrival and make arrangements for labour shortage and see that the output does not fall below the average. The case of breakdown, if any, in the night, and the position of raw material needed and in stock, are brought to his notice; and he has to make the necessary arrangements for repairs and for obtaining steel scrap, cast iron scrap, ore, mill scale, lime, limestone, fluor-spar, ferro-manganese, silico-manganese, aluminium, dolomite, etc., which are needed during and for melting. Above all he must be a man who, besides the technical knowledge which he is bound to possess, has sympathy for, and understanding of the emotional make-up of the workers under him. Indian labour is extremely sentimental, and a certain percentage of men are often worried with the cares of family life or are addicted to drink or absent themselves on the slightest pretext. He must have the knack to tackle the grouter and must be prepared to plead the cause of the staff in his charge. His relations with the shift men must be cordial and he must have their willing cooperation.

As in the Blast Furnace, so here, the shift foreman (p.33) is a technical expert and is responsible for the working of furnaces in his charge. His main job is the coordination of work during his shift in such a manner that no furnace is short of labour and the raw material needed for the manufacture of different grades of steel in the various furnaces is constantly /
constantly available. He has also to see that pig iron for charging arrives in time and that the ingots are moved promptly. He controls the entire plant and has also to look to the gas plant which supplies gas for heating the furnace. He must be present when the bath is ready for tapping and is invariably consulted by the First Hand.

Besides the shift foreman there is a supervisor in each shift. He is a metallurgy expert and determines from the sample taken by the spoonman the amount of carbon in the bath. It is a practice that provides the necessary cue. The degree of carbon determines the surface tension of the metal. He is present at the time of tapping and examines the samples from the tapped metal and tenders his advice about carbonizing.

Now we shall describe the operation of an Open Hearth and indicate therein the duties of the staff concerned. Open Hearths are of two kinds: they are either acid or basic. This differentiation is based on the lining of the furnace.

The Basic Open Hearth is a rectangular structure of silica bricks bound together with internal plates and tie rods; and is made of basic refractory material. The furnace is in the charge of First Hand who is assisted by a Second Hand and by Third and Fourth Hands. He must see to charging and tapping and is an expert in regulating the volume of gas from the Producer Plant so that the bath may get rid of the impurities that mar its quality as steel. Pig iron and steel scrap are charged through the doors marked A by the charging machine. The First Hand receives the specifications of its chemical composition from the Blast Furnace and knows what chemical processes are needed to reduce or get rid of carbon, silicon, manganese, phosphorous and sulphur. The doors are closed and combustion starts as producer gas is passed into the furnace. The hot burnt gases leave the furnace at the opposite end. The temperature /
temperature of the furnace is regulated by the First Hand, assisted by the Second Hand. The charge takes 4 to 7 hours to get completely melted. During melting a certain amount of ore is fed into the slag "to maintain the boil and to continue the elimination of the carbon". It is either the First Hand or the Second Hand who determines the time and the amount.

During melting a certain amount of iron and silicon are oxidized by the atmosphere in the furnace, and it is from the oxides that slag is formed. It is through raising the iron oxide content of the slag that the First and Second Hands oxidize the silicon and the manganese and carbon in the bath. The desired degree of elimination is made possible by charging hematite ore. When the carbon approaches the desired value, some limestone is added to the slag. It is clear from this summary of the operations that the First Hand and the Second Hand must be experts in metallurgy besides the basic knowledge of engineering. They must be quick in their power of observing the reactions in the bath. The difference between the First Hand and the Second Hand is in their length of service. The Second Hand is in the process of getting trained to fill the responsible position of First Hand when there is a vacancy. The main duties of these two may be summarized as informing the machine operator of the amount of ore the charge would require, and how and where to place the various parts of the charge. They regulate the heating of the furnace; and the Second Hand is responsible for running off the slag. They direct any repairs necessary during the operation. The First Hand is under the supervision of the Supervisor or Melter. The furnace is tilted and the tap-hole is opened. The steel then runs down the lander into the waiting ladle. Blue overglasses are worn to protect the eyes from the blinding glare of the liquid steel. When the liquid steel has almost run out it is followed by the less brilliant slag.
slag from the top and this forms a covering blanket over the metal in the ladle. The determination of the degree of brightness which marks off steel from the slag is a matter of experience which the First Hand acquires in the course of his duties as Second Hand. The ladle is then tipped and the remainder of the slag falls into the pit below. When the liquid steel is in the ladle killing additions are added and also some powdered anthracite coal to bring the carbon back to the desired value.

The Third and Fourth Hands perform mostly work which may be described as manual labour in connection with the maintenance and repairs of the furnace and the placing and charging of raw material and other chemicals. In the course of these duties they pick up the technical skill required of the Second Hand and improve upon their experience by attending specific courses in the nightschool. They place the supply of dolomite, feed ore, fluor-spar, ferro-manganese and ferro-phosphorous at the places indicated by the Second Hand, and the solid recarbonizing additions on the platform convenient for charging into the ladle when directed or instructed by the Second Hand. They help him in digging the plug out of the tapping hole when the heat is ready to tap and assist him in making up the bank of the furnace before recharging and in the plugging of the tap hole. Further, they assist in relining the lander or steel spout after each heat, and clean up the surroundings of the furnace. Their assistance is most needed in 'fitting' the bottom of the furnace, i.e. repairing all damages to the bottom by throwing silica sand on the affected parts where slag has attacked the hearth. Any liquid steel or slag trapped in holes has to be splashed out with rabbles and the holes repaired with sand. This takes about one half-hour to one hour. Meanwhile the Second Hand is employed in making the tap hole with a plug of ganister mixed with crushed anthracite.
anthracite coal, and backed up with sand.

The duties of the other staff are not too onerous. The Spoonman takes samples from the bath when the heat is getting, or is, ready. It requires special skill to spoon the front part; the ladle must be inclined at a particular angle and the spot is located in the midst of the glare through the blue overglasses. He also charges dolomite when necessary.

Furnace khalasies do odd jobs like assisting in the heat test. This consists in shaking a square bar inside the furnace and then taking it out. The heat of the square bar is the measure of the temperature of the furnace. But mostly they are engaged in cleaning up the muck of which there is enough all round. The Mixer Foreman is a person with no special qualification. He belongs to the labour class, but through experience as furnace khalasí has acquired knowledge of, or skill in, guessing the weight of pig iron (fluid) that has to be mixed with scrap in charging the furnace. He has under him a staff of ordinary labourers who help in bringing the scrap and pig iron 'fluid) together.

Like the Blast Furnace, the Steel Making Shop (Open Hearth) too has its accessories: (1) Pit Side; (2) Gas Plant; (3) Stockyard; (4) Calcining Plant.

(1) Pit Side. The organization here as elsewhere consists of a general foreman at the top. He is responsible for the maintenance of the entire pit yard, i.e. the removal of the slag, the movement of ladles, the pouring of steel into the ingot moulds, supervision of the coordination of the working of the crane drivers with the workers in the Pitside responsible for pouring fluid steel into the moulds. He maintains the roster for the different shifts, working himself in the general shift 0730-1130; 1330-1700. He knows the weakness and shortcomings of Indian labour and knows when to tighten the screw. He is assisted by the shift foreman. But it is an easy
easy job to get team work done. Mutual jealousies and personal feelings of animosity for some advantage denied or promotion held back or slackness not condoned all tend to mar the efficient functioning of the organization. It is the qualities of leadership that are most needed in this job.

The most important job is that of a Shift Foreman who works under the General Foreman. He has to be in touch with the shift foreman in the Furnace section so as to know when the fluid metal would be ready for casting into the moulds, and when slag is to be removed. He keeps himself informed of the likely hour for the tapping of different furnaces and so arranges that the ladles have been emptied into moulds on bogies and the bogies have been moved into the Stripper Yard. At no step should there be any break in the chain to dislocate labour or occasion wastage. The qualities of personality needed in the general foreman are equally necessary for the shift foreman. One of the most important problems which he has to tackle is that of absenteeism, and much can be done if his personal relations with his workers are cordial.

There are three categories of these shift foremen: (i) Pitside Foreman; (ii) Casting Foreman; (iii) Pitside Khalasj Foreman.

None of these are people who have any technical training except such skill as the routine work may impart to an average worker. They are of course X-literate in the sense of being able to read and write in their mother tongue only. Some of them have just a smattering of the knowledge of English and the ability to do ordinary sums.

The Pitside foreman has under him the Pitside Khalasj foreman who is in charge of labourers and details them according to the orders of the Pitside foreman. They are engaged in removing the slag and muck and cleaning the pit and setting ladles in place for receiving the fluid steel.
In the movements of the ladles the Pitside foreman works in collaboration with the Loco Crane chargeman who is responsible for getting the craneman to operate the crane to lift the ladles when full or place them in position when empty to receive the fluid steel. The Pitside recorder is a clerk primarily to the general foreman and incidentally to the shift foreman to receive, and keep a record of, petitions from labourers.

The most strenuous job is that of Casting foreman. He has under him (1) steel pourers; (2) casting mates; and (3) ingot delivery man. In order to appreciate what the coordination of these jobs is like, we must have an idea of the ways adopted to transfer the fluid steel in the ladles to the moulds. The ladles are lifted by the crane and moved on to the top of the moulds standing on bogies. The top of the fluid steel is covered with slag which serves as a blanket and prevents the radiation of heat from the metal. The steel pourers work the lever which opens a hole at the bottom of the ladle and the fluid metal runs into the mould. He also advises the craneman to move on the ladle to another mould or away from the moulds if it is empty, or almost empty, or the slag is running into the mould. It is all a matter of routine and the steel pourers require no special skill except such as, given normal intelligence, they imbibe as labourers, assisting pourers. Casting mates are persons at the head of the gangs of labourers who clean the moulds. The ingot delivery man advised the stripper section of the time when the heat is ready for being tapped, or is being tapped, and despatches the moulds, after the metal has been poured into them, to the stripper yard. The metal, when it solidifies inside the mould, is known as ingot. The casting foreman is the person who coordinates the work of all these in a fashion that the operation of each section furthers the other and there is no waste /
waste of labour or time. Any delay in the casting section would hold up ladles and, may be, work in the stripper yard. In a big factory like the Tata works in Jamshedpur, where so many connected units function together and in conjunction, economy of time and quick despatch are of positive importance. Hence it is that there is a seeming multiplicity of foremen. Besides these duties, the casting foreman is responsible for the repair of teemers (ladles) and their safe transit and replacement.

II. Stockyard. It corresponds more or less to the Traffic section of the Blast Furnace - see pp. 35-37. Here the duties of the Traffic section are combined with those of the stockyard in the Blast Furnace, see pp. 35-37. The General foreman is in charge of receiving and issuing through the stockyard foreman of steel scrap and raw materials required for the steel making furnaces. It is a huge charge and the work is done through (i) stockyard foreman; (ii) assistant stockyard foreman; (iii) stockyard recorders; (iv) stockyard mates; (v) tar mixer man; and (vii) shunting jamadar. The stockyard foreman is responsible for receiving material and issuing to the furnaces. The stock recorders enter the receipt of the various items of raw material and issue it at the direction of the stockyard foreman, deputising for the general foreman. The stockyard foreman receives requisitions from the general foreman or his deputy shift foreman of the steel melting shop and passes order for the issue of raw material. He must examine the stock and check it up, both for its quality and the quantity issued and that still on hand. The assistant stockyard foreman is in charge of the scrap yard and supplies scrap to the furnaces (see pp. 38). The weighment recorders weigh the bogies as they convey raw material from the stockyard to the furnace; this is an easy process and almost a mere routine job. The bogies pass /
pass the weighment bridge and the gross weight is recorded. The tar is deducted and the weight of the raw material is found. Stockyard mates have under them labourers who move loads and unload raw material; and the shunting jamedar sets the line for the bogies and leads the cars on to the proper tracked for loading and for transhipment purposes. The tar mixer man works only in the general shift and does the routine job (unskilled) of preparing ferro-manganese charges, alloy steel nickel, etc., the proportion being given by the stockyard foreman. Of all the ranks discussed, the general foreman, the stockyard foreman and his assistant, have general knowledge of the intermediate standard or higher, and have acquired either from books or by experience enough knowledge of chemistry to understand the theory of chemical composition of the raw materials. Their jobs are mostly administrative and require in a fair measure the qualities of leadership adumbrated at pp. 96.

III. Gas Plant. The plant is intended to manufacture producer gas for the furnaces. As usual there is a general foreman who is in sole charge of the plant. He is a man with a lot of practical experience and some technical qualification, preferably a graduate in metallurgy. The gas is made by passing a mixture of air and steam through a bed of red-hot coke or ordinary bituminous coal. Enriched with volatile gases, it burns with a luminous flame. (See the sketch on the left hand page). The technical knowledge needed on the part of the general foreman and the shift foreman under him relates to the chemical action inside the producer. The carbon in the coal must be burnt to carbon monoxide. If there is any carbon dioxide, its presence would be a dead loss because it does not burn. One pound of coal should make 60-70 cubic feet of producer gas. The ash accumulates at the bottom of the producer and has to be removed from time to time. The gas is supplied to the furnaces in the Open Hearth.
As between the general foreman and the shift foreman, the latter is immediately concerned with labour and gas making, and the former steps in when an exigency arises. The main concern of the general foreman is to keep himself informed of what has happened overnight when he comes to duty at 0730, and then to plan for the next twenty-four hours. He has to see that the coal supply does not run short and the muck is removed. He maintains roster and settles minor disputes. The shifts foremen work in shifts, the hours of the shift changing every week.

The coal pit foreman is from amongst the labourers, senior in service and clever at handling men. He is concerned with unloading coal in the pit from the wagons and supplies it to the gas plant. He has gangs of labourers under him and each gang is under a mate.

Gas makers work under the shift foremen and look after the operations, described above, of two or three producers, each producer has khalasies (labourers with experience) to attend to its operations. The gas maker is one of the labourers who has shown himself to be clever in the understanding of the operations of the producer gas plant and possesses or has acquired ability to read and write. Thus the arrangement is like this: the shift foreman is in charge of the whole plant during his shift, and gets work done by the khalasies through gas makers who know the routine of gas production.

Ash mates remove the ashes and the drainage cleaners clean the drain. They are ordinary labourers with more of brawn than brain.

Another accessory to the Open Hearth is the calcining plant. The work does not require any special skill and the plant is manned by ordinary labourers.
Calcination consists in heating substances like limestone to a red heat to drive off carbon dioxide and moisture. The plant is in the charge of a foreman who supervises labour, arranges their shifts, sees to the firing of kiln, and supervises the charging of cupolas. A cupola is a vertical shaft furnace, into which the raw materials and fuel are charged at the top, and the burnt or calcinated material is tapped out at intervals from the well at the bottom. Air for the combustion of the fuel is introduced through one or more rows of tuyeres a short distance above the bottom. The charging of cupolas, that is getting material into another when those in hand have been put into operation, is supervised either by the foreman or his assistant. The division of duties is a matter of convenience from day to day and week to week.

Calcinating plant mates are labourers who rake the material in the cupolas; and the labour force mate is in charge of labourers who do odd jobs and carry head loads. The number taker is the shift clerk who keeps record of the material received and the material sent out.

The calcinating plant calcinates limestone and dolomite for the use of Open Hearth.

Lastly we have a mechanical staff which is in charge of maintenance and upkeep of the entire plant in the department. A comparison of the chart on pp. 34-35 would show that the jobs on the mechanical side are fewer in the Open Hearth than in the Blast Furnace. But whatever there are, they are the same as in Col.I, except that there are engine drivers who take moulds on bogies to the Stripper yard. Their job is to operate locomotive engines. These are mostly uneducated people who worked as firemen, cleaners, and then finally became engine drivers.

Instead of water tender we have waterman. He attends to the boiler, the water in which is heated from the gas.
gas from the Open Hearth furnace, and it is then allowed to escape. His work does not require any special skill except that the boiler has to be supplied with water. More experience of a few days at the job would train an unskilled worker of Class II in the duties.

Bessemer Plant (Duplex).

The difference between an Open Hearth and a Bessemer Plant lies in the fact that in the latter silicon, manganese and carbon are oxidized in the converter before the molten metal is charged into the furnaces. In the furnace the attempt is to eliminate sulphur and phosphorus. Thus the production of steel is expedited. As the process of removing impurities from pig iron in the liquid state was discovered by Bessemer, it is named after him. About half an hour or one hour in the converter and another five to six hours in the open hearth furnace, and the conversion of pig iron into steel is completed. Whereas an open hearth furnace will turn out an average of about 15 heats a week of straight running, the same furnace operated as a duplexing unit will produce about 40 heats in the same period.

Steel is essentially an alloy of iron and carbon, carbon bringing hardness and strength to the iron. But it must be kept down to a definite proportion. Steel for structural purposes contains up to 0.65 per cent of carbon, while from 0.65 to 1.7 per cent is used in springs and tool steels. Above 1.7 per cent carbon tends to deteriorate the quality of steel. In the Duplex plant, molten pig iron is stored in the 'metal mixer'. A mixer is a tilting basic open hearth furnace which is used to store hot pig iron as received from the blast furnaces. It is from this storage that the steel furnaces draw their supply. This procedure is convenient both to the blast furnaces and to the steel furnaces. The former tap pig iron according to their convenience /
convenience, and the latter have an ever ready supply of hot metal. The mixer is fired with producer gas or coke oven gas, i.e., the surface slag in the mixer is kept heated by burning either coal tar or the producer gas or the coke oven gas. The Mixer House staff is consequently not skilled staff. The necessary competence is acquired by observing the job for some time. The mixer men arrange for the firing of the mixer and receive the molten metal from the furnaces for storage. Skimmers distribute the stored metal according to the needs of the converters. There are a number of ordinary labourers called khalasies. The entire staff is under a foreman who is a senior labourer with capacity to read and write in his mother tongue and with the qualities of a leader to the extent that he should get the labourers do their jobs carefully and earnestly when there is work for them.

Converter. A converter consists of a cylindrical body of steel plates, mounted on trunnions (see opposite page), about which it is rotated by hydraulic power. The inside is lined with silica bricks and the bottom is pierced with tuyeres connecting with the windbox underneath.

To begin with the converter is turned down to receive the molten iron from the ladles which obtain their supply from the mixer. When the required quantity of iron has been poured in, the converter man at the converter gives a signal and the converter regulator gives the necessary warning and puts on air blast. This blows from the wind-box, through the tuyeres, into the converter. The latter is then slowly turned up so that the metal covers the tuyeres (see p.61) and receives the direct blast of air. The passage of the

---

3 On the charging side of the converters, the building is three-storied. The ground floor extends under converters and provides enough space for the removal of bottoms, slag, etc. The second floor is called the charging floor and is on a level with the trunnions. From this floor, molten metal from the mixer is charged into the converters. The third floor is called the scraping floor and all cold material is charged from this.
the blast agitates the metal and a shower of sparks is emitted from the mouth of the converter. The iron oxide (FeO) thus formed reacts on the impurities in the iron, removing silicon:

\[
\text{Si} + \text{FeO} \rightarrow \text{SiO}_2 + \text{Fe}
\]

For this process the molten iron should contain from 1.5 to 2.5% of silicon; with silicon less than 1.5% it will blow cold, and with more than 2.5% generate too much heat.

With the progress of the blow, a flame gradually appears at the mouth of the converter, and manganese begins to be oxidized. Here is the job for the steel blower. Some of the oxides of silicon, manganese and iron are ejected in the form of brown flames, and the remainder in the converter combine and form a slag which comes on the top. The process of elimination occasions flames of different colours, and it is by the shade of them that the steel blower determines the extent of the elimination of manganese and carbon. This is a skill which comes by practice and possibly some have native capacity for this discrimination. The chemical process (carbon, iron oxide → carbon monoxide + iron) is known as 'the boil', owing to the violent agitation caused by the escape of carbon monoxide from the metal. In the course of the boil large quantities of liquid metal and slag are ejected from the mouth of the converter and ultimately a white flame appears. It is from the luminosity of this flame that the steel blower determines the completion of the process of elimination. It should be remembered that the converter regulator adjusts the blow according to the directions of the steel blower who is finally responsible for the quality of the metal.

---

4 When the reaction starts in the converter, the flame is short and transparent red. Along with the increase in the oxidation process the flame becomes longer and whiter in colour. The time for oxidation depends upon the quality of pig iron used. As the process of oxidation approaches its end the flame becomes reduced in length giving an indication to the steel blower that his metal is ready. Then the blow is stopped.
metal in the converter. The entire process takes about twenty minutes and the flame suddenly drops. This is an indication of the fact that the carbon has been completely eliminated. The regulator turns the vessel down and shuts off the blast as soon as the metal is clear of the tuyeres. Silicon, manganese, and carbon have now been eliminated, but not sulphur or phosphorous. The converter man now adds a weighted quantity of pig iron to the metal in the converter. The carbon in the pig iron recarbonizes the molten iron, thereby giving the desired carbon content to the steel.  

The molten metal is now poured into ladles operated by jib cranes under the supervision of the converter man and transferred to the Open Hearth furnaces for the elimination of sulphur and phosphorous.

The staff of the converter consists of a general foreman who works in the general shift 0730-1130 and 1330-1700. He maintains the roster for the different shifts, makes a comparative study of the metal blown in different shifts and if there is any complaint against the operations he looks into it. He is responsible for the proper upkeep of the Bottom House (to be discussed later) and for the proper heating of the metal in the mixer. The machine of the converter and the blow house should be inspected each day on his arrival and he should be satisfied that there are no flaws and no chances of breakdown. He should apprise himself of the state of affairs at about 1700 and leave instructions for the night shift about any unusual pressure of work or about instructions from the works manager or general superintendent. The shift foreman deputizes the general foreman in his shift so far as the upkeep of the machinery, the coordination of work among the mixer house, the /

---

5In the Bessemer process the whole of the carbon must be eliminated from the iron and then put back in the necessary measure afterwards for the colour of the flame does not yet enable the steel blower to guess the extent of its elimination. He can only state when it is completely eliminated.
the converter with its blow room and the bottom house are concerned. His qualifications, generally a degree in Science and training in the Technical Institute, Jamshedpur, are the same as those of the general foreman. He is a junior to the general foreman and may in his turn become a general foreman. He must go over the works on his arrival and leave notes about the attendance of labour and the general condition of the plant for his successor.

The steel blowers are graduates in Science and have had in most cases two years' training in the Technical Institute where they learn the theory of steel making and are given practical experience of different plants under a supervisor. They are selected for the job from the ranks of converter regulators if they have shown efficiency in spotting the colours of the flame and thereby determining the elimination of manganese and carbon. Operating the machine for the tilting of the converter and helping the blower in maintaining the blast, converter regulators have a good chance to learn the higher job. The steel blowers are paid essentially for the quick perception of the shades of the colour of the flame and thereby determine the measure of the elimination of silicon, manganese and carbon; and the converter regulator regulates the blast according to the instructions of the steel blower. The two jobs are interlinked and both the Regulator and the blower operate from the same platform. They also supervise the blow room which supplies the blast, though there is not much by way of rectification of flaws as the work in the blow room is almost mechanical.

The converter men have three grades and are generally Science graduates, particularly those in the first and second grades. Their duty is to see that the converter is maintained in good condition and they have under them converter khelasies, converter recorders, and transfer men.
The hierarchy is like this:

<table>
<thead>
<tr>
<th>Position</th>
<th>Grade</th>
<th>Shifts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converter Recorder</td>
<td>(Man 1st)</td>
<td>0800 to 1600</td>
</tr>
<tr>
<td>Transfer Men</td>
<td>(Man 2nd)</td>
<td>1600 to 2400</td>
</tr>
<tr>
<td>Converter Man 3rd</td>
<td>(Grade)</td>
<td>2400 to 0800</td>
</tr>
<tr>
<td>Converter Foreman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Converter Khalasies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The converter men must arrive ten minutes before their duty and inform themselves about the condition of the converter. The first converter man is the coordinating link between the blower man and the converter regulator on the platform opposite (about 40 yards away) and looks to the operations preliminary to blowing on his side. He arranges to receive the metal from the mixer and marks out the converter which is in a condition to stand blowing. He signals when the metal has been poured and must be present during the blowing operations to attend to the trouble that the converter might develop. The second converter man arranges the necessary repairs to the converter after each blowing and arranges for the transfer of the metal when blown to the ladle, and he is also responsible for recarbonizing. The third converter man assists him in these operations, but is primarily concerned with the examination of the bottoms and their repairs through the bottom house staff. We shall indicate the importance of his job when we come to the bottom house. The khalasies under him examine the silica lining after each blow and he is also responsible for stocking pig iron for recarbonizing.

The converter recorders are mere clerks who keep an account of the metal got from the mixer and the metal which finally goes to the Open Hearth. They record the number of blows in their shifts and maintain attendance registers and stock registers of the raw materials. The transfer men are ordinary khalasies who have had some education and through long experience have become /
become capable of determining the quantity of slag in the material blown when it is transferred to the furnaces. The furnaces are of the revolving-tilting type. The contents of the ladles are poured into the furnace with a runner or the hot metal chute mechanically operated. Care is taken to reduce the passage of slag to the minimum. As the white colour of the liquid steel shows a change to red and the steady flow is broken up, pouring is stopped. The operation is supervised by the second hand steel melter.

**Furnaces**

The capacity of the furnaces in S.M.S.2 in the Tatas ranges from 200 to 250 tons and they take out 100-120 tons of metal at a time. The furnaces are heated with producer gas produced from coal (see p. 55). It is necessary to avoid coal inside the furnace for it is rich in volatile matter and this may occasion jamming of metal in the course of melting on the top of the furnace. The metal is heated inside the furnace from two to five hours, the period depending upon the nature of the blown metal and the quality of steel required. The operation is supervised by the first hand steel melter who is an expert in determining the amount of heat and the duration of boil for different grades of the blown metal to convert them into various kinds of steel. The most important part of the job is the elimination of sulphur and the adjustment of the percentage of carbon that will give the necessary strength to the steel. The second hand is responsible for the changing of the furnace and for tapping. He is the first assistant to the steel melter and has the same qualifications. Naturally he is anxious to help the first hand and imbibes the experience which the first hand should possess. The third and fourth hands have duties corresponding to the third and fourth hands in S.M.S.1 (see p. 57) and so does the spoonman. The job of the mixer foreman has been discussed earlier.
The accessories of S.M.S.2 are (i) Pitside; (ii) Bottom House; (iii) Gas House; (iv) Stripper Yard; (v) The Traffic Staff; (vi) Mixer House.

(i) The Pitside: the same as in S.M.S.1, see page 51.
(ii) Gas House: see page 55 as in S.M.S.1.
(v) Traffic Staff.—The same as in Blast Furnace, see pages 352-357. Gunners correspond to shunters; pointsmen set the points; coupling porters couple the bogies carrying ladles or detach them. The cranes are used for lifting ladles and for charging metal into the furnace. The crane drivers operate the cranes with electricity. The mere mechanism of the crane is not difficult to acquire, but the driver must be circumspect in running the crane with or without a load. He must give warning to the people moving about and getting into the way of the crane and may have on occasion to stop dead because some unwary walker has failed to pay attention to the signal. In short, he is a man with strong nerves and capacity for quick reaction. Most men can be drivers, but not all successful drivers. The crane is also used for charging the furnace; and the drivers acquire skill in manipulating the crane. The traffic recorder keeps record of the ingots sent to the stripper yard.

The most important section of S.M.S.2 is the Bottom House. It is mainly concerned with the upkeep of the bottom of the converter and is equipped with overhead cranes and buggies for handling bottoms. The wear on the lining of the converter is very severe, particularly at the bottom. Hence the bottom is made detachable, and is changed after every 15-20 blows. It is from 14-18 inches thick according to the size of the converter. The bottom contains the tuyeres (see p. 59), ranging from 8-30, and each tuyere contains 8-12 holes (3/8 - 9/16 in. diameter) through which the blast passes. When the bottom is changed, repair is also done.
done to the lining with silica bricks. The lining too has got to be changed after about 2,000 blows. The staff detailed for the Bottom House consists of firemen, khalasies, pan attendants and shift foremen. The shift foreman is in charge of the bottoms of all the converters and his duty is to find out on his arrival the condition of bottoms in the different converters. He gets into touch with the converter man and works under him. Besides arranging repairs and changing bottoms, he is consulted by pan attendants if there is any difficulty in changing the bottoms. His main asset is long experience of the job in various capacities. The pan attendant carries out the change with the assistance of khalasies (labourers) who bring the material, like brick etc., needed for the lining of the bottom. The fireman is concerned with the ovens where the round bottoms which require changing are dried. His only qualification for the job is long experience and a certain superiority over other labourers in the matter of observation.

Stripper Yard

This is the connecting link between the S.M. Shops and the Blooming Mill. The moulds containing ingots are transhipped to the stripper yard. Here the overhead cranes pick the ingots out. A stripper of the electric type is "in the form of a strong overhead crane, from which is suspended a vertical arm, provided with two jaws that fit over "lugs cast on either side and near the top of the mould."

Operating between the jaws is ram, or plunger, capable of exerting pressure on the top of the ingot, while it is being stripped, sufficient to balance the pull. The mould is raised off the ingots and placed on an empty car standing ready to receive them. The ingots are left standing on the car which brought them.

The staff of the stripper yard consists of a general
general foreman, shift foreman, recorders and crane drivers. The crane drivers lift the moulds in the manner described in the foregoing paragraph; the recorder keeps record of the ingots received and sent from the stripper yard to the soaking pits. The shift foreman, working in the shifts 0800-1600; 1600-2400; 2400-0800, arranges for the lifting of moulds according to the needs of the soaking pit and arranges for stabling cars with moulds on the stools. The cars with moulds are sent back to the steelmaking shops. In fact the job of the shift foreman is like that of a yard foreman who must keep the yard as free from congestion as possible, and keep the soaking pits supplied with ingots. He also regulates the supply according to the quality which is needed by the rolling mills and receives advice from the soaking pits. The general foreman is to maintain roster, look to the maintenance of the yard, and attend to the labour troubles, due to absence or otherwise. The foremen are expected to go over the yard on their arrival and take stock of the situation and plan beforehand how to keep the yard uncongested. The general foreman lays down the broad lines and the shift foreman works on them, using his discretion in the light of the exigencies of the hour. The position at the end of each shift has to be recorded for the benefit of the shift foreman in the next shift, and for the information of the general foreman who goes over such records on his arrival and suggests ways and means to improve the quantity of output if there is room for it.

This completes the operational side of S.M.S.2. Like other departments it has a mechanical side for its upkeep and repairs. The staff and their duties are the same as in the case of the Blast Furnaces, S.M.S.1, see pp. 43-44 857-58. Drillers are those engaged in boring holes in plates, etc., serangs are manual labourers corresponding to riggers. They can
can climb very high and do petty repairs. The storekeeper issuer keeps record of the articles issued from the store and the recorder keeps record of the requisitions made and supplies obtained.

**Blooming Mill**

The last department to be discussed in our thesis is the Blooming Mill. Bloom means "mass of puddled iron hammered or squeezed into thick bar"; and the blooming mill does this to the ingots through the operations of the soaking pit, cogging and the driving of the blooms through controls. At the end of this, the bloom can be rolled into structures, rails or bars or billets, etc. The department is under a superintendent who is a trained man with a long experience in the department as shift foreman, general foreman, and assistant superintendent. He is therefore not only conversant with the theory of the technical jobs, but has had actual training in them. He has to tackle twofold problems: (a) the operational relating to the keeping of production at a high level and improving upon the previous record, with due regard to quality. He has therefore to size up the supervisory staff under him and the subordinate staff, and should be able to use the human factor under his direction effectively; (b) those connected with labour. The superintendent in the Tatas for this department has experience and a large measure of cooperation. Of the two important factors in industrial relations (1) the economic drive; (2) recognition or status of workers; he is not in complete control of (1), but can easily control (2). The first thing that he does on his arrival is to go round the works with his assistants, and this provides him an opportunity to study his workers on the spot day after day. He takes stock of the work overnight and plans it for the next twenty-four hours in the light of the requisitions from the rolling mills. He instructs /
instructs the furnace department for the quality of steel to be manufactured. The records of the material received in the stripper yard and rolled into blooms of different classes are prepared by his office with the help of the assistant superintendent and signed by him. He coordinates the activities of the soaking pit and the cogging; holds conferences of the supervisory staff if necessary; and works out in relation to labour the policy of the Company, i.e., keeping record for the promotion of workers, sending reports of long-term absentees and laying down qualifications for the future employees. The most important part of his work in this direction is to recommend people for promotion to supervisory posts with care and discrimination. In the words of a banker "a capacity for pushing sixpences across a counter is no guarantee of an ability to supervise the 'pushers of sixpences.'"\(^6\)

He is assisted in the discharge of his technical duties, that is, the smooth, and if possible improved, running of the department, by his assistant. He (the assistant) is a technically trained man and with the experience of work as shift foreman and general foreman. He accompanies the superintendent during his round in the morning and takes note of the observations of the latter and carries out the necessary instructions by explaining and discussing them with the general foreman. He helps the office in the preparation of the returns and keeps the superintendent informed of the labour situation, i.e., the number of absentees and any suspected labour trouble. He scrutinizes the reports of the shift foremen, submitted through the general foreman, and prepares estimates for replacement and repairs, if any, to the plant. Besides this he attends to the correspondence from the general superintendent.

---

\(^6\) "An Introduction to Industrial Psychology" by May Smith; Cassell, 1943.
superintendent. The burden of the executive duties relating to the coordination of the activities of different sections falls on the general foreman. Besides accompanying the superintendent on his rounds in the morning if he is free, he must spend some time in every section, scrutinizing the work overnight and its continuation in the morning. He meets every shift foreman and ascertains from him the condition of his plant and if any flaws have been discovered or any improvement is needed, or there is any lack of cooperation among the sections he personally attends to it. He listens to the cases of industrial complaints, coming through shift foremen, and often squares up differences or takes the edge off the complaint by his tactful handling. His success depends upon the measure of his popularity. The most successful general foreman is a quiet person who knows his workers of all grades to the finger-tips, and attends to the work of each some time or other, thus encouraging the promising and goading the slothful. He goes over the plant between 1600 and 1700 to apprise himself of the latest developments before going off duty.

Sometimes he gets an assistant for training and asks him to share his responsibilities. Now we are in a position to follow the detailed working of the mill.

Soaking Pit

The ingots from the stripper yard are placed by the crane drivers working overhead into the soaking pits. The soaking pits are heated by producer gas and are opened at the top by the heaters to allow the ingots to be placed inside them. They may be compared to ovens and the heat radiating from them when they are opened to put ingots in or take them out is very intense indeed. The crane drivers working these cranes have to get inured to this heat. They are allowed one hour's rest for two hours of active duty.
The soaking pits are regulated for heating the ingots by the heater who works in shifts. He knows the composition of the ingots as obtained from the Steel Making Shop and imparts the degree of heat that will give chemical stability to the components. Any flaw in heating if serious results in rejection or deterioration in the quality of the finished product in the rolling mill. The temperature of the furnace is determined by pyrometer and the heater decides the duration of the heating process for the ingots in different pits. The man is not necessarily technically trained but is educated, having, say, passed the intermediate examination in science, and has through experience as soaking pit recorder and assistant heater acquired the necessary skill. As there are about four pits in operation most of the time, the heater who is in charge of them is assisted by four assistant heaters, each of whom attends to one pit. The competence of the assistant heater is much the same as that of heater, but he generally consults the heater who is engaged in coordinating the output of the pits and attends to the repair of their bottoms.

7 Soaking pits are deep chambers, or underground furnaces of square or rectangular sections, heated by the regeneration principle and opening at the top. They are large enough to contain four, six or eight blooming mill ingots per hole, in an upright position. Spanning the soaking pit furnaces are electric travelling cranes. The tongs which lift the ingots are connected with a drum on a lifting arm, and are actuated by means of a curved groove in the main hoist so that their distance apart may be varied. Inside each furnace or pit there are rectangular holes and are built side by side, separated by firebrick walls. Each hole has two regenerators, one on each side. The holes are closed by fire brick covers, each cover is supported on four wheels which roll on cast steel rails lying on the division wall between the pits.

8 He prescribes the order in which the cranesman would draw the ingots.
bottoms and general upkeep. The head heaters occupy a dignified position and are supposed to coordinate the operations in the soaking pits with the cogging and the stripper yard. They are also responsible for checking the work of soaking pit recorders, number takers, and that of the foreman of the bottom making.

Soaking pit recorders combine the work of a clerk with that of opening the doors of the pits for the ingots. They keep record of the cast no. of ingots, their quality and the number of each ingot. They are in contact with the crane drivers and signal to them to find a particular soaking pit and open the door for them. Thus they have a complete record of the cast from the steel making shop which is being treated in a particular soaking pit, the serial number of the ingots in it, when received, and when sent out. Getting signals from and giving signals to the drivers either when indicating the pit to which the ingot is to be brought or to be taken from, they require quick power of observation. Their educational qualifications seldom exceed passing of intermediate examination, but their chief merit is quick observation and alertness. Number takers issue chits for the ingots (rather blooms) sent out from the soaking pits to the rolls, and with these chits begins the life history of the bloom. Any defect in the rolling as finished product of this number can be traced through the chit to the steel making shop from which it came. It is thus a mere clerical job, but the work done is really of great importance for the purpose of manufacture. Then there are ordinary khalasies (labourers) who, under the direction of assistant heaters, operate valves for heating gas from producers.

Like the converters, the bottom of the soaking pit is subject to very great tension and has to be repaired or remade. The work is done by the khalasies (labourers) who lay firebricks under the supervision of the bottom making foremen.
foreman, of which there is one in each shift. The tools used are shovels, long-handled pokers, and cutters. During the time that bottoms are being made, the gas and air are shut off. Coke breeze from the blast furnace coke bins is used to make the bottom. Coke breeze is used because it absorbs and makes fragile the molten oxide that runs off the ingot, protects the brickwork and helps to maintain a reducing atmosphere in the furnace. The bottom making foreman is conversant with the technique of bottom making and guides the work. Experience is his asset, but that alone would not do. He is fairly well educated and is conversant with bricklaying and the engineering of it in relation to heating. A fairly intelligent person with experience - such is the description of the mental profile of this class of foreman. The general foreman and his assistant who are in the general shift 0730-1130, 1330-1700, are responsible for the materials to be used in repairs. They arrange the duties of the foremen and khalasies (labourers) and keep a record of the day to day repairs. Coming in the morning they find out what bottoms would be down for repairs in different shifts and make arrangements accordingly. If there are any technical difficulties in making the bottom they explain them to the foreman concerned. They also inform the head heater of the likely situation during the next twenty-four hours. As usual they deal with labour under their charge and require some of the tact we discussed under Superintendents. The men under them are more amenable to discipline than those under the superintendent, being ordinary labourers, but they are easily excited too. There is one matine under the general foreman. She is the head of women labourers called rijlas and lifts coke breeze by a mechanical process for storing it to make the bottoms. The ash pit khalasies collect burnt coke breeze for the repair of bottoms.
The ingots when picked up from the soaking pits are placed on a rolling platform, and the process of cogging begins. There are three classes of persons engaged in this job - coggers, manipulators and control drivers. All these operate from the same platform and roll the bloom into the particular size needed. They receive instructions about the size from the mill foreman on duty. The control drivers regulate the running of the ingot on the revolving rollers to the cogging machine. Here the cogger and manipulators take charge of it. The manipulator turns the ingots to roll them into blooms, and the cogger presses them to the required size. The Tatas have installed the Reversing mill because the top roll is adjustable and various sizes of blooms, billets or slabs can be rolled on one set of rolls. There are two rolls in each set and they are changed every week and dressed in the roll shop. The bottom roll rests with each neck on a babbit lined with cast iron bearing. Sheet steel shields are placed over the necks of the bottom roll to keep scales from getting between the necks and bearings. The ingot is rolled by adjusting the space between the bottom and top rolls. The lifting tables lift the ingots into the rolls on one side and when it has passed to the other. Another lifting table makes it run between the rolls. Each table has a vertical motion only. The material is raised and lowered by a reversing electrical motor which is provided with a magnetic brake for automatically stopping the tables at the correct levels. The control driver controls the tables which edge the ingot into the rolls. The manipulator turns the ingots as desired between the presses by moving the piece from groove to groove and straightening it when necessary. He has to be very quick in his observation and a man quick at reactions. The cogger

Observation - if the control of the tables is slack, the ingots would not edge into the rolls as promptly as they should and this would occasion waste of time. Hence he must be very quick in observing when the ingot is released from the press and is to be edged into the rolls. No time should be lost in doing this and therefore he should be quick to react.
cogger presses the ingot to flatten them into blooms. He requires the same psychological abilities as does the manipulator. The control driver runs the ingot on the tables, the cogger flattens them by exerting pressure with the rolls, vertical and sideways, the manipulator makes it run into specified grooves to bring the bloom into the desired dimensions for final rolling. In the Tatas these jobs are manned by 'C' class apprentices who have received education up to the middle standard or the high school classes, and have been through a course of practical training, at one time of five years' duration, but now two only (see Chapter VII). Spell hands are provided to relieve these persons. Their jobs are not only strenuous but continuous. When the blooms leave the rollers they pass through a bloom stamping machine. Then they pass the shears which are equipped with a gauge and stopper for cutting a number of pieces of the same length. These are operated by the shearman who sets the stopper and works the machine. It is by no means a very skilled job. Any ordinary khalasi with a little practice can get himself adjusted to the job. The pieces as they go down are either rolled on to the bar mill or diverted by the kicker down a table to be reheated before being rolled into rails. The staff consists of -

Shear recorder. He gets the bloom (as the ingot is known) after rolling, indicates the size to the shearman and discards bad portions which are diverted from the table. He is educated (High School standard) and in course of time learns the job by observation. The number taker who knows the number of the ingot as well as the number given to the bloom directs the movements of the bloom, sending it to one of the rolling mills or to the reheating furnace. If the blooms get coupled, the gas cutter cuts them with the help of acetylene gas. The crop thrower throws out bad ends.
Barring the shear recorder and the number taker, none of the other jobs require any high standard of education, and the necessary skill is acquired by observation and experience.

Opposite the shearman is the shear pulpit control driver. He works the table rollers to take the blooms as they are cut by the shears. He too belongs to the khalasi or labour class and does the job almost mechanically with quickness of observation which comes through practice.

At the head of this organization is the mill foreman. He works in shifts and is responsible for the coordination of all work from the time the ingot is received from the soaking pit to the time it is sent up for rolling into rails or bars. He keeps himself informed of the material coming from the steel making shops and along with the heaters arranges for their heating. He keeps a record of the amount of heating done in the soaking pit, issues instructions for rolling, and supervises the operation. He arranges the distribution of blooms and their reheating if they are to be rolled into rails or structural s. It is of utmost importance that he should go round on his arrival and apprise himself of the situation in the mills. He should further acquaint himself from the records about the material that is coming from the steel making shops to the soaking pits, and from the soaking pits to the blooming mill. He looks into the labour questions like a heavy absentee list or personal grievances of the workers. Lack of cooperation may retard the smooth working of the mill. He is generally a Science graduate, with long experience combined, if possible, with training in the Technical Institute, Jamshedpur. He has for his assistance fresh graduates from the Technical Institute as probationers or apprentices. But he has also permanent assistants who may be Science graduates with experience or Intermediate (Science) passed men with a long experience. Of the three assistants one /
one is generally a Technical Institute graduate. The duties of the assistant are like those of the mill foreman, with this difference that he is under orders and is detailed either to look into the records of the material or supervise the work in the mill if there is some trouble with the machinery or there is any congestion at any point.

There is a big force of coolie labour and it is under the labour foreman.

The accessories relating to the blooming mill are (a) gas producer plant; (b) control drivers; (c) chip yard.

The organization of the gas producer for heating the reheating furnaces is the same as in steel making shops (see p. 55). We have already discussed the jobs of control drivers (see p. 75). The chip yard is under a foreman who is Eleven at detecting the flawed parts of the blooms which were separated from those going to the mills, being suspects. He gets the bad portions chipped and thus saves waste of blooms. These salvaged pieces can be used for rolling some inferior stuff. His is a skilled job, the skill lying in detecting the flawed parts. The chipping is done by chippers and checkers keep a note of the quality of steel. The foreman may be a middle passed man with special experience through length of service. The chippers are like ironmongers, with limited skill in chipping the blooms clean.

On the mechanical side the organization is parallel to that in the steel making shops with the difference that there are babbitters, transfer table operators and shearmen as well in the mechanical section of the Department. The babbitters put babbits and, though not literate, have acquired skill through experience. The skill is of course very specific and narrow. The transfer table operators work the transfer table and get the slabs pushed outside the mill. We have already discussed the job of shearmen. In fact these
these men should be on the operation side, but their affiliation to the mechanical section is a legacy of the past and so they are shown under Mechanical Force.

We shall now sum up the hierarchy of the staff discussed in relation to operations in different departments in a diagrammatic form and refer to the pages wherein their relation to the plant and its operation has been discussed within brackets. A correct understanding of their hierarchical order is necessary for the occupational analysis we attempt in the next chapter.
CHAPTER III

CLASSIFICATION OF JOBS

(a) Rationale

We have discussed at some length the working of the Tata Iron and Steel factory in relation to the labour engaged in its operations. And it is against this background that we propose to set forth our Rationale of the Classification of Jobs. The expression "job" means a "piece of work (to be) done", and the psychology of Aptitude Testing requires an analysis of jobs in broad outline to discover the allied ones. These are called Family of Jobs; and the analysis helps us to find out what specific technical training and mental abilities each family of jobs requires. We use the expression "occupation" to describe a family of jobs. The efforts of psychologists like Macrae were directed towards the analysis of each job and they aspired to have a separate psychograph for each so that the individual profile may find its closest correspondence, and men and women may be guided into the most fitting vocation. This could be achieved by

(1) discovering the psychological trends that would ensure a correct handling of the machine or performance of the task;
(2) measuring the extent of each such trend in the average worker with as much exactitude as possible. The plan makes an appeal to the imagination for it conjures up before our mind's eye a pigeon-holing of men and women into the right pigeon-hole.

There were attempts to work out this plan in different parts of the world. In Spain the Institute of Vocational /

1 "The psychologist dreams of the day when, having constructed a silhouette representing the characteristics of the person examined, he would proceed to superimpose this human profile on a number of occupational profiles until he finds one with which it exactly coincides." - Macrae, A. "Talents & Temperament" - London, Nisbet & Co., 1932.
Vocational Guidance made surveys of occupations and did intensive job analysis; in Germany the Central Laboratory was engaged in a similar task; in Sweden the Board of the Royal State Railways started the job analysis of the subordinate jobs towards the end of 1937 in right earnest; in Czechoslovakia studies of the requirements of different occupations were made by the Psycho-Technical Institute. The pioneering work was really done by the U.S.A. Beginning with an extensive programme of mental testing in 1912, when an attempt was made to specify different levels of intelligence for various jobs, work on job analyses has continued unabated to this day. The Occupational Analysis Section of the U.S.A. Employment Service has undertaken a comprehensive job analysis of trade requirements. Great Britain came into the field late, but has been doing very useful work in the matter of job analyses through the National Institute of Industrial Psychology. Last but not the least in importance is the work that is being done in the Soviet Union. Here of all the countries in the world vocational selection is also a programme of placement. And this is a great thing for it takes away the sting of unemployment or ill employment. Nor is job analysis pushed to the extreme. The division of jobs is into broad classes like professional, semi-professional, semi-skilled, and it is within the limits of these categories that an attempt is being made to select and place men in the job or jobs they show themselves most fitted for.

There has unfortunately been no attempt to evolve an unequivocal terminology for Vocational Psychology; and the expressions "job", "occupation", "analysis" and "specification" are used without a definite significance. We would therefore attempt (1) to state the principles of psychology which we accept and on which our investigation is built /
built up: and (2) select a terminology of our own and state
the significance we attach to each expression. As we attempt
a classification of jobs in this chapter we are mainly
concerned here with (2). (1) has been discussed at some
length in Chapter I and will be touched upon again in
Chapter IV and the subsequent chapters.

Job: see p. 79 e.g., the job of a typist or
stenographer, or secretary, which besides the job of a
stenographer includes that of a record keeper. The expression
is a relative one as the examples above would show.

Occupation applies to family of jobs. The jobs
that have a number of fundamental features in common
constitute a family of jobs, or in our terminology occupation.
Each of these has these fundamentals in common, but has its
own specific features. We can best illustrate our point by
Angyal's distinction between deeper trends and specificity.
The deeper trends are the chief motivating forces, but as they
encounter the environment (heteronomy) they develop into
specific activities. The constellations of deeper trends may
be compared to group factors, integrated by a 'g' factor of a
limited range (see Chapter I) and specificity to specific
factors?

Both the constellations and specific factors owe
their internal composition to tension, that is, the impact of
the environment on the subject, or in the statistical
language the impact of a representative environment on an
average subject. Both are hypothetical, but this is the best
way of describing multiplicity of facts in an intelligible
manner.

Job Description is the statement of the operations
in a job in the context of cognate operations, as we did in
Chapter II. It may be a detailed, or in broad outline as in
our case. A detailed job description is very helpful in
placement, so as to make the best of eligible candidates by meeting their wishes as far as possible and get the most apt person for jobs requiring some special training or standards of efficiency.

Job Analysis is a statement of the general and specific psychological traits expected from, or to be found in, an average efficient worker in a job.

Occupational Analysis is a statement of the general psychological traits expected from, or to be found in, the average efficient workers in a family of jobs. We call it "occupational psychograph" when we represent these traits graphically.

Occupational Specification is occupational analysis supplemented by details about technical, social and economic aspects of the family of jobs.

As stated in Chapter I, our object is to frame an aptitude test which should assess the broad tendencies which we consider those who aspire for engineering jobs should possess. The plan that we propose to follow is that of occupational specification in relation to the jobs in the departments of Blast Furnace, Steel Making Shops, and the Blooming Mill. The number of jobs in these departments is so large that a detailed job description or job analysis would prevent us from seeing the wood for the trees, and then the time at our disposal has been too short to launch on such a detailed study. Besides this occupational specification on the lines proposed by us would give us an idea of the organismic nature of the different occupational levels. The different jobs in an occupation make a whole, and the occupation can be treated as a system in Angyal's sense of the term, and the different occupational levels can be arranged into a sort of hierarchy - Unskilled Class II → Unskilled Class I → Skilled Class II → Skilled Class I → Technical Class II → Technical Class I. Our view finds support /
support in the findings of P.E. Vernon set forth in "Factor Analysis in the Work of D.S.P. (The War Office) and of S.P. (The Admiralty) - P.E.V. No.207." A further reason for accepting some version of the G theory is the quite unexpected degree of generality in Service jobs, as distinct from tests, revealed by our follow-up investigations. The uniformity of the multiple regression equations between the tests and proficiency in a great number of jobs was so striking that it seemed that all branches of the Army and all Naval categories were demanding one and the same type of man.

We shall give specifications for different levels of occupation under the following heads:

(a) Description of Occupation.
(b) Jobs Included.
(c) Technical Aspect
   (i) General
   (ii) Specific.
(d) Social and Economic Aspects.
(e) Psychological Aspects.

The jobs in the different departments of the Tatas, considered from the point of view of mechanical aptitude (engineering), may be graded into three classes: (1) technical by which is meant theoretical efficiency with practical skill and administrative ability of a high order in particular; (2) skilled where theoretical efficiency is combined with well developed practical efficiency; (3) unskilled, where the jobs do not entail any previous training in theory and the necessary practical skill is acquired through experience and capacity for observation. In view of the multiplicity of jobs in the Tatas, the plan adopted here is to sub-divide technical, skilled and unskilled into two grades:

Technical jobs, Classes I and II.
Skilled jobs, Classes I and II.
Unskilled jobs, Classes I and II.

A labourer would ordinarily, on his first appointment /

3 "True there was some scope for differential or specialised tests - mechanical, clerical, electrical, scale-reading, Morse aptitude, and the like, but it was remarkably small."
appointment, be placed in Unskilled Class II, but when he gains experience in the job and is considered good enough for a higher job he may be promoted to Unskilled jobs Class I. Thus a fitter helper is to be placed under Unskilled Class II, but if he acquires proficiency through experience and is considered good enough to take up the job independently, he may be promoted to Unskilled jobs Class I. This differentiation is called for in India at present because in 90 per cent. cases labour is illiterate and the facilities for training in practical work do not exist. And so, if a labourer acquires proficiency in a particular job and shows promise, that is some indication of his aptitude. In the concluding chapter we shall make our recommendations for training within industry for such men.

Skilled jobs Class II are those which require a course of theoretical and practical training; and if and when the worker enriches himself by experience and efficient work, he may be promoted to Skilled jobs Class I. Or men with the necessary qualifications and previous experience elsewhere may be recruited direct to this class.

Where theoretical and practical training are obtained after graduation in Metallurgy or Mechanical or Electrical Engineering, the worker is placed in Technical Class II. If he shows abilities for administration and organization and a vacancy occurs, he may be promoted to Class I.

Having classified the jobs under those broad heads and subdivided each head into two, we now proceed to discuss the principle of grouping the jobs under one or the other head. There are three methods commonly in use - classifying, ranking, and points system.

The classification method consists in having pre-established series or categories to which jobs are assigned.
The classification is an artificial one and is used as a convenient device. We have adopted this plan in classifying the jobs in the Blast Furnaces, Steel Making Shops and the Blooming Mill into Technical, Skilled and Unskilled.

The ranking method consists in grading the job objectively according to the value of the work, each job being evaluated in terms of other jobs and not in terms of salary or wage rates. This is the method that we would adopt in our final plan for testing - each higher job is the lower one plus some extra traits; e.g., a blast furnace foreman belongs to Technical jobs Class II, whereas a third hand in the steel making shops belongs to Skill jobs Class I. Now the testing programme for Technical job Class II includes the traits included in testing for Skilled jobs Class I, plus an assessment of some specific traits, like a higher standard for leadership and a theoretical knowledge of Metallurgy, of the physics of heating and the chemistry of making pig iron of the quality desired by the management. Thus the jobs which require much the same fundamental traits constitute one class, and the jobs next to these are those which require all these plus some other traits or a higher level of the same abilities. Thus we get a hierarchy of jobs: Unskilled Class II → Unskilled Class I → Skilled Class II → Skilled Class I → Technical Class II → Technical Class I.

The point system consists of a predetermined list of factors generally common to all jobs for which a schedule of points has been prepared and are to be assigned to each factor. We have tentatively fixed upon certain traits as essential for success in each class of occupation, and would in the course of our second survey lay down the minimum for each trait as a necessary condition for eligibility to different occupational levels. Thus the point system is a helpful statistical device for giving a quantitative description.
description of the essential features of a family of jobs. All the three methods are supplementary and help to classify jobs with increasing accuracy, but the points system method is the most effective, though quite arduous.

(b) Application of Rationale

We now proceed to apply the Rationale set forth above to the jobs in the Tata Iron and Steel Company, Jamshedpur.

Classification

Technical Jobs

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast Furnace</td>
<td>S.M.S's Blooming Mill</td>
</tr>
<tr>
<td>SUPERINTENDENT</td>
<td>SUPERINTENDENT</td>
</tr>
<tr>
<td>ASST. Supt.</td>
<td>ASST. Supt.</td>
</tr>
<tr>
<td>GENERAL FOREMAN</td>
<td>GENERAL FOREMAN</td>
</tr>
</tbody>
</table>

| Blast Furnace | S.M.S's Blooming Mill |
| SUPERINTENDENT | SUPERINTENDENT |
| ASST. Supt. | ASST. Supt. |
| GENERAL FOREMAN | GENERAL FOREMAN |

Technical Jobs (Mechanical)

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td>Mechanical Foreman</td>
</tr>
<tr>
<td>General Foreman</td>
<td>Asst.</td>
</tr>
</tbody>
</table>

Skilled Jobs

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast Furnace</td>
<td>S.M.S's Blooming Mill</td>
</tr>
<tr>
<td>THIRD HAND</td>
<td>HEAD HEATERS</td>
</tr>
<tr>
<td>FOURTH HAND</td>
<td>ASST. HEATERS</td>
</tr>
<tr>
<td>CONVERTER</td>
<td>GENERAL FOREMAN</td>
</tr>
<tr>
<td>CONVERTER</td>
<td>CONVEYOR MAN</td>
</tr>
<tr>
<td>SHIFT FOREMAN</td>
<td>STOCK YARD FOREMAN</td>
</tr>
<tr>
<td>(BOTTOM HOUSE)</td>
<td>(BOTTOM HOUSE)</td>
</tr>
</tbody>
</table>

| Blast Furnace | S.M.S's Blooming Mill |
| THIRD HAND | HEAD HEATERS |
| FOURTH HAND | ASST. HEATERS |
| CONVERTER | GENERAL FOREMAN |
| CONVERTER | CONVEYOR MAN |
| SHIFT FOREMAN | STOCK YARD FOREMAN |
| (BOTTOM HOUSE) | (BOTTOM HOUSE) |

Gas House - Foreman: General and Shift

Skilled
### Skilled Jobs (Mechanical)

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shift Foreman</td>
<td>Shift Head Rigger</td>
</tr>
<tr>
<td>Shift Mistry</td>
<td>Fitters, Welders</td>
</tr>
<tr>
<td></td>
<td>Blacksmith</td>
</tr>
<tr>
<td></td>
<td>Gas Burner Mistry</td>
</tr>
<tr>
<td></td>
<td>Moulder</td>
</tr>
<tr>
<td></td>
<td>Pyrometerman</td>
</tr>
<tr>
<td></td>
<td>Engine Drivers</td>
</tr>
<tr>
<td></td>
<td>Transfer Table Operators</td>
</tr>
</tbody>
</table>

### Unskilled

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast Furnace Keeper &amp; Snapper</td>
<td>S.M.S's Mill.</td>
</tr>
<tr>
<td>Assistant Khalsi</td>
<td>Shear recorder</td>
</tr>
<tr>
<td>Cinder</td>
<td>Number</td>
</tr>
<tr>
<td>snapper</td>
<td>taker</td>
</tr>
<tr>
<td>Stove Tender</td>
<td>General Lab-recorder</td>
</tr>
<tr>
<td>Runnerman</td>
<td>Gas cutter</td>
</tr>
<tr>
<td></td>
<td>Coke thrower</td>
</tr>
</tbody>
</table>

### Unskilled (Mechanical)

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobbler</td>
<td>Khalsies</td>
</tr>
<tr>
<td>Stove cleaner</td>
<td></td>
</tr>
<tr>
<td>Hammerman</td>
<td></td>
</tr>
<tr>
<td>Oiler</td>
<td></td>
</tr>
</tbody>
</table>

### Occupational Specifications

**Occupation.** Technical supervision and organization.

Technical supervision implies that the men in this category have a thorough grasp of the theoretical and practical aspects of the operations, metallurgical and mechanical, and though they may not be extremely clever with their fingers they should make up the deficiency if it exists by a wide theoretical knowledge. They should be able to organize their departments in a manner that turnover is as low as possible, the workers are contented, and the output as high as the plant and human labour would permit.

The jobs included under this occupational group in the
the Blast Furnaces, Steel Making Shops and the Blooming Mill are those of superintendents, assistant superintendents, and general foremen. We have discussed at pages 46-47, 69-70 the part which they play in the operations of their departments. We describe here briefly the sphere of work for each.

The superintendents are the heads of their departments, viz. the Blast Furnaces, Steel Making Shops, and the Blooming Mill. Their powers of discretion in the matter of discipline, i.e. punishment and dismissal of unskilled labour classes I and II are very wide; their word is law in the matter of the maintenance and operation of the furnaces, the steel making shops and the blooming mill. Consequently they have an intimate contact with the plant and its operations on the one hand and the labour engaged on the other. This necessitates renewed acquaintance with all the three at the beginning of each working day, that 0730 when they come on duty. This is done in the course of their round. Their assistants help them in the matter of the maintenance of the plant and the requirements of the day, and the general foreman in that of the actual operations in progress and labour. It is really effective observation during a round that discriminates one superintendent from another. A clever person has at the back of his mind a picture of the whole department as it should be in its operations as a necessary development of what it was the evening before. All the departures from his mental picture catch his eye and he promptly finds out the reason therefor, e.g. if the tapping of a furnace has been delayed the superintendent of the blast furnace must find out the causes and remedy them. If there has been a breakdown, he has to inquire into its causes and prevent its recurrence. If the number of absentees is large, the general foreman must tackle the situation in consultation with /
with the superintendent and ring up the Labour Office for more hands. He must keep himself informed of the progress of beginners. Cleaning, oiling, immediate repairs and replacement, and the putting of the cleverest persons in key positions (say that of a shift foreman) are all important points which require day to day scrutiny. The plant is not the same next morning, it is either a little better or a little worse. It is the duty of the superintendent to keep it going at the highest level of proficiency. His round generally takes from one hour to two hours, during which he takes down relevant notes in his notebook. When back in his office, he draws up his plans in consultation with the assistant superintendent. If any specific information is needed the general foreman may be called in for consultation. He then attends to the office work relating to the stocks received, production, attendance of labour, and complaints of labourers. He also arranges coordination with other departments, e.g. the steel making shop may require gas from the coke ovens. He will ring up the superintendent, coke ovens, and make the necessary arrangements, and then confirm them by official correspondence. The afternoon from 1300 to 1700 is generally devoted to supervision and the inspection of the plant so that it may be in good working condition for the night shift. If there is something untoward or extraordinary at night, he is telephoned, and in the light of his knowledge in the afternoon issues the necessary instructions. If there is something very serious, he must come down to the department.

The **jobs included** in this category - Technical jobs **Class I** - are those of assistant superintendent and general foreman. The difference among jobs is one of degree rather than kind. The assistant superintendents and general foremen possess much the same educational and technical qualifications as the superintendent, and in some cases better, but the superintendent has to his credit long experience, and this is
a great asset in a factory. Rightly does C.A. Oakley remark: "Indeed, we have become accustomed to finding intellectual people when engaged in the practical affairs of life failing 'to take what is clearly the right course, and not infrequently 'doing something very ill advised indeed." The superintendent has insight into the technical problems and tact in handling men, and these are the qualities that his assistant and general foremen are acquiring if they are young. The assistant is also a technical expert for his department and is the adviser to the superintendent in all technical matters and deals with all papers relating to technical points, e.g. the quality of ore best suited to the manufacture of steel of a particular quality. A good deal of the routine office work passes through him and in many cases his recommendation is accepted by the superintendent, e.g. the replacement of parts, the transfer and posting of men in the personnel, the question of the promotion of men working in what has been described in this thesis as Unskilled Jobs Class II.

The General Foreman is concerned immediately with labour. The shift foremen are only responsible for the work in their shift, but the general foreman is concerned with the output for the whole day - and it is his duty to spot the possible trouble in the working of the plan decided upon by the superintendent. Carelessness on the part of any one shift foreman is reflected in the final output, e.g. if the pig iron taken into the furnace at a steel making shop is below the required specification, it will entail greater heating and addition of chemicals than would pig iron of the right specification. The general foreman in the blast furnaces must keep an eye on such aberrations; he coordinates the activities of different departments to ensure efficiency.

---

and improved output. He is in touch with the foreman of the accessories and the mechanical section; and it is the binding force of his personality that makes for coordinated efforts. It is to him that the men in different grades in the different sections of the department look up for justice. To him come lots of complaints, and it requires a good deal of tact to redress grievances without giving the immediate officer of the aggrieved a chance to think that action has been taken over his head. He is not only a technical expert whose advice can be readily obtained by the operation and the mechanical staff on technical points, but he is also the friend, counsellor and guide of the men under him. If he succeeds, he does so not by dint of his technical skill alone but by his fair play.

Technical Aspects - General: Men in this class must be graduates in the science of metallurgy or mechanical or electrical engineering (or must have acquired the necessary proficiency by private study). They must be very good at devising practical application of the theoretical technical knowledge, but not necessarily quite clever with their hands. A person whose score in the practical has been low at the university or college, cannot hope to do well at the factory. He must be able to express himself in the English language and in the prevailing language of the workers.

Specific: They should have served a period of apprenticeship in the cognate departments of the factory for a couple of years and given satisfaction to the superintendents concerned. They should have worked in the department concerned for at least ten years and should have acquainted themselves with the specific technique of the plant both on the operational and mechanical side as shift foremen if general.

5 If they have been promoted from lower ranks, they are bound to have been quite clever with their hands.
general foremen, and as shift foreman and general foreman if superintendent or his assistant.

Social and Economic Aspects: All these jobs, that of superintendent, assistant superintendent and general foreman, carry salaries ranging from Rs. 450 to Rs. 1200 per month and the benefit of production bonus on the operation side. Besides this, all have a share in the profits of the factory, in the form of a profit sharing bonus. The factory deducts a month’s salary every year and adds to it the same amount and this goes towards the Provident Fund. The houses are provided by the Tatas and are well situated and furnished. The rent is law for the accommodation and amenities provided. Electricity is supplied at a very cheap rate and so also is water.

All these jobs give the holders a high social status, and they are ranked as officers in superior grades. They are eligible as members in any club. But the successful man is also a member of the associations where he can meet his subordinates as fellow men and cultivate their sympathies. However, the hiatus between the financial position of the superior staff and the subordinates is so great that such associations are rare.

Psychological Aspects: (1) A man should have superior cognitive ability to coordinate the technical activities of the different sections of his department. The higher the rank of an officer in the hierarchy the greater the need for synthesising the work of different jobs into a whole. For example, a fitter need know only his job and nothing more. Within his own limitations he can be very effective, but a shift foreman has to know and coordinate so many jobs, e.g. it is in the interest of efficiency that the general foreman of the steel making shop coordinate the activities of the pitside.
the gas plant, the converter, the bottom house, and the smelting furnaces. His capacity for the synthesis of the environmental data relating to one's occupation we have designated as 'g' (see Chapter I).

(ii) He should also possess certain specific cognitive abilities in a large measure. They are (i) perception of spatial relations; (ii) drawing and pattern completion; (iii) mechanical ability. The ability to reduce into linear measures the solid and to represent linearly what is before the mind's eye, a building, a bridge, etc., and to have the constructive imagination to complete incomplete profiles of the nature one is likely to meet in one's vocational activities is one which is most needed in engineering and even metallurgical jobs. Further, we expect men engaged in such jobs to possess mechanical ability—that is the ability to understand the principles underlying modern mechanisms. The tests for these traits may be a paper and pencil one or a performance one. A combination of the two is best. These are the abilities uppermost in our mind when we think of the engineering jobs.

In the course of our observations of these jobs, we used a five-point scale\(^7\) to estimate the importance of the different jobs.

---

\(^7\) See Note B. pp. 114-15

The following plan was adopted to take down notes during observation:

<table>
<thead>
<tr>
<th>Quantitative Estimate</th>
<th>Symbol</th>
<th>Points on the Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inessential</td>
<td>- -</td>
<td>0</td>
</tr>
<tr>
<td>Doubtful utility</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Essential, but not in the measure indispensable for those actively engaged in work requiring this specific trait.</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Very essential</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Very essential and in unusually large measure</td>
<td>++</td>
<td>4</td>
</tr>
</tbody>
</table>

See Note A. pp. 112-113
different cognitive abilities we would expect the men in this occupational group to possess. We summarise our estimates in psychograph below:—

**Traits**

I. Intelligence: Verbal
   Non-verbal

II. Drawing ability and pattern sense

III. Mechanical ability manifesting itself in
   (a) manual dexterity
   (b) mechanical explanations
   (c) perceptual speed reaction
   (d) stereotyped movements

But this psychograph is confined to the cognitive traits. We have to specify the personality traits as well which will make a worker in this class acceptable to the management. As a result of our discussions with those considered to be proficient in their jobs in this occupation and our own observation, we decided upon including the following personality qualities which the supervisory staff should possess in an appreciable measure:— self-confidence, industry, emotional stability and leadership.

Self-confidence may be judged in a measure by observing the behaviour of a testee in the course of an individual test. For example, the way in which a person attempts a Form Brand test gives us an indication of the fact whether he is nervous or confident of doing it as well as he can. A nervous person takes more than average time in inserting plugs in a rotating form board and his scores in, say, five trials are uneven. There are persons who take an increasingly shorter time as they progress from the first to the
the fifth trial. These are nervous to begin but soon regain confidence. But a certain percentage obtains a uniformly good score in all the five trials. These possess self-confidence in a much larger measure than those who show improvement in subsequent trials. This is also corroborated by the facial expression which betray emotional disturbance. A man may be industrious but lacking in self-confidence. He fumbles and perspires and is uncertain in his movements. The shock of novelty unnerves a large number of persons, but a few face the ordeal without flinching. The Third Report of Research by the City of Birmingham Education Committee for the Selection of Skilled Apprentices for the Engineering Trades supports our contention. Eight tests were administered to two groups A. and B. Group A. consisted of 29 boys to whom the tests were given after they had been in school a few weeks. Group B. consisted of boys who either knew that their admission partly depended on the test results or who did the tests on their first two days at the school. It was found that the mean score of Group A. who could take the tests without any worry about their admission was higher than that of Group B, the difference varying from .33 to 14.69. The cumulative record of the college career, and if the men to be selected are in the service of the factory, their service sheet, provide enough data about industry. Both of these are very essential qualities for men in superior posts.

As for emotional stability, we could use the criterion commended by May Smith.11

(a) /


10 N.I.I.P. Training; N.I.I.P. Variable Adjustment; Cox’s Models; Cox’s Explanations; N.I.I.P. Group Test 35; N.I.I.P. Form Relations; N.I.I.P. Memory for Designs; Cox’s Diagrams.

(a) Those who, for practical purposes, can be regarded as emotionally balanced, i.e. the persons who would not be flustered in the midst of situations which often occur in organizing a big department or running its administration and are likely to occasion worry, annoyance or loss of temper, e.g. the knowledge that you are distorting facts to the Labour Union and is likely to create trouble or neglect of duty by some foreman or breakdown through the carelessness of some member of the staff. (4)\(^x\).

(b) Those who have slight difficulties occasionally or in regard to one limited condition, e.g. impatience at breakdowns. Experience may lead such persons to take a more tolerant view. (3)\(^x\).

(c) Those who are somewhat unbalanced, but not to such a degree as to interfere seriously with efficiency or health. (2)\(^x\).

(d) Those who are finding their emotional difficulty a serious hindrance. (1)\(^x\).\(^{12}\)

Leadership is one of the most baffling human qualities. Field Marshal Viscount Montgomery, Chief of the Imperial General Staff, unbeaten in battle from Alexandria to the Baltic, described it as "the will to dominate, together with the character that inspires confidence". The expressions "will" and "character" require some explanation. From the psychological point of view, human organism has developed self-consciousness. This conscious self is only a part of the biological self, but tends to "establish its own autonomous government"\(^{13}\) and to shape the environment to its own design.

\(^{12}\text{Cf. Anayal's Concept of Bionegativity. - He defines it as "a personality constellation in which one or more parts processes disturb the total function of the organism" - Foundations for a Science of Personality, p.328.}\)

\(^{x}\text{Figures in brackets give the corresponding points on our scale - see footnote 8.}\)

\(^{13}\text{Foundations for a Science of Personality, p.118.}\)
Some succeed in this far more than others, partly because of certain attributes and partly by reason of their upbringing, training and experience. Character is an ethically neutral expression in psychology and stands for certain canalized patterns of responses motivated by more or less integrated ideas and feelings about men and things. Thus a general may, by reason of his innate capacity and training, have acquired patterns of behaviour in planning his strategy, disposal of his troops and placing the higher interests of his men and his country above his own self. His men can thus confide in him.

Applied to industry, leadership would stand for the will to manage the different situations, e.g. the problem of higher production, or reducing absenteeism, one's own way, and at the same time inspire confidence in men that there would be a uniform deal in essentials on different occasions and with all classes of people. In other words, the workers realize that the foreman is a man of principles and would not allow any personal motives to mar his deal. The best plan would be to have a list of about twenty-five qualities and get a random sample of men in every occupational level mark the qualities that they find in their best leader. We should then analyse the responses in the following manner:

<table>
<thead>
<tr>
<th>Qualities</th>
<th>Percentage of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>70</td>
</tr>
<tr>
<td>B</td>
<td>60</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
</tr>
<tr>
<td>D</td>
<td>20</td>
</tr>
<tr>
<td>E</td>
<td>10</td>
</tr>
<tr>
<td>F</td>
<td>70</td>
</tr>
<tr>
<td>G</td>
<td>25</td>
</tr>
</tbody>
</table>

The qualities with high percentages of responses may be said to be an index of what people expect of a leader. We give our version of leadership after verification through discussion with men interested in the problems of personnel selection, elsewhere. The following is a hypothetical psychograph.
psychograph of the personality qualities of workers in this occupational level:-

<table>
<thead>
<tr>
<th>Traits</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-confidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional Stability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leadership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We may now consolidate the two psychographs, the one for the cognitive and the other for personality traits:-

<table>
<thead>
<tr>
<th>Traits</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence, Verbal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-verbal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawing Ability and pattern sense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical ability manifesting itself in:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) manual dexterity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) mechanical explanations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) perceptual speed-reaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) stereotyped movements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Personality traits
Self-confidence
Industry
Emotional stability
Leadership

We have analysed Technical Jobs Class I at some length because the main aspects of these are needed in Technical Jobs Class II and in Skilled Jobs Classes I and II. In what follows we shall indicate the major differences among them. Technical Jobs Class II (see p. 86) include shift foreman and furnace foreman in the Blast Furnaces; shift foreman, first hand, second hand, shift foreman, converter; steel blower and converter regulator in the Steel Making Shops;
mill foreman, assistant mill foreman in the Blooming Mill; and mechanical foreman and assistant mechanical foreman on the Mechanical side. Now all these jobs are filled by men who can rise to the post of superintendent if they are found satisfactory. All of them begin with technical education in mechanical engineering and with a tolerable knowledge of metallurgy. But as they are posted\(^x\) to different departments, they tend to get set to specific work in their departments and thereby constrict the scope of their synthesising capacity which their general training fitted them for. What distinguishes Class II jobs from Class I is the narrow sphere of (a) organization, and (b) specialization. Thus the furnace foreman in a blast furnace confines himself to the work at his own furnace, and in course of time loses touch with the operations in the steel making shops or the blooming mill. As for organization, he is only concerned with labour at his furnace. The same is true of first hand and second hand at the steel making shops, and the steel blower and converter regulator, the mill foreman and his assistant. The shift foremen in each section have a broader organization to control, but that is confined to their own section only. Thus the shift foreman in the blast furnace is concerned with labour at the different furnaces and their accessories.

However, so far as cognitive aspects are concerned, the officers in Class II possess the same traits as those in Class I. Some of these are fresh from the Technical Institute and on the theoretical side are superior to their officers in Class I. But they are inferior to them in two respects: (a) they have not a wide acquaintance with the working of the plant nor the insight to remedy all the unforeseen defects. It is a matter of experience, though the best use of experience depends upon unusual powers of analysis and synthesis; (b) the capacity to tackle labour problems and the /

\(^x\) This is guided partly by their own preferences and partly by the exigencies of the factory.
the effective coordination of different sections. We are now
in a position to analyse this occupational level.

**Occupation: Technical Supervision and Organization.**

(i) Technical Supervision. - For efficient supervision the worker must have a thorough and correct understanding of the mechanism of the plant he is in charge of and also of the chemical operations. As against the personnel in Class I (see p. 36) these men have good practical ability because of their hour to hour contact with actual ability. They should therefore be expected to be on the whole better than those in Class I at manual dexterity, reaction to the varied situations in the plants, and stereotyped movements.

(ii) They should possess the qualities of self-confidence, industry, emotional stability and leadership, in the same measure as those in Class I, though the range of organization within which these come into play is confined to their own plant. They should also be able to coordinate the work of men in various grades in their section. In fact their promotion to Class I will depend upon their attaining a high level in these. A popular shift foreman would be an asset to his department as general foreman. His men know him and as they admire his qualities they win over men in other sections he is placed over to offer their cooperation and support.

Both the shift foreman and the other staff included in this group work in shifts: 0800 to 1600; 1600 to 2400; 2400 to 0800. They must go round on coming to duty and acquaint themselves with the situation and look up the notes of persons they relieve. Thus they are in a position to meet the possible difficulties on the operation or the maintenance side. An efficient worker arrives fifteen minutes before his duty hour and prepares an outline of the work to be done during the next eight hours. He quietly notes such deficiencies
deficiencies as his predecessor might have overlooked and remedies them to the best of his competence. He is obliging to the man he relieves for he would not expose him to criticisms if he can and is not a source of worry to the person who relieves him for he leaves no loops or drawbacks in the work during his duty hours. He takes stock of the situation half an hour before his relief and gives a picture of what the plant and its operation are like in his diary and makes a note of the special care, if any, that may be needed in the next shift.

The jobs included in this class of occupation have already been indicated at p.——and shown diagrammatically at C 66. Their relation to the plant has been discussed under Blast Furnaces, Steel Making Shops and the Blooming Mill at pages 33, 47, 49, 60 & 76.

Technical Aspect: General as on p. 91.

Specific: They should know the aspects of mechanical engineering and metallurgy relating to their sections as discussed on pages 91 —and give satisfaction to their shift foreman and general foreman. They should keep themselves informed of the latest developments in their line and be competent to remedy day to day defects and difficulties, e.g. clogging of the machine; exploding the salamander in a Blast Furnace; breaking the seal of the tap hole or treating the pig iron received if it has more phosphorous or sulphur in it than is permissible in the case of steel to be manufactured. In the Blooming Mill the mill foreman should be able to locate and remedy defects in controlling or manipulating or cogging. He should be able to determine from the appearance of the ingot as it is brought from the soaking pit if it has been subjected to the proper degree of heating.

Social and Economic: The rates of pay have not been disclosed to me by the Management. The note under Social and Economic /
Economic at pages 92 applies to this class as well.

**Psychological Aspect:** See notes on pages 92-97.

The following is the psychograph for this class:

**Trait**

1. Intelligence: Verbal
    * Non-verbal (spatial)

2. Drawing ability and pattern completion

3. Mechanical ability -
   - (a) Manual dexterity
   - (b) Mechanical explanation
   - (c) Perception reaction
   - (d) Stereotyped movements

4. Personality
   - Self-confidence
   - Industry
   - Emotional stability
   - Leadership

The difference between the psychographs for Class I and Class II is brought out by using a dotted contour for Class I, the emphasis in Class II is on practical ability.

**Skilled Jobs, Classes I and II.** A reference to page 96 will show that Class I includes third hands, fourth hands on the furnace side in Steel Making Shops; converters first, second and third, and head heater, assistant head heater, general foreman, bottom making section of the soaking pits; the shift foreman, Bottom House; the mixer foreman, Gas House foreman, general and shift; and the shift foreman and shift mistery on the mechanical side. The specific functions of these in the factory have been discussed at pages 90, 92, 94, 96, 97. These constitute a family of jobs as the duties of workers in this occupational level in the same department are interrelated and there is much in common between the workers.
workers in the corresponding jobs in different departments. Negatively, none of these requires a high class technical training. The people who get on to these are either High School passed men or graduates who have learnt the work in the jobs through experience, observation and private study. Some of the High School passed men have received training for five years in elementary mechanical engineering and elementary metallurgy at the Technical Institute. All these are supervisory jobs, but the labour to be supervised is not a highly trained one. We now amplify these features with specific reference to each job.

Steel Making Shop: Third and Fourth Hands. - A reference to page 50 would show that these persons are mainly concerned with work which requires manual dexterity and powers of observation - maintenance and repairs of the furnace under the technical guidance of first and second hands. By assembling dolomite, feed ore, etc., under the direction of second hand they learn the proportion in which they are to be used, and when and how. The help they render in digging out the plug hole or relining the launder or steel spout etc., gives them an opportunity to acquire manual dexterity. We would therefore expect in the new entrant a good measure of capacity for manual dexterity and quickness in the power of observation. If he possesses these and the necessary personality traits, he is sure to acquire the requisites of the job. Most of these are recruited from the lower ranks and hence come to the work with some amount of skill already acquired, and then improve upon it.

Converters 1st, 2nd, 3rd (see page 63) are more skilful in their operations than third and fourth hands. They are generally science graduates or trade apprentices of the Technical Institute, Jamshedpur, who have read up to the High School.
School standard and had training in mechanical work. First converter requires powers of quick observation as he is responsible for fixing up the converter in which the metal is to be blown and for receiving the metal and then signalling to the steel blower to start the operations. If he is a trained Technical Institute graduate, he has only to adjust himself to the work; if he is a graduate or a trade apprentice he has risen from the post of third converter and therefore comes with experience. In any case he has acquired manual dexterity. There is little room for initiative in this job. Second converter is mainly concerned with (1) the maintenance of the converter; (2) transfer of the metal, when blown, to the ladles and for recarbonizing the blown metal. Both of them require power of observation. The actual repairs to the bottom are done by the Bottom House staff under the supervision of third converter. But the second converter has to be vigilant about the defects in the repairs done and damage to the bottom after the metal blown has been emptied. The transfer of the metal to the ladles requires manual dexterity, but is mostly a matter of mechanical manipulation. The only important thing is recarbonizing, and the ability to do this is acquired through experience. The third converter is a junior of the second, and assists him in the maintenance of the converters. He employs the Bottom House khalasies under the Bottom House foreman for the repair of such bottoms as are down for rebuilding. The jobs of the Bottom House shift foreman and third converter have many points in common - the chief being the skill to build good bottoms and to observe the defects therein. But the job of the bottom shift foreman is more limited in its scope. He is a master mason, while third converter knows more about the chemical qualities of the silica lining and can tell by observation whether the lining is damaged or no. The shift foreman works in cooperation with third
third converter and examines the bottoms of converters to keep them in good condition and prevent mishaps. The actual building work is done by the khalasies in charge of a mason bottom foreman. Both third converter and the Bottom House shift foreman must have acquired skill in building the bottoms, and the theoretical principles underlying their construction. The chief qualities besides manual dexterity and power of observation that we expect from them are the qualities of good masons, and it would be useful to administer to them tests intended for bricklayers.

The Gas House general and shift foremen (see pages 56) are science men, with a B.Sc. degree, or those who have passed the intermediate examination with science. A student of chemistry has not much difficulty in becoming acquainted with the technique of the manufacture of gas, and no specific vocational test is called for. He must be a person with a high level of general intelligence, and to be really useful to the factory must be interested in metallurgy or mechanical engineering. In fact the best man at this job is a graduate in Metallurgy provided he has the qualities of leadership (see page 36).

The mixer foreman is also, like the foreman of the gas producing plant, a man with a good knowledge of chemistry and metallurgy (see page 59).

Blooming Mill: The general foreman of the bottom making section of the soaking pits requires the same abilities as does the Bottom House shift foreman.

Heaters and assistant heaters require a good knowledge of metallurgy, and though at present these posts are filled by Science graduates or those who have passed their intermediate examination with Science, the best men for the job are graduates in Metallurgy.

All the jobs in this category require a robust physique.
physique and the ages of men vary from 21 to 60 years.

Mechanical foremen are concerned with the maintenance of the plant and require the abilities needed of the workers, discussed above, with greater emphasis on mechanical ability. But as the placing of men in either the operational or mechanical side is a matter of vacancies forthcoming rather than ticketing off according to greater or less leaning for mechanical jobs, we should at this stage be satisfied if they conform to the Occupation psychograph for this class of job.

We may now summarise the main features of this category of workers:

(a) Mostly graduates in science.
(b) Qualification or training by the factory, in metallurgy, masonry and elementary mechanical engineering.
(c) Apprenticeship for three years or promotion from lower ranks.
(d) Social and Economic.- These men have the chance to go up as general foreman or first hand or mill hand in their respective departments.
(e) Psychological aspects:

<table>
<thead>
<tr>
<th>Traits</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Intelligence: Verbal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Verbal (Spatial Relations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II. Drawing ability and pattern completion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III. Mechanical ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Manual dexterity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Mechanical explanations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Perceptual speed reaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Stereotyped movements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To these must be added the personality traits we expect this class of workers to possess. We did not find a high degree of self-confidence in this class of people most of whom /
whom were struggling to get on to higher jobs. Even the most confident cannot stand failure and defeat for an infinite period. And these people had often to strive against overwhelming odds - favouritism and nepotism in a certain class of supervisors. But they were quite industrious. Nor were they very high in the ranking for emotional stability, though many of them knew well enough how to get workers under them pull their weight. We may represent the Occupational psychograph for this occupational level thus:

<table>
<thead>
<tr>
<th>Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Intelligence: Verbal</td>
</tr>
<tr>
<td>Non-verbal (spatial relations)</td>
</tr>
<tr>
<td>II. Drawing ability and pattern completion</td>
</tr>
<tr>
<td>III. Mechanical ability as in:</td>
</tr>
<tr>
<td>(a) Manual dexterity</td>
</tr>
<tr>
<td>(b) Mechanical explanation</td>
</tr>
<tr>
<td>(c) Perceptual speed-reaction</td>
</tr>
<tr>
<td>(d) Stereotyped movements</td>
</tr>
<tr>
<td>IV. Personality traits:</td>
</tr>
<tr>
<td>(a) Self-confidence</td>
</tr>
<tr>
<td>(b) Industry</td>
</tr>
<tr>
<td>(c) Emotional stability</td>
</tr>
<tr>
<td>(d) Leadership</td>
</tr>
</tbody>
</table>

Skilled Jobs Class II.- The jobs included in this occupational group are those of (1) Stock House and High Line foremen and Traffic Foremen, Stockyard and Pitside foremen and the foremen of bottom making (Soaking Pits), general and shift foremen, stripper yard, coggers, manipulators and control drivers on the Operation side, and shift head rigger, fitters, welders, blacksmith, moulder, gas burner mistri, pyrometeman, engine drivers and transfer table operators on the /
the Mechanical side (see page 87). All these jobs require manual dexterity rather than any theoretical knowledge. The situations in which this capacity is brought into operation differ from job to job, and we make these situations the basis of our classification:

(1) Jobs of riggers, fitters, welders, blacksmith, moulder, gas burner mistri, engine drivers, transfer table operators, cogsers, manipulators and control drivers all require manual dexterity, i.e., deftness with the hands in a very high measure. The head rigger (see page 43) is responsible for the work of those who do petty repairs by climbing giddy heights. Fitters (see page 43) are engaged in fitting up parts, welders in joining pieces, moulders in making parts in moulds, and blacksmiths in shaping iron pieces. All these owe their proficiency to skill with their hands.

Engine drivers, transfer table operators (see pages 57 & 7), cogsers, manipulators and control drivers have to handle machines and operate them, and so besides manual dexterity they require mechanical ability as well. The same is true of the gas burners mistri. He must know the mechanism of the gas producer plant and the way to operate it. The pyrometerman should be able to fit up the pyrometer and take readings.

(2) Stock House, High Line foremen, traffic foremen, (see page 37), the Stockyard and Pitside foremen in the Steel Making shops, the foreman, bottom making (Soaking Pits), and the general and shift foremen of the stripper yard, all were engaged in work requiring manual dexterity before they were promoted to the posts they hold. The Stock House and High Line foreman (see page 37) had to empty mundas (open trucks) and drive the lorry in the earlier days of their service. The Stockyard foreman had to work at the furnaces to repair them and charge the ore into them. The Pitside foreman removed the slag himself at one time and is expected to know /
know the best method of handling it and loading it. The bottom-making (soaking pits) foreman had the actual experience of repairing and building the bottoms of the pits, and the stripper yard foreman had first-hand experience of stripping the ingots and knows the best way of doing it. Thus all these jobs presuppose some degree or other of manual dexterity, but more than that, the ability to organise labour.

The following psychograph gives the qualities which our observation led to consider essential for this class of worker. A candidate when selected for this occupational level should be allowed to try his hand at a number of jobs in this category as an apprentice and then allotted to such of them as occupy a high place in his preference. Besides aptitude, the liking is often influenced by congenial companionship and the desire to continue in the profession of one's father or family.

### Traits

#### I. Mechanical ability

(a) Manual dexterity

(b) Perceptual reaction

(c) Stereotyped movements

#### II. Intelligence:

- Non-verbal (spatial relations)
- Planning and foresight

#### III. Personality traits:

(a) Industry

(b) Stability of emotions

(c) Leadership (power of organisation)

The pay for this class ranges from Rs.60 to Rs.250 per month and the employee has the chance of being promoted to skilled jobs Class I if he can show good work and acquire some proficiency in theoretical knowledge.

Lastly /
Lastly we come to the jobs classed as unskilled. By skill is meant, to use the words of Oakley, ease in execution and the class of people included in this group are in the course of acquiring it. But the expression "ease in execution" is a comparative one. Even a labourer who does no other work except collecting rags, acquires some ease. What we mean by ease is the facility a person would acquire through experience in relation to jobs which require some degree of technical training. Hence we have classed keeper and his assistant and the cinder snapper, stove tender and runerman (see pages 41 ) as unskilled. But as they have acquired ease in the performance of an ordinary sort of manual work we have placed them under unskilled jobs Class I (see page 87). For the same reasons the jobs of the converter khalasi (see page 63 ) foreman, recorder ( P 63 ) and transfer men in the Steel Making shops have been placed under Class I. The shear recorder (see page 75), number taker (see page 75), general labour foreman, gas cutter, crop thrower in the Blooming Mill and cobbler, stove cleaner, hammerman and oiler on the mechanical side have a very limited scope for manual dexterity. We have mentioned their activities in discussing the human factor in the operation of the plant. The following is the occupational psychograph for this class of workers:

<table>
<thead>
<tr>
<th>Traits</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Mechanical ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Perceptual reaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Manual dexterity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II. Intelligence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-verbal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(spatial relations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III. Personality traits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Stability of emotions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All the rest of labour is described as Unskilled
Class II, and this amounts to saying that they work under the direction of men who have had either practical training or because of their experience and efficiency have been placed in jobs which require ease in the execution of work relating to the maintenance or operation of the plant. As labour is required for heavy load and other work of this nature, it is very difficult to have a well marked occupational psychograph for this class. The only condition for employment is that they should be physically fit and be not too deficient in intelligence. The minima for both have to be determined empirically.
112.

NOTE "A".

We were considerably assisted in our observation of the fundamental traits needed for engineering jobs by a study of the tests employed by E. Patricia Allen and Percival Smith for the selection of skilled apprentices for engineering trades in pursuance of a research sponsored by the City of Birmingham Education Committee. The following is a list of the tests employed:

1. **N.I.I.P. Tracing**: A pencil and paper group test of ability to draw a continuous line as quickly as possible from one point to another through small gaps in certain obstructions without touching the edge of the obstruction.

2. **N.I.I.P. Variable Adjustment**: A pencil and paper group test of ability to extend as quickly as possible a series of lines of varying lengths by distances equal to their own lengths.

3. **Cox's Mechanical Models**: A series of 12 wooden models. Each model is so constructed that the candidate can only see the first or last link in a chain of mechanical events which occur when a model is worked by hand. He is required to show by a simple sketch (with the addition of a verbal explanation if he likes) how the observed movements are brought about.

4. **Cox's Mechanical Explanation**: In this group test the candidate is presented with a paper containing five mechanical diagrams each of which is accompanied by a written description. He is required to answer a set of questions about each diagram which involves explanation of the way various parts of the mechanism work.

5. **N.I.I.P. Form Relations Test**: This is a pencil and paper group test of ability to judge visually both shape and size. The candidate has to select from among a series of numbered shapes those necessary to fill certain spaces. There are eight sub-tests, and judgment of both plane and solid /
solid shapes is necessary.

6. **N.I.T.P. Memory for Design Test:** This is a pencil and paper group test of immediate visual memory for eight designs. Each design is exhibited for ten seconds and the candidate is immediately required to reproduce it to the best of his ability.

7. **Cow's Mechanical Diagrams:** For this group test four large wall diagrams are employed and a booklet of questions is supplied to each candidate. The first two diagrams represent actual objects (a brake band and an automatic tipping scale), while the remaining two represent various mechanically connected items such as rods and wheels, which, although working together, constitute no existing object. Each item is lettered and the candidate referring to the letters, answers questions as to how the mechanism works.

These eight tests were selected out of 15 used in the first experiment in 1931 because they were found to be most predictive.

(Third Report of Research - January 1939)
Mechanical Ability, according to Wittenborn, is "an expression for whatever ability or abilities are required for creditable work with tools and machinery, i.e. mechanical "work." (Educational and Psychological Measurement: Vol.II, No.3, Autumn 1945). A battery of 26 tests under VII heads was employed, and the following six factors were found:

(i) Spatial visualization;
(ii) Stereotyped movements;
(iii) Scholastic ability;
(iv) Manual dexterity;
(v) Perceptual-speed;
(vi) Steadiness.

The following tests were included in the battery:

I. Standard Group Intelligence Tests:
   (i) Army Alpha, Form 6 (Group Paper)
   (ii) Otis Self-Administering Tests of Mental Ability, Higher Examination, Form A. (Group Paper).

V. Tests
   (i) Otis Self-Administering Tests of Mental Ability, Higher Examination, Form A. (Group Paper).

II. Simple Motor Tests:
   (i) Tapping Test A. (Group Paper).
   (ii) Tapping Test B. (Group Paper)
   (iii) Tapping Test C. (Individual Apparatus).
   (iv) Steadiness of motor control (Individual Apparatus)
   (v) Accuracy of Movement or Tracing Board (Group Paper)
   (vi) Accuracy of Movement or Tracing Board (Individual Apparatus)
   (vii) Aiming (Individual Paper)
   (viii) Speed of Movement (Group Paper).

III. Balancing Tests:
   (i) Body Balancing (Individual Apparatus)
   (ii) Stick Balancing (Individual Apparatus).

IV. Complex Eye-Hand Coordination Tests:
   (i) Link's Machine Operators (Individual Apparatus)
   (ii) Card Sorting (Individual Apparatus)
   (iii) Card Assembly (Individual Apparatus)
   (iv) /
(iv) Packing Blocks (Individual Apparatus).

V. Assembly Tests involving manipulation and responses to Spatial Relations:

(i) Stenquist Assembly (Group Apparatus)
(ii) Paper Form Board (Group Paper)
(iii) Link's Spatial Relations (Individual Apparatus)
(iv) Cube Construction (Group apparatus)

VI. Tests of Mechanical Knowledge:

Stenquist Picture Tests I and II (Group Paper)

VII. Miscellaneous Tests:

(i) Slow Movement or Motor Inhibition (Individual Paper)
(ii) Digit Symbol Substitution (Group Paper)
(iii) Letter Cancellation (Group Paper)
(iv) Number Cancellation (Group Paper)
(v) Rhythm or Perception of Time (Group Apparatus)

The testees were boys rather than men because it was felt that in boys individual differences would be determined less by differences in the amount of mechanical training and more by stable abilities which accrue from "general sources."
CHAPTER IV.

SAMPLING HUMAN TRAITS

Each job, whatever its nature, requires to begin with the direction of mental effort. In course of time the strain of mental effort decreases and one gets used to the work in hand. The feats of an acrobat may dazzle the spectators, yet they have become a matter of course to him. But mostly, if not universally, people engaged in a job are willing, not necessarily anxious, to enlarge their understanding of the work in hand. Even the lethargic Indian peasant is interested in agricultural exhibitions and in getting an insight into the working of the latest agricultural machinery. And he would certainly use it if he had the resources to do so. These facts are intended to illustrate two things: (1) with mental effort there comes proficiency in one's job and the mental effort decreases as one gains proficiency (of course within the limits of one's capacity); (2) proficiency itself is relative, and to excel in a line the sphere of the job has to be broadened so that one may know its bearings and inter-coralations. Thus the sphere of chemistry applied to the melting of iron had to be broadened with the help of the knowledge of physics to expedite the process of "reducing" in the Blast Furnace with the use of blast. And the standard of proficiency also goes up. The men in charge of blast furnaces and converters are now trained technical graduates. It is not enough to acquire a working knowledge by experience, but the candidates selected should combine a sound theoretical knowledge with a capacity to benefit by experience. These are the persons who may be expected to make improvements in the process of melting or refining. Most people when they apply for a job profess interest in it, but appearances are sometimes deceptive. The attempt should therefore be to find out /
out the attitude of a candidate to the job or groups of jobs he professes interest in. Is it merely economic or social pressure that makes the applicant aspire to the job, or does he really have a real liking for the kind of work the job would entail? Has he made this inclination of his purposive and effective by his studies? To diagnose this we have to determine his attitude towards the job or, to be more exact, towards the family of such jobs. 

Attitude is an expression used to describe the approach of a person to a certain occupation or class of occupations. And psychology seeks to find out (1) "Given a certain situation or stimulus, how will the individual respond"? (2) what are the deeper trends which prompt his response?; and (3) what is the degree of valence in the external influences, such as economic and social incentives, that will sustain his response?

Let us now illustrate the concept of Attitude as put forward here. Suppose we want to find out the suitability of a candidate X for the job of furnace foreman. We know from the biographical data that he has taken a university degree in Metallurgy and has also studied Elementary Engineering. But we are concerned to find out what would be the most probable response of the candidate when working at a sweating temperature for eight hours and facing the practical problems of melting. In other words, what would be his "tendency to action" in such a situation. Here our inventory and tests should

1. An Attitude is a disposition to act which is built up by the integration of numerous specific responses of a similar type, but which exists as a general neural "set", and when activated by a specific stimulus results in behaviour that is more obviously a function of the disposition than of the activating stimulus. - Psychological Review Publications: Monograph Vol.XLII, No.5, p.5.


should serve as pointers, and we should be able to construct an attitude scale for this whole class of workers, i.e. Technical Jobs, Class II. The place of a candidate on this scale would give us an idea of what would be the nature of his probable response. He may be naturally disposed towards such jobs, and the economic and social incentives would ensure its continuance and prevent him from drifting into avenues where his talents and his education might be wasted.

In order to assure ourselves of the permanence of this disposition, we would find out the deeper trends, exhibited in his hobbies, imagination, family and social environment, and his economic outlook in the matter of industrialisation of his country and his social outlook towards dignity of manual labour. Lastly, we determine the value of external influences like social status and economic betterment. A person who takes up a job in order to ensure a high social status and economic prosperity, can never be so good and thorough in it as a person who is strongly motivated by his inner disposition towards that class of occupation.

An Occupational Psychograph (see Chapter III) is a graphic way of describing analytically the attitude expected of an average worker. It is hypothetical to begin with, but becomes objective as the data accumulate (see Chapter III/85) and enable us to quantify the traits. Corresponding to the Occupational Psychograph is the Individual Psychograph which gives quantitatively the assessment of an individual in relation to the traits in the Occupational Psychograph.

Let us see how the psychologist goes about his job in preparing an Occupational Psychograph. He studies jobs to find out how they may be grouped, and as he advances in his investigations he traces out relationship or affinities among the "families", e.g. jobs X Y Z constitute one family as
as they all require the same technical training and human traits as, for instance, ability to use fingers cleverly, the capacity to perceive spatial relations and fit up a machine and acuteness of visual perception to distinguish various shades of colour. Each job may also require certain specific abilities but we want a first fitter and the men so selected may then be guided into different jobs according as they possess specific abilities for this or that group of jobs. There may, however, be men who, because of their superior talents, can do equally well in all these; and if they possess the makings of a good leader in them they should make good officers. These are men who could be well up in quite a few families of jobs; their number is very small, but they are the salt of the earth in their own line.

The psychologist should have the capacity to devise with increasing success tests which provoke into activity the mental traits which constitute the structure of the Occupational Psychograph for a family of jobs. The usual practice is to start with a battery of tests, quite comprehensive, and then to administer it to a random sample (say, selected according to the tables of Fisher and Yates) of workers in that occupation. The choice of the tests may be well informed or ill informed, well planned or haphazard. We discuss a modus operandi for the choice of tests elsewhere in this thesis. It is said that the tests should show a high correlation with proficiency and low correlation among themselves. The scores in Proficiency are described as the criterion. The hypothesis underlying this procedure is that there are independent abilities, unitary or complex in their organization, which are brought into activity in the performance of the test.

4. The psychologist himself needs two things: (a) experience or very close intimacy with the jobs he studies; (b) a penetrating insight into the mind of workers.
performance of certain jobs or groups of jobs, and if each of them makes its effective contribution, the performance would would be successful. Each test is correlated with the criterion and the tests themselves are intercorrelated. And thus the best weights are obtained by the process of Pivotal Condensation for Multiple Correlation, i.e., the maximum correlation of the tests cumulatively with the criterion. Statistically this hypothesis is justified thus: Suppose there are A, B, C, D and E tests for P, Q, R, S and T abilities, and each of them is a pure test of one independent ability and of none other. The following conclusions follow:

1. As these abilities are needed cumulatively for proficiency in a family of jobs, we expect each to correlate highly with the criterion.

2. The intercorrelations of the tests should be low as they assess independent abilities.

No. 1 presupposes that proficiency can be analysed into components, and these components are individually the contribution of one ability in particular. And, if so, the correlation between each test and proficiency is not between one test and the whole of proficiency, but between one ability measured by as pure a test as possible, and one component of proficiency. So the co-variance is not between proficiency as a whole and each test, but between the components of proficiency and each pure test. Symbolically there is nothing very strange or impossible about this hypothesis. The entire area within the circle of Proficiency is Proficiency, and if the tests are represented by small circles, each one of them will have a segment of the big circle of Proficiency as the area of covariance. But there is no division into compartments in the working of the human mind in relation to a job or family of
of jobs. Proficiency is a dynamic conception and the abilities are only comparatively independent. For example, ability to understand the human mind is one ability, and the ability to express oneself in felicitous language another. Some have one and some the other. Thus these two abilities may appear comparatively independent. But the same person may combine both. In fact, Proficiency is not a mere summation of independent abilities. It is a unique product. In applying statistical devices, we make human activity which is essentially dynamic static. The notion of a static treatment would have been justified if a cross-section of human mind in operation could give us a picture of human abilities functioning independently in relation to a job. But this never happens. What we are writing on this page is not the mere resultant of our knowledge of English, conditions in an iron and steel factory, psychology and statistics; it is a complex whole which has become integrated through what Angyal calls "symbolisation". All that we may posit about this whole is that the aforesaid branches of knowledge have gone into the synthesis, and this synthesis would be richer as our understanding of these branches develops into an integrated whole. But we cannot isolate the various contributions completely as we do successfully in a chemical analysis. We are, therefore, driven to the conclusion that abilities, taken in isolation, cannot account for proficiency. There is a constant process of synthesis which makes the contribution of these one whole at each stage of experience or learning. Angyal very pertinently remarks "the dynamic structure".

5. Discussing Thurstone's analysis of Strang's data on professional interests, Chant says: "he (Thurstone) finds the following independent interest factors: (1) interest in science; (2) interest in language; (3) interest in people; (4) interest in business. Independent in this instance certainly does not mean that they cannot express themselves in the behaviour of the same individual, so to this extent at least they are not psychologically independent." - The Jour. of Educational Psychology, 1935, Vol. XXVI, pp. 265-66.
structure of the organism can be more adequately described "as a system of attitudes than as a system of drives. The "process of activation of an attitude may be called Setting. 6 We may represent this holistic concept of attitude thus:

The activation in the factory setting:

<table>
<thead>
<tr>
<th>Attitude A.</th>
<th>Attitude B.</th>
<th>Attitude C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liking for mechanical ability.</td>
<td>Practical work.</td>
<td>Confident approach to the work in hand.</td>
</tr>
</tbody>
</table>

Objectively all these are presented as a whole and from the point of view of other subject the attitudes in relation to each constitute a system.

There is something like a hierarchy almost unconscious in the organization of the attitudes. And it is the compactness of this organization that accounts for individual differences in the approach to one's occupation. A man with compact organization shows determination, understanding and perseverance in his occupation, whereas one with loose organization tends to dissipate energy. It is in this sense that Angyal describes Attitudes as Activity Patterns. They "define only the pattern, but not the details of the corresponding activity." 7

We are therefore justified in concluding that the abilities, taken in isolation, cannot account for Proficiency. This has an important bearing on the formulation of tests for the selection of personnel in the factory. These should be framed with due regard to the activities which the jobs entail; and abilities in relation to jobs in factories tend to shade into one another and we should confine ourselves to broad ones. A conglomeration of tests is no good, whatever its utility in discovering /

---

discovering factors and getting a simple structure. That must await a second survey. We may sum up our position thus:

1. Proficiency cannot be split into static components, each of them being the contribution of one ability.

2. Abilities themselves do not function independently. They are organized into whole of more or less compactness through attitudes. The higher the mental level of a person the greater is his capacity to organise his abilities into one whole in relation to his jobs or family of jobs. The contribution in such cases is one whole, though there is greater manifestation of one ability than another in most cases.

3. The conception of independent abilities in factory workers is not a tenable one. One is equally well justified in advancing the hypothesis of contributory abilities. By contributory abilities we mean abilities like drawing ability and verbal ability which, though seemingly independent, may be integrated in the same person. Each contributes towards an integration. Thus it is the verbal ability which enabled surrealists or cubists to indicate the principles of their drawings to others. In the case of factory workers, we propose to formulate tests which relate individually to some (in this first survey) of the abilities we expect the workers in a particular group to possess (e.g. see the psychograph at p. 162) and correlate high with technical proficiency, that is near about 60. And if they intercorrelate highly, we need not throw them out for reasons stated in Chapter I, page 14. The Multiple Correlation of this Battery of Tests with the proficiency of the select population to which we plan to administer our tests should then be found and the best weights obtained.

4. If we accept the inevitability of a synthesising capacity of a limited nature, we would be justified /
justified in talking in terms of group factors. No test can be completely pure; and hence to facilitate classification for the purpose of earmarking tests as predominantly assessing certain traits in the Occupational psychograph, we fall back upon this concept. By group factor we mean a hypothetical concept which covers some ability or abilities assessed by some tests, but not all, or to an insignificant degree. The expression to describe the extent to which a test possesses a certain group factor is "saturation" or "loading".

5. When we have taken out the general factor and the group factors, whatever of the communalities remains is specific to the tests.

6. The statistical device to achieve these results is Factorial Analysis.

7. The loadings of factors may be either negative or positive or zero. Negative loadings are not very helpful for the purposes of classification (see 4)}, and hence to make the analysis meaningful, it is best to rotate the axes and make the negative loadings positive.

According to Thurstone, a negative loading is meaningless because it "would have to be interpreted to mean "that the possession of an ability has a detrimental effect on "the test performance."

We recommend rotation to get positive loadings and eliminate negative loadings, not because we think they are meaningless, but because they are likely to occasion confusion. A hypothetical concept like Factor is a symbol for the combination of a number of abilities, and it may be deleterious to the functioning of some other combination, e.g. Carlini was melancholic temperamentally, but he cultivated the skill of a joker as well, with the result that this skill, instead of relieving his melancholy, as it did /

---

did of the audience, deepened his own. This is a case of one trait having a deleterious effect on another. But a multiplicity of negative loadings would only make for confusion and hence it is a good device to make all loadings either positive or nearly zero. According to Thurstone the mind "is structured into constellations" and Factorial Analysis should help us to divine it. This is more than is justified by the present advance in Factorial Analysis. All that we are justified in saying is that an average human mind has a capacity to synthesise the data from its environment into certain constellations, well or ill knit, according to its innate capacity. Social, economic and educational environment. These constellations are the neural counterparts of attitudes and motivate the usual reaction of an average person in the group tested to the environment to which the tests relate. Thus a number of persons living and working in the same environment may have similar constellations. This is in keeping with Hull's hypothesis regarding Generalized Stimuli and Generalized Response. "Some of this 'structure' is", as Thomson says, "no doubt innate; but more of it probably due to environment and education and life."

9 Emerson describes an amusing incident: "When Carlini was convulsing Naples with laughter, a patient waited on a physician in that city to obtain some remedy for excessive melancholy which was rapidly consuming his life. The physician endeavoured to cheer his spirits and advised him to go to the theatre and see Carlini. He replied, "I am Carlini"." - "Letters and Social Aims" by Ralph Waldo Emerson - Routledge 1899, p.166.

10 E.g. Culture of a group usually contains a small or large number of behaviour patterns.

engaged in a family of jobs several contributory abilities tend to develop a synthesis in some measure or other. Working on this hypothesis we propose to frame an aptitude test for engineering jobs intended to assess ability for the perception of spatial relations, for drawing and pattern completion and mechanical ability (mechanical models and explanations), and administer it to a select group of workers whose technical proficiency is easily ascertainable from the workers under them and those above them (if possible). We shall take care to find out that these are men who have a similarity of attitude towards their jobs, i.e., they have a real interest in engineering jobs of some form or other and have been trained or gained considerable experience in such work. We would supplement this by tests of Verbal and Non-Verbal Intelligences and attempt to discover a common core of ability with the help of the classificatory device of Factorial Analysis. The results of this survey would serve as a jumping board for a more comprehensive second survey.

In view of the fact that the management of Tata's expressed their inability to obtain technical proficiency of the population, we wanted to test, we adopted the following plan to assess technical proficiency to validate our proposed tests:

(i) The technical proficiency of the testees was discussed with their superior officers whenever possible and a score assigned.

(ii) It was discussed with their subordinates or colleagues and the consensus of opinion found.

(iii) In some cases it was discussed with both, and the two scores were recorded separately, like 45/50, and the lower score was accepted.

(iv) The following plan was used in getting the assessment made. The person assessing technical proficiency was /
was asked to locate the man in one of the four quarters.

He was told to think in terms of four steps and to say where the man may be said to stand.

It was easy enough for a large number of persons to say where the testee stood. If it was 3 the score was 40, and if it was 80. But there were cases in which the statement was not categorical and then the man was to locate as well as he could the place in one of the rectangles. Thus, supposing he said X was not exactly on the third step, but he would not say he was on the fourth. Then could he be midway between P2, P being the 4th step? The answer most often was "possibly". And so we assessed the proficiency as $\frac{20 + 30}{2} = 25$, i.e. the average of two estimates, the lower and the higher. This plan saved time and made it possible to get an estimate of the technical proficiency of the man concerned from those in close touch with him. The work had to be done through confidential enquiries and private talks. As said before, the management found it almost impossible to obtain the technical proficiency score of the people tested and we had to resort to this device. Brief notes like step 4 or step 3 were taken down on the spot and converted into scores at night.

The maximum limit was fixed at 80 because we thought it safer to err on the side of underestimate particularly when the assessment was based on private talks and confidential enquiries. Allowance had to be made for professional jealousy and interdepartmental bickerings, and in all such cases so far as possible the opinion of the subordinates and superiors were both obtained. Both the subordinates and the superior officers were unwilling to state their opinion publicly and hence we avoided taking down their names.
CHAPTER V

TESTS: THEIR FORMULATION AND TRY-OUT

A. FORMULATION

We now proceed to make our selection of the tests. The field we have surveyed in Chapter III was very wide and consequently it was very difficult to draw up tests for the whole factory in our first survey. The work could only be done piecemeal and we began by drawing up tests for engineering aptitude, treating different kinds of engineering, mechanical, electrical, etc., as variants of certain fundamental traits. We decided to administer the tests we chose to a group of the population engaged in technical jobs Class II and skilled jobs Class I. The traits we were attempting to assess were those indicated in the hypothetical occupational psychographs at pages 102 and 107. These limitations were necessary for two reasons: (i) we wanted to begin with a small number of traits which we thought might give us the broad essentials of the cognitive abilities most needed (and to be found) in those who go in for engineering jobs of the nature analysed in Chapter III. This is what we pleaded for in our Rationale, Chapter IV; (ii) The time at our disposal was limited and we could not arrange the testing programme as we would have liked. It had to be fitted into the daily routine of the grades of workers we had selected to test. No man could be spared twice and not necessarily when he was free.

The next problem before us was to have tests of intelligence, verbal and non-verbal, so that we might be able to find out the mean scores for these classes of workers and later administer them to skilled workers, Classes I and II separately. We have used the expression 'g' (general intelligence) in a limited sense in Chapter I. But we expect men in the superior services and in skilled jobs to have a greater capacity for the synthesis of the environmental data than in the workers lower down in the scale of employment. They must have the competence /
competence to understand the immediate environment as well as an average adult of 16+ does. This would enable them to bring their instructions and explanation to the level of the illiterate and semi-literate workers in India. In short, a good score in such tests raises the expectation that they have sturdy common sense. Men who are good at these tests (i.e. are above the average) are very likely to understand the technique of their jobs satisfactorily if they have the necessary mechanical aptitude. We agree with Alexander that "g" is on the average more important than any of the other factors" using 'g' as an expression for the capacity to synthesise the environmental of increasing complexity and range.

We had thus to formulate three tests as the starting point of our survey, viz.-(i) a Verbal Group Test of Intelligence; (ii) a Non-Verbal Group Test of Intelligence; and (iii) an Aptitude Test.

Verbal Group Test of Intelligence: We analyzed the tests of Terman and Merrill for 11+ and 14+ and discovered that most of the items could be arranged under certain broad heads like Perception, Memory, Imagination and Reasoning. These are abstract expressions, but have gained currency in Psychology, general and experimental. We analyzed the Moray House Test, Adult 2 by W.G. Emmett (in consultation with Professor G.H. Thomson) and found that the items in it could also be classified under these heads.

---

1 We do not consider 'g' ubiquitous in the sense of Spearman.

2 Perceptions of Spatial Relations:
   Test Items - 63-72 (shading into those under Imagination).
   Imagination:
   11-13 (Constructive Imagination); 27; 28; 29-35; 36-39; 40-45; 73-81 (language); 90-92 (Memory) arith.; 95-100.
   Reasoning:
   1-10 (Reasoning by Analogy); 53-66 (Reasoning by Analogy);
   26 (Arithmetical Reasoning); 82-89 (Arithmetical Reasoning); 93-94 (Arithmetical Reasoning).
It was on this basis that we proceeded to draw up two parallel forms on the assumption that a high correlation between them was a good measure of the reliability of test items. Both of these may then be taken to provoke into activity much the same mental operations. These two forms were administered to candidates seeking admission to the Indian Air Training Centre, University of Allahabad, and we went on improving them with varying degrees of success till we had evolved Forms A and B. These forms were administered to one hundred children, 60 boys and 40 girls, by Miss R. Paintal, a student of mine, in the Punjab. She also undertook to standardize the test. The main features of the administration were (a) selection of a suitable place for the administration of the forms with due regard to ventilation, lighting, comfortable seats and avoidance of distraction; (b) the time for the administering of the test was so arranged that the testees came to the test with fresh brains. Of course allowance had to be made for the convenience of the institutions concerned; (c) instructions were explained and where necessary demonstrations were given as how to do a thing or avoid doing it. A buffer test was worked out with the help of the testees. The time allowed for each of the two forms was 45 minutes.

The first half of the try-out group was given Form A, first and the other half Form B, first, the interval between the administration of the two forms being a week, or ten days if holidays supervened. The following results were obtained:

<table>
<thead>
<tr>
<th>Try-Out (Age 16+)</th>
<th>Form A</th>
<th>Form B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>92-6</td>
<td>90-6</td>
</tr>
<tr>
<td>Mean</td>
<td>43.7</td>
<td>42.8</td>
</tr>
<tr>
<td>S.D.</td>
<td>19.42</td>
<td>19.20</td>
</tr>
<tr>
<td>Gm</td>
<td>1.942</td>
<td>1.92</td>
</tr>
</tbody>
</table>

Correlation between Forms A and B: .8523

Index of Reliability: .92 i.e. the correlation coefficient between the obtained scores and their corresponding "theoretically" true scores. The correlation between the two forms

3 & 4 See Appendix B.
forms is not satisfactory, seeing that the Moray House tests correlate as high as .95 for boys and .957 for girls, the number being 470 and time interval 48 days. However, this was only the beginning of a long process of refinement to attain the standard reached by the Moray House tests.

Our next step was to have a final test paper of 100 items based on the analysis of the items in the two forms. The following table gives 100 test items in Forms A. and B. which fall within the various step intervals:

<table>
<thead>
<tr>
<th>Step Intervals</th>
<th>Frequency</th>
<th>S.N. of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-99</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td>10</td>
<td>10B, 7B, 8B, 9B, 11B, 26B, 1B, 29A, 27A, 66B.</td>
</tr>
<tr>
<td>60-69</td>
<td>11</td>
<td>67B, 68A, 30A, 31B, 32B.</td>
</tr>
<tr>
<td>50-59</td>
<td>22</td>
<td>33A, 35B, 34B, 49A, 50B, 17B.</td>
</tr>
<tr>
<td>40-49</td>
<td>22</td>
<td>19A, 20A, 18B, 54B.</td>
</tr>
<tr>
<td>10-19</td>
<td>7</td>
<td>100B, 13A, 16B, 99A, 14B, 3A, 4A, 5A, 6A.</td>
</tr>
<tr>
<td>0-9</td>
<td>2</td>
<td>41A, 44B, 42B, 43A, 47B, 45A, 46A.</td>
</tr>
</tbody>
</table>

According to the procedure in vogue in Moray House, all the items answered by more than 80% or less than 20% should have been thrown out as they are not much good for discrimination. If we had adopted this procedure, we would have had to knock off 15 questions, 6 in the step interval 80-89, 7 in 10-19 and 2 in 0-9. However, we selected 100 items.
items, picking out the parallel question with higher facility value. The method adopted by us aimed at obtaining a curve as close to the theoretical frequency as possible. 5

Miss Paintal and ourselves cooperated so far, but each one of us made an independent selection from the Try-Out scores (see Appendix C). Both of us made some departures from the principle of selecting test-items of higher facility value in preference to the lower. Miss Paintal selected three items with lower facility value in the interest of the uniformity of instructions for a group of test items or because they were one of the chain of questions on a single problem. As we are concerned from this point onward with our test alone, we shall give reasons for our own departures. We made a departure in the case of seven test items, viz., items 43, 53, 62, 63, 65, 94 and 95. Items 94 and 95 of Form B were selected in spite of their lower facility value because they formed part of a chain of questions on a single problem. (See page 6 of the Verbal Group Test). Items (Form B) 43, 53; (Form A) 62, 63 and 65, were selected, in spite of their lower facility value, because the test was intended for the educated adult population of the Tata Iron and Steel Company, and we wanted/ 5 According to the practice in vogue in Morey House, we should have taken about 200 questions and administered them in two parts to the Try-Out group. After the scripts had been marked they should have been divided into six groups in order of merit. We should have then tabulated the mark for each item under these six groups and found the total of the subjects answering each test item by adding the number under each group, e.g.-

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>Total %</th>
<th>E.13</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>13</td>
<td>18</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>79.79</td>
<td></td>
</tr>
</tbody>
</table>

To find out the efficiency value we use the formula $E_{.13} = \frac{(S1 + S2) - (S5 + S6)}{\sqrt{3}}$ where $S1$ is the top sixth and $S2$ second top sixth, and $S5$ and $S6$ the bottom ones. Thus the $E1$ may be $(25 + 13) - (8 + 2) = 43 - 20 = 33 = .99$. 

Besides rejecting all questions above 80% facility value and below 20% facility value, we do not admit any question whose efficiency correlation is less than .5. The advantage of this procedure lies in increasing S.D., which should, in the case of a complete year group, be at least 25% of the number of test items.
wanted to introduce a few difficult questions. All these
relate to language. We expected the educated employees in the
Technical Jobs Class \textit{Hand and Skilled} in the factory to have a
better understanding of the English language than the 16+
population of schools and colleges. The following table
gives the difference between the facility value of the items
included and their parallels which were excluded.

<table>
<thead>
<tr>
<th>Item</th>
<th>Forms</th>
<th>Facility Value</th>
<th>Item Selected</th>
<th>Difference in Facility Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>A</td>
<td>14</td>
<td>43B</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>A</td>
<td>31</td>
<td>53B</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>A</td>
<td>42</td>
<td>62B</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>A</td>
<td>25</td>
<td>63A</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>A</td>
<td>26</td>
<td>65A</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>94</td>
<td>A</td>
<td>42</td>
<td>94B</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>A</td>
<td>31</td>
<td>95B</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix C gives in a tabular form the questions
which are common to our draft and that of Miss Paintal. There
are only eight items in which our tests differ. Column 2

gives the number of items in Miss Paintal's tests which

corresponds to ours and columns 4 and 5 show the form from

which we selected the item, and column 3 the facility value

for the question selected. In 92 cases our choice is the

same; in the other eight cases Miss Paintal chose the parallel
questions from a form different from ours. Altogether the two
tests are almost the same. We wanted Miss Paintal's test to
be much like ours (we followed the same principle in selecting test items) so that when she had standardised her test over 100 16 subjects, we might have the mean and S.D. for adult population in schools and colleges and compare them with ours. Our expectations were that the standard deviation in our testing would be larger than in the case of Miss Paintal. She had only one age group (16+), whereas in our case ages ranged from about 22 to 50 years. Miss Paintal arranged the items selected in the ascending order of difficulty, but we retained the serial number of the parallel forms.

Besides the Verbal Group Intelligence Test we also included in our testing, and so did Miss Paintal, a modification of the Army Beta Test. Our object was to have a non-verbal test of intelligence, based mostly on the perception of spatial relations, and find out the correlation between the two. The Beta Test has been administered to a very large population in the U.S.A. and can safely be taken as a good yard measure for testing the intelligence of adults. We introduced a few changes.

The Beta Test as designed in the U.S.A. consists of

1) Maze Test; 2) Cube Analysis; 3) X-C Series;
4) Digit Symbol; 5) Number Checking; 6) Pictorial Completion; 7) Geometrical Construction. The time allowed is 50 minutes. We made of it a thoroughgoing group test and prepared a manual of instructions (see Appendix D.), illustrating by sketches the principal features of each test. Each item in the test was allowed one mark, and these were cut down to 100. The maximum score in the original Beta Test is 118 and the method of scoring is as follows:

<table>
<thead>
<tr>
<th>Test</th>
<th>Method of Scoring</th>
<th>Maximum Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Half point for each half</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Number right</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Number right</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>One third of number right</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Right minus wrong</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>Number right</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>Number right</td>
<td>10</td>
</tr>
</tbody>
</table>

We /
We give a tabular analysis of our modifications and indicate in column 4 the nature thereof:

<table>
<thead>
<tr>
<th>No. of Item</th>
<th>Original Description</th>
<th>Our Modification</th>
<th>Nature of Modification</th>
<th>Maximum Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Base</td>
<td></td>
<td>One mark for each right answer is either right or wrong</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>II Cube Analysis</td>
<td></td>
<td>No modification in scoring</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>III X-O</td>
<td></td>
<td>No modification. Number right.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>IV Digit Symbol</td>
<td></td>
<td>Each item carries one mark if correctly entered.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>V Number Checking</td>
<td></td>
<td>In the original test the method of correct checking was adopted.</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>VI Picture Completion</td>
<td></td>
<td>Omitted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VII Geometrical Construction</td>
<td></td>
<td>One mark for each right answer.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>VII Matrix</td>
<td></td>
<td>Our addition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We had to drop the picture completion test because of the difficulty of getting blocks prepared, and in its place we introduced a matrix sub-test. As this modified Beta Test was to be used for the educated adults in the technical jobs of the factory, we thought it better not to make marking easy by adopting the procedure of the original test in the case of the
the Maze sub-test and the Digit Symbol sub-test. In Number Checking right minus wrong would have been a much better method of scoring. But we felt that as we had tightened up marking in Tests I and II we must allow latitude in this test. We further shortened the time to 22 minutes as a result of our experimentation with various groups. Miss Paintal allowed 30 minutes. Her non-verbal test contained a Picture Completion Test and did not omit it as did ours. The number checking test gave breathing space to the otherwise hardworked testees. The shortening of the time limit made speed a very important factor for this test. (For the test see Appendix D)

Finally we come to the Aptitude Test. The original draft was prepared in collaboration with Mr. J. P. SRIVASTAVA. It was intended for testing the candidates who aspired for engineering jobs. In pursuance of the Rationale set forth in Chapter IV, we began with the most general cognitive traits included in the Occupational psychographs (see page 137) and had sub-tests on observation of similarities and following directions, perception of spatial relations, drawing and pattern completion and mechanical ability. Manual dexterity, stereotyped movements and perceptual reaction could not be brought into a paper and pencil aptitude test and had to be left out, during our first survey, in testing the employees in technical.

6 We started the experimentation about time with 30 minutes and gave the test to about 40 clerks of the Tata Iron and Steel Company. We found the mean score for the group which was in the neighbourhood of 55. When the same time was allowed to the graduate apprentices of the Technical Institute the mean score shot up. We then reduced the time limit to 20: it was found rather too short. We finally got good results with 22 minutes, the mean verging on 50.

7 A scrutiny of the items of this test on the lines of Moray House will result in throwing out not a few items but the whole of some sub-tests, e.g. the Maze test, the X-O test, and possibly the Number Checking test. We postpone decision till we come to a final appraisal of our test results. See Chapter V.
technical jobs Class II and skilled jobs Class I. Now the Beta test as adapted by us is mostly a test of the ability to perceive spatial relations. This scheme has been designed with a set purpose—the tests are allied and there is a link to connect up one test with the other. The Verbal Group Test of Intelligence has 25 questions out of 100 on the Perception of Spatial Relations, and the Beta Test relates 50 to 60 per cent. to these relations, and the Aptitude Test has 25 per cent. questions which would be covered by this head of classification. We have put forward in Chapter IV the view that the conception of independent abilities should give place to contributory ones in relation to industrial jobs, and the tests were designed in pursuance of this. "Life," says Stern, "is the unity of being and acting in a totality open to the environment. A living "being is of such character that its total nature is constantly "being actualized through its activity while likewise remaining "a whole in its incessant intercourse with the environment."\(^8\)

The draft prepared in collaboration with Mr. Srivastava consisted of the following:

<table>
<thead>
<tr>
<th>Sections</th>
<th>Test Items</th>
<th>Nature of Test</th>
<th>Psychological significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Qns. 1-3, T.items 17</td>
<td>Spatial relations</td>
<td>Test of sustained attention and visual discrimination.</td>
</tr>
<tr>
<td>II</td>
<td>Qns. 1-3, T.items 19</td>
<td>Following directions</td>
<td>Reaction.</td>
</tr>
<tr>
<td>III</td>
<td>Qns. 1-2</td>
<td>Geometrical drawing and completion of pattern</td>
<td>Constructive imagination</td>
</tr>
<tr>
<td>IV</td>
<td>Qns. 1-2</td>
<td>Mechanical models and tools</td>
<td>Mechanical ability.</td>
</tr>
<tr>
<td>V</td>
<td>Qns. 1-5, T.items 6</td>
<td>Mechanical problems</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>Qns. 1-2, T.items 17</td>
<td>Everyday science</td>
<td>Interest in physical science.</td>
</tr>
<tr>
<td>VII</td>
<td>T. items 8</td>
<td>Mathematical problems relating to physical laws</td>
<td>Interest in mathematical aspects of mechanical operations.</td>
</tr>
</tbody>
</table>

---

\(^8\) General Psychology (from the Personalistic Standpoint) by William Stern. Macmillan 1933 - p.71.
The test was administered to 45 students of the Engineering College, Benares Hindu University, and the following Mean and Standard Deviation were obtained:

Mean: 85.1
Standard Deviation: 11.24

Next we proceeded to find out the inter-correlations of the sub-tests or sections with a view to combining the highly correlated sections if each of them tested the same supposed ability or some ability which, on afterthought, might lead us to think to be unnecessary.

**Correlational Matrix**

<table>
<thead>
<tr>
<th></th>
<th>Sec.I</th>
<th>Sec.II</th>
<th>Sec.III</th>
<th>Sec.IV</th>
<th>Sec.V</th>
<th>Sec.VI</th>
<th>Sec.VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sec.I</td>
<td></td>
<td>0.0481</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sec.II</td>
<td>0.1511</td>
<td></td>
<td>0.0751</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sec.III</td>
<td>0.1580</td>
<td>0.4288</td>
<td>0.0751</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sec.IV</td>
<td>0.3660</td>
<td>0.1435</td>
<td>0.3668</td>
<td>0.4103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sec.V</td>
<td>0.1947</td>
<td>0.2468</td>
<td>0.3978</td>
<td>0.5291</td>
<td>0.0360</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sec.VI</td>
<td>0.0628</td>
<td>0.0844</td>
<td>0.2616</td>
<td>0.2322</td>
<td>0.2400</td>
<td>0.2932</td>
<td></td>
</tr>
<tr>
<td>Sec.VII</td>
<td>0.3668</td>
<td>0.4103</td>
<td>0.3668</td>
<td>0.5719</td>
<td>0.3668</td>
<td>0.3668</td>
<td>0.3668</td>
</tr>
</tbody>
</table>

Section II (following of directions) did not relate to any ability particularly needed for engineering jobs and so we deleted it.

Sections III, IV and V correlated high, i.e., above .25, among themselves and hence we treated them as complementary.

Section VI correlated high with Sections II, III, IV and VII, and low with Sections I and V. As the section contains quite a few items which had no bearing as such on aptitude for engineering jobs, we decided to drop it in the first survey and incorporate it in the test which we propose to administer in the second for specific ability for metallurgical jobs.

Section VII correlated low with Section I, and its correlation /
correlation with Sections III, IV and V ranged from .24 to .28. It contained mathematical questions and we decided to retain it.

Thus we decided to retain sections relating to Spatial Relations (Section I); Geometrical Drawing and Completion of Patterns (Section III); Mechanical Models and Tools and Mechanical Problems (Sections IV and V); Mathematical Problems (Section VII), and deleted sections relating to the following of directions (Section II) and Everyday Science (Section VI).

The next step was to find out which of the questions in the sections selected were satisfactory to be retained. As the battery was intended to be administered to the superior staff of the Tatas (men in technical jobs Classes I and II) and to those in skilled jobs Classes I and II, who could not on an average be as competent as the students of the Engineering College, we decided upon having so far as possible a steep slope of the facility values of the test items selected. This, we hoped, would ensure enough of easy questions for the workers in skilled jobs, and yet would contain a good percentage of difficult ones to make the battery not too easy for men in the superior ranks. (See Histogram Appendix.)

Section I. - Taking each question separately and arranging the parts according to the descending order of the facility value, we get the following slope:

<table>
<thead>
<tr>
<th>Q.1</th>
<th>d</th>
<th>41</th>
<th>91</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>e</td>
<td>40</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>f</td>
<td>40</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>g</td>
<td>40</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>h</td>
<td>39</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>38</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>j</td>
<td>37</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>k</td>
<td>36</td>
<td>80</td>
</tr>
<tr>
<td>Q.s. 2 &amp; 3</td>
<td>a</td>
<td>33</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>30</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>27</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>d</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>e</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>f</td>
<td>6</td>
<td>13</td>
</tr>
</tbody>
</table>

Combining /
Combining the facility value of all the items we get the following:

<table>
<thead>
<tr>
<th>Q.1</th>
<th>%</th>
<th>Q.2</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>38</td>
<td>a</td>
<td>43</td>
</tr>
<tr>
<td>b</td>
<td>36</td>
<td>b</td>
<td>35</td>
</tr>
<tr>
<td>c</td>
<td>33</td>
<td>c</td>
<td>35</td>
</tr>
<tr>
<td>d</td>
<td>32</td>
<td>d</td>
<td>34</td>
</tr>
<tr>
<td>e</td>
<td>29</td>
<td>e</td>
<td>33</td>
</tr>
<tr>
<td>f</td>
<td>28</td>
<td>f</td>
<td>28</td>
</tr>
<tr>
<td>g</td>
<td>26</td>
<td>g</td>
<td>21</td>
</tr>
<tr>
<td>h</td>
<td>21</td>
<td>h</td>
<td>20</td>
</tr>
<tr>
<td>i</td>
<td>17</td>
<td>i</td>
<td>15</td>
</tr>
<tr>
<td>j</td>
<td>13</td>
<td>j</td>
<td>13</td>
</tr>
<tr>
<td>k</td>
<td>12</td>
<td>k</td>
<td>12</td>
</tr>
<tr>
<td>l</td>
<td>10</td>
<td>l</td>
<td>10</td>
</tr>
<tr>
<td>m</td>
<td>9</td>
<td>m</td>
<td>9</td>
</tr>
<tr>
<td>n</td>
<td>8</td>
<td>n</td>
<td>8</td>
</tr>
<tr>
<td>o</td>
<td>6</td>
<td>o</td>
<td>6</td>
</tr>
<tr>
<td>p</td>
<td>5</td>
<td>p</td>
<td>5</td>
</tr>
<tr>
<td>q</td>
<td>4</td>
<td>q</td>
<td>4</td>
</tr>
<tr>
<td>r</td>
<td>3</td>
<td>r</td>
<td>3</td>
</tr>
<tr>
<td>s</td>
<td>2</td>
<td>s</td>
<td>2</td>
</tr>
<tr>
<td>t</td>
<td>1</td>
<td>t</td>
<td>1</td>
</tr>
</tbody>
</table>

The slope is not steep, the number of facility values above 50 is almost four times as large as those below 50. We, however, retain the whole section as it correlates very low with all other sections. This sub-test contains items on spatial relations and if the correlation of these items with the Beta Test is high in our first survey, we may drop the Beta Test.

Section III. - Taking each question separately, we get the following slopes:

<table>
<thead>
<tr>
<th>Q.1</th>
<th>%</th>
<th>Q.2</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>84</td>
<td>a</td>
<td>96</td>
</tr>
<tr>
<td>b</td>
<td>80</td>
<td>b</td>
<td>78</td>
</tr>
<tr>
<td>c</td>
<td>73</td>
<td>c</td>
<td>78</td>
</tr>
<tr>
<td>d</td>
<td>71</td>
<td>d</td>
<td>76</td>
</tr>
<tr>
<td>e</td>
<td>64</td>
<td>e</td>
<td>73</td>
</tr>
<tr>
<td>f</td>
<td>64</td>
<td>f</td>
<td>64</td>
</tr>
<tr>
<td>g</td>
<td>62</td>
<td>g</td>
<td>62</td>
</tr>
<tr>
<td>h</td>
<td>58</td>
<td>h</td>
<td>58</td>
</tr>
<tr>
<td>i</td>
<td>57</td>
<td>i</td>
<td>57</td>
</tr>
<tr>
<td>j</td>
<td>53</td>
<td>j</td>
<td>53</td>
</tr>
<tr>
<td>k</td>
<td>52</td>
<td>k</td>
<td>52</td>
</tr>
<tr>
<td>l</td>
<td>48</td>
<td>l</td>
<td>48</td>
</tr>
<tr>
<td>m</td>
<td>47</td>
<td>m</td>
<td>47</td>
</tr>
<tr>
<td>n</td>
<td>44</td>
<td>n</td>
<td>44</td>
</tr>
<tr>
<td>o</td>
<td>38</td>
<td>o</td>
<td>38</td>
</tr>
<tr>
<td>p</td>
<td>33</td>
<td>p</td>
<td>33</td>
</tr>
<tr>
<td>q</td>
<td>32</td>
<td>q</td>
<td>32</td>
</tr>
<tr>
<td>r</td>
<td>31</td>
<td>r</td>
<td>31</td>
</tr>
<tr>
<td>s</td>
<td>30</td>
<td>s</td>
<td>30</td>
</tr>
<tr>
<td>t</td>
<td>29</td>
<td>t</td>
<td>29</td>
</tr>
<tr>
<td>u</td>
<td>28</td>
<td>u</td>
<td>28</td>
</tr>
<tr>
<td>v</td>
<td>27</td>
<td>v</td>
<td>27</td>
</tr>
<tr>
<td>w</td>
<td>26</td>
<td>w</td>
<td>26</td>
</tr>
<tr>
<td>x</td>
<td>25</td>
<td>x</td>
<td>25</td>
</tr>
<tr>
<td>y</td>
<td>24</td>
<td>y</td>
<td>24</td>
</tr>
<tr>
<td>z</td>
<td>23</td>
<td>z</td>
<td>23</td>
</tr>
</tbody>
</table>

Combining the two questions we get the following slope which shows that the items range from the easiest to the most difficult, and the dispersion of the facility value is not uneven:

Q.3 a/
Section IV. — Taking each question separately, we get the following slopes:

<table>
<thead>
<tr>
<th>Q. 1</th>
<th></th>
<th>Q. 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>42</td>
<td>b</td>
<td>44</td>
</tr>
<tr>
<td>b</td>
<td>42</td>
<td>c</td>
<td>43</td>
</tr>
<tr>
<td>c</td>
<td>17</td>
<td>d</td>
<td>41</td>
</tr>
<tr>
<td>d</td>
<td>21</td>
<td>e</td>
<td>38</td>
</tr>
<tr>
<td>e</td>
<td>1</td>
<td>f</td>
<td>7</td>
</tr>
<tr>
<td>f</td>
<td>0</td>
<td>g</td>
<td>7</td>
</tr>
<tr>
<td>g</td>
<td>7</td>
<td>h</td>
<td>2</td>
</tr>
<tr>
<td>h</td>
<td>7</td>
<td>i</td>
<td>0</td>
</tr>
<tr>
<td>i</td>
<td>0</td>
<td>j</td>
<td>5</td>
</tr>
<tr>
<td>j</td>
<td>5</td>
<td>k</td>
<td>0</td>
</tr>
<tr>
<td>k</td>
<td>0</td>
<td>l</td>
<td>0</td>
</tr>
<tr>
<td>l</td>
<td>0</td>
<td>m</td>
<td>0</td>
</tr>
<tr>
<td>m</td>
<td>0</td>
<td>n</td>
<td>0</td>
</tr>
<tr>
<td>n</td>
<td>0</td>
<td>o</td>
<td>0</td>
</tr>
<tr>
<td>o</td>
<td>0</td>
<td>p</td>
<td>0</td>
</tr>
<tr>
<td>p</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q.1.— There are two items of the facility value of 93% and so we deleted one of them. We have not admitted more than one item of the facility value above 90 in any questions so far. This leaves us only one test item above the facility value 50, the rest are below it. We deleted Q.1.c of the facility value of 38, and thus there are left the following 93, 47, 7, 0; 93 is set off by 7 and 0.

Q.2.— There are three items of the facility value above 90, one of 80, two of 15, one of 5, and 2 of 0. We deleted the two top and the two bottom ones, as the two most easy and the two most difficult items. This would have left us only one question of 91% facility value. But the draftsman misunderstood our signs and deleted items h and f instead of deleting items c and b of 100 and 98 facility value. And thus the question has two items which are extremely easy.

Q.3.— We retained all the items.

Q.4 /
Q.4.- We deleted two items of the facility value of 93 and 91 and retained only one with 91\% facility value. We get the following slope for the whole section:-

<table>
<thead>
<tr>
<th>Question</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.2.e</td>
<td>100</td>
<td>Q.3.d</td>
</tr>
<tr>
<td>Q.2.b</td>
<td>93</td>
<td>Q.3.f</td>
</tr>
<tr>
<td>Q.2.a</td>
<td>96</td>
<td>Q.3.e</td>
</tr>
<tr>
<td>Q.1.e</td>
<td>93</td>
<td>Q.4.d</td>
</tr>
<tr>
<td>Q.3.c</td>
<td>91</td>
<td>Q.4.i</td>
</tr>
<tr>
<td>Q.3.a</td>
<td>89</td>
<td>Q.4.e</td>
</tr>
<tr>
<td>Q.2.a</td>
<td>84</td>
<td>Q.4.f</td>
</tr>
<tr>
<td>Q.3.b</td>
<td>80</td>
<td>Q.5.e</td>
</tr>
<tr>
<td>Q.4.b</td>
<td>73</td>
<td>Q.5.f</td>
</tr>
<tr>
<td>Q.4.c</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

(1) According to the Moray House standards Q's 2/e & b; Q3/b; Q1/b; Q4/c; Q3/e and Q3/a of facility values 100, 96, 93, 91, 89, 84; and Q2/i, Q1/e, Q2/e & f, of facility values 15, 7, 5, 2 and 0 should have been deleted, leaving only 7 items.

However, the easiest items are offset by the most difficult.

<table>
<thead>
<tr>
<th>Section V.</th>
<th>93</th>
<th>96</th>
<th>93</th>
<th>84</th>
<th>15</th>
<th>7</th>
<th>5</th>
<th>2</th>
<th>0</th>
</tr>
</thead>
</table>

We deleted Q.5 of the facility value of 96 and retained the rest. 10

<table>
<thead>
<tr>
<th>Section VII.</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.4.e</td>
<td>Q.2</td>
</tr>
<tr>
<td>Q.4.a</td>
<td>Q.3</td>
</tr>
<tr>
<td>Q.4.b</td>
<td>Q.4.a</td>
</tr>
<tr>
<td>Q.4.c</td>
<td>Q.5</td>
</tr>
</tbody>
</table>

We deleted Q's 4 and 3 with 91 and 89 facility value and retained the rest.

Having admitted quite a few test items in Sections I, III and IV with facility values above 90\%, we deleted all such in Sections V and VII.

In Section VII we came, fortunately and through shear /
sheer coincidence, very near the Moray House standard. There is only one question, 5b, with a facility value of 15 which should have been deleted. 11

B Try-Out in the Tatas

We administered all the three tests — the Verbal Group Intelligence Test, the Beta Test, and the Aptitude Test (see Appendix D) to a population of 214 men in the Technical Jobs Class II and Skilled Jobs Class III. The management did its best to spare and persuade as many men in these jobs as possible to take the tests. Our method of sampling was to take the list of the supervisory staff of each department and to pick out about one third by drawing lots. But of those so selected, only two-fifths or so could be persuaded to take the tests. Though the number of subjects who took all the tests was only 214, the number of subjects tested for each test separately was larger.

<table>
<thead>
<tr>
<th>Group Intelligence Test</th>
<th>223</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Beta Test</td>
<td>231</td>
</tr>
<tr>
<td>Aptitude Test</td>
<td>264</td>
</tr>
</tbody>
</table>

The

We give below a table showing the items which should have been deleted according to the Moray House standard. We reserve our final decision till we come to the analysis of the facility value for each test item after the try-out in the Tatas where the test would be administered to workers in Technical jobs Class II and Skilled Jobs Class III. [See Note]

Section I.  Q.1 - a, b, c, d, e, f, g.
Q.5 - c and d.
Altogether 9 test items out of 17 are of doubtful value.

Section III.  Q.1 - a.
Q.2 - a, c, j.

Section IV.  Q.1 - a, b, c, f.
Q.2 - the whole question.
Q.3 - b, c, e.
Q.4 - c, d, e.

Section V.  Q's 5, 2 and 4a.

Section VII.  Q's 3 and 4&5b.

Thus, out of 71 test items retained by us, we should have deleted 29; and this would have left us only 42 test items. (But Compare Note A)
The tests were administered according to the instructions laid down for each, though we could not ensure that the subjects came fresh to the hall we held our tests in. However, a very large percentage did. The following are the figures for the Mean and Standard Deviation for each test:

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>S.D.</th>
<th>S.E. of Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Intelligence Test</td>
<td>49.29</td>
<td>23.07</td>
<td>1.545</td>
</tr>
<tr>
<td>Modified Beta Test</td>
<td>52.57</td>
<td>26.85</td>
<td>1.774</td>
</tr>
<tr>
<td>Aptitude Test</td>
<td>35.74</td>
<td>12.87</td>
<td>0.7921</td>
</tr>
</tbody>
</table>

Let us compare these figures with those obtained by Miss R. Paintal for the Group Intelligence and the Modified Beta Test with a population of 16+. We have stated at page 133 that her tests were somewhat different from ours. We give below the figures for the two:

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Intelligence Test</td>
<td>45.64</td>
<td>17.33</td>
</tr>
<tr>
<td>Non-Verbal &quot;</td>
<td>49.50</td>
<td>17.88</td>
</tr>
</tbody>
</table>

The ages of the population tested by us vary from 22 to 50 years and consequently the standard deviation is bound to be much larger than in the case of Miss Paintal. But our mean is higher in both the tests and comes very near 50% of the maximum score in each test. In the case of the Aptitude Test, we may compare our figures with those obtained by Mr J.P. Svirastava from the Banaras University Engineering College:

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Svirastava's</td>
<td>37.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Ours</td>
<td>35.74</td>
<td>12.87</td>
</tr>
</tbody>
</table>

The standard deviation in the case of Mr Svirastava is rather low, but in our case it is 5 points higher. The mean in our case is about 50% of the maximum score.

Thus our means are quite satisfactory for the class of people for whom the tests are intended. But the same cannot be said of the standard deviation. It should be one-fourth of the number of test items, i.e., if the maximum score is 100, the standard deviation should be in the neighbourhood /
neighbourhood of 25. This ensures that the test items have brought a larger degree of variability in capacity within the limits of 30% than would be possible with a low standard deviation.

Judging by this criterion, the standard deviation of our Verbal and Non-Verbal Group Intelligence Tests are satisfactory. They are 23.07 and 36.967 respectively - that is, one one-fourth of the maximum score. But the standard deviation of the Aptitude Test is not so satisfactory. It is only 12.87, whereas to make the battery sensitive enough it should be 18. This weakness is probably due to our admitting test items below the facility value of 20% and above 80%.

Our next step was to obtain proficiency scores for the population tested, and this we did in the manner indicated in Chapter IV. We then obtained intercorrelations among the Verbal Group Intelligence Test, Non-Verbal Group Intelligence, the Battery of Aptitude Tests and its subtests relating to Spatial Relations, Drawing and Pattern Completion and Mechanical Ability and Proficiency scores.

The following is the Correlational Matrix:*  

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof.</td>
<td>.</td>
<td>.325</td>
<td>.635</td>
<td>.9800</td>
<td>.5193</td>
<td>.7382</td>
<td>.7179</td>
</tr>
<tr>
<td>V.T.</td>
<td>.</td>
<td>.635</td>
<td>.702</td>
<td>.6927</td>
<td>.6243</td>
<td>.5144</td>
<td>.5438</td>
</tr>
<tr>
<td>B.T.</td>
<td>.</td>
<td>.635</td>
<td>.702</td>
<td>.6395</td>
<td>.6062</td>
<td>.4723</td>
<td>.5165</td>
</tr>
<tr>
<td>Apt.T.</td>
<td>.</td>
<td>.980</td>
<td>.627</td>
<td>.6395</td>
<td>.7951</td>
<td>.8438</td>
<td>.7920</td>
</tr>
<tr>
<td>Sp.R.</td>
<td>.</td>
<td>.635</td>
<td>.606</td>
<td>.7951</td>
<td>.8438</td>
<td>.5445</td>
<td>.5246</td>
</tr>
<tr>
<td>Draw.</td>
<td>.</td>
<td>.635</td>
<td>.606</td>
<td>.7951</td>
<td>.8438</td>
<td>.5445</td>
<td>.5499</td>
</tr>
<tr>
<td>Mech.Ab.</td>
<td>.</td>
<td>.635</td>
<td>.606</td>
<td>.7951</td>
<td>.8438</td>
<td>.5445</td>
<td>.5499</td>
</tr>
</tbody>
</table>

The intercorrelations among the tests are quite high and there are no low correlations even among the sub-tests of the battery of Aptitude Test as in the correlational matrix at page 138. We are of opinion that this rise in the intercorrelations /

* See Note 8
intercorrelations is due to the fact that the subjects tested have a greater capacity for the synthesis of the data under each test than was the case with the students of the Engineering College at Benares. This is what we meant when we said in Chapter I, "the expression 'g' is used for the synthesis of certain group factors ...". How many of the "group factors can be combined, rather contribute towards the articulation of a whole will depend upon the gravitation of the bonds involved and the degree of gravitation, will depend upon the innate strength of the neurones and the "environmental influences which make varied interconnections "possible." (pages 81-86).

The correlation of the tests, particularly the battery of Aptitude test, with the Proficiency scores is quite high. We therefore proceeded to find out Regression Coefficients (see NOTE B) and obtained the following:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V.T.</td>
<td>.1035</td>
<td>.0309</td>
<td>.7449</td>
<td>- .0761</td>
<td>.0223</td>
<td>.0415</td>
</tr>
</tbody>
</table>

The only significant weight is one for the Aptitude test. As said at page 137 there is much in common between the Beta test and the Spatial Relation sub-test, and hence the weightage for the Spatial Relation sub-test is negative. We further analyzed the correlational matrix of the tests (see Appendix E) and obtain four factors as a result of the centroid analysis and the rotation of axes.

<table>
<thead>
<tr>
<th></th>
<th>F.I</th>
<th>F.II</th>
<th>F.III</th>
<th>F.IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.T.</td>
<td>.4238</td>
<td>.0296</td>
<td>.3292</td>
<td>.6474</td>
</tr>
<tr>
<td>E.T.</td>
<td>.4427</td>
<td>0</td>
<td>.3292</td>
<td>.6233</td>
</tr>
<tr>
<td>Sp.Rel.</td>
<td>.0953</td>
<td>.1598</td>
<td>.0595</td>
<td>.8702</td>
</tr>
<tr>
<td>Drawing</td>
<td>.0242</td>
<td>.5690</td>
<td>.4745</td>
<td>.5188</td>
</tr>
<tr>
<td>Mech.Ab.</td>
<td>.4849</td>
<td>.4839</td>
<td>0</td>
<td>.5272</td>
</tr>
</tbody>
</table>

F.4 has appreciable loading in each test and we therefore designate it as 'G' factor. F.1 has appreciable loadings /
loadings in the Verbal Test, Beta Test and Mechanical Ability
sub-test, and has negligible loadings in other tests. We
designate it as Verbal Factor. Its appreciable loading in the
Beta Test is due to the fact that the subject had to interpret
the instructions and illustrations for each section in the
English language and a deficiency in it was a definite handicap.
F.2 has appreciable loadings in the battery of the Aptitude
Test, in the Drawing and Pattern Completion sub-test and in the
Mechanical Ability sub-test; and so we designate it as
Mechanical Ability Factor. F.3 has appreciable loadings in
the Verbal, the Beta and the Drawing and Completion Tests, and
we designate it Spatial Factor. A scrutiny of the Verbal Test
will show that it contains a section on spatial relations
(i.e. the items relating to perception). Thus our tests assess
the 'G', Mechanical Ability, the Ability for Drawing and
Pattern Completion and for Discovering Spatial Relations. But
the Regression Coefficients (see page 146) show that the
Aptitude Test alone is sufficient to assess ability for
engineering jobs and may be supplemented by the Verbal
Intelligence Test. We can safely drop the Beta Test. The
multiple correlation obtained with the help of regression
coefficients is .8698 which is no improvement on the correlation
between the battery of Aptitude Test and proficiency, i.e. .88.
Altogether the Aptitude and the Verbal Intelligence Test can be
said to have been validated; the regression coefficients for
these are significant at .0000 and .03 levels, respectively.

12 The correlation obtained by the Straight Sum and the
Pooling Square is .762 for the Verbal and Non-Verbal
Group Intelligence Tests and the Battery of Aptitude
Tests; .696 for all the tests and the sub-tests, and
.647 for the Verbal and the Non-Verbal Intelligence
Tests and the three sub-tests of the Aptitude Test
(see Note 8).
### NOTE A.

**FACILITY VALUE**

<table>
<thead>
<tr>
<th>Section A.</th>
<th>Section B.</th>
<th>Section C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q. I (1) 61</td>
<td>Q. IV. (1) 65</td>
<td>Q. VI. (1) 12</td>
</tr>
<tr>
<td>(2) 87</td>
<td>(2) 65</td>
<td>(2) 77</td>
</tr>
<tr>
<td>(3) 70</td>
<td>(3) 65</td>
<td>(3) 91</td>
</tr>
<tr>
<td>(4) 50</td>
<td>(4) 30</td>
<td>(4) 53</td>
</tr>
<tr>
<td>(5) 85</td>
<td>(5) 30</td>
<td>(5) 23</td>
</tr>
<tr>
<td>(6) 61</td>
<td>(6) 30</td>
<td>(6) 74</td>
</tr>
<tr>
<td>(7) 70</td>
<td>(7) 42</td>
<td>Q. VII. (1) 80</td>
</tr>
<tr>
<td>(8) 52</td>
<td>(8) 55</td>
<td>(2) 32</td>
</tr>
<tr>
<td>(9) 60</td>
<td>(9) 54</td>
<td>(3) 53</td>
</tr>
<tr>
<td>(10) 60</td>
<td>(10) 22</td>
<td>(4) 3</td>
</tr>
<tr>
<td>Q. II. (a) 56</td>
<td>Q. VIII. (1) 45</td>
<td></td>
</tr>
<tr>
<td>(b) 50</td>
<td>(2) 26</td>
<td>(2) 62</td>
</tr>
<tr>
<td>Q. III. (1) 61</td>
<td>Q. IX. (1) 61</td>
<td></td>
</tr>
<tr>
<td>(2) 57</td>
<td>(2) 70</td>
<td>(2) 70</td>
</tr>
<tr>
<td>(3) 60</td>
<td>(3) 50</td>
<td>(3) 50</td>
</tr>
<tr>
<td>(4) 45</td>
<td>(4) 41</td>
<td>(4) 47</td>
</tr>
<tr>
<td>(5) 45</td>
<td>Q. X. 75</td>
<td></td>
</tr>
<tr>
<td>Q. V. (1) 20</td>
<td>Q. XI. 72</td>
<td></td>
</tr>
<tr>
<td>(2) 22</td>
<td>Q. XII. 40</td>
<td></td>
</tr>
<tr>
<td>(3) 22</td>
<td>Q. XIII. 81</td>
<td></td>
</tr>
<tr>
<td>(4) 14</td>
<td>Q. XIV. 24</td>
<td></td>
</tr>
<tr>
<td>(5) 24</td>
<td>Q. XV. 15</td>
<td></td>
</tr>
<tr>
<td>(6) 21</td>
<td>Q. XVI. 11</td>
<td></td>
</tr>
<tr>
<td>Q. VII. (a) 56</td>
<td>Q. XVII. 35</td>
<td></td>
</tr>
<tr>
<td>(b) 50</td>
<td>Q. XVIII. 0</td>
<td></td>
</tr>
<tr>
<td>Q. VIII. (1) 45</td>
<td>Q. XIX. 1.9</td>
<td></td>
</tr>
<tr>
<td>Q. IX. (1) 61</td>
<td>Q. XX. 1.4</td>
<td></td>
</tr>
</tbody>
</table>

Correlation of the Items which should have been Rejected
according to the Moray House Standards under Sections with
Proficiency Scores:

- **Spatial Relations**: .6227
- **Drawing and Pattern Completion**: .8230
- **Mechanical Ability**: .5877

20 Items to be Rejected
See Page 51.
NOTE B.

WEIGHTS AND MULTIPLE CORRELATION.

The following Regression Coefficients for the sub-tests relating to Drawing and Pattern Completion, Mechanical Ability and Spatial Relations and the Verbal (Group) Intelligence, Modified Beta and the Aptitude Tests were obtained by Aitken’s Method of Pivotal Condensation.

<table>
<thead>
<tr>
<th>Sub-tests</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing and Pattern Completion</td>
<td>0.223</td>
</tr>
<tr>
<td>Mechanical Ability</td>
<td>0.0415</td>
</tr>
<tr>
<td>Spatial Relations</td>
<td>0.0751</td>
</tr>
<tr>
<td>Verbal (Group) Intelligence</td>
<td>0.1095</td>
</tr>
<tr>
<td>Modified Beta</td>
<td>0.0299</td>
</tr>
<tr>
<td>Aptitude</td>
<td>0.7549</td>
</tr>
</tbody>
</table>

\[ \text{rm}^2 = 0.7382 \times 0.223 + 0.7179 \times 0.0415 + 0.619 \times 0.0751 + 0.6825 \times 0.1095 + 0.5858 \times 0.0299 + 0.3800 \times 0.7549 \]

\[ \text{rm} = \frac{0.7913}{0.7913} = 0.88955 \text{ or } 88.96 \text{ app.} \]

Check

The Multiple Correlation was checked with the help of the Pooling Square:

\[
\begin{array}{c|c|c|c|c|c|c}
1 & .7913 & & & & & \\
\hline
.7913 & .0165 & + & .0299 & & & \\
\hline
& .0512 & + & .0748 & & & \\
& .0572 & + & .0845 & & & \\
\hline
1 & .7913 & & & & & \\
\end{array}
\]

\[ \text{rm} = \frac{0.7913}{0.7913} = 0.88955 = 89 \text{ app.} \]

The following correlations with Proficiency scores were obtained by the Method of "The Straight Sum and the Pooling Square".

<table>
<thead>
<tr>
<th>Tests</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal (Group) Intelligence, Modified Beta and Aptitude Tests and Sub-tests relating to Spatial Relations, Drawing and Pattern Completion and Mechanical Ability</td>
<td>0.698</td>
</tr>
<tr>
<td>Verbal (Group) Intelligence and Modified Beta Tests and sub-tests relating to Spatial Relations, Drawing and Pattern Completion and Mechanical Ability (Aptitude Test left out)</td>
<td>0.647</td>
</tr>
<tr>
<td>Verbal (Group) Intelligence, Modified Beta and Aptitude Tests (sub-tests left out)</td>
<td>0.762</td>
</tr>
</tbody>
</table>
CHAPTER VI.

(A)

A CRITICAL ESTIMATE OF DATA AND CONSTRUCTIVE PLAN FOR SECOND SURVEY.

We have presented a statistical analysis of our data in the preceding chapter. It is to the credit of our tests that (1) they correlate highly among themselves as planned (see Chapter I, p. 6); (2) they correlate highly with Proficiency; and (3) the Mechanical Aptitude Test has the largest weight, (see Chapter V.).

But it would be wrong to say that we have the most potent tests for the selection of workers in the technical jobs. In estimating proficiency, we took account of the general engineering ability of the persons tested, but left out (1) special abilities, and (2) personality traits. Now both of them are equally important in administrative jobs. It is not only necessary to possess mechanical aptitude as assessed by our tests, but also workers in the different departments must have special qualifications through training or private study, in the technical line concerned, e.g. metallurgy in the Blast Furnace, pattern making in the Foundry, etc. However, these are matters to be determined principally by trade tests. Most people when selected would be able to make up their mind within a month or so of their preliminary training as to where their inclinations lay. Placement in specific jobs is not so much a matter of personnel selection as of vocational guidance within the factory. We are therefore not disposed to frame Aptitude Tests for specific jobs. Our Aptitude Test should serve as an effective fitter and thereafter we depend on short term observation (say, a week) of the candidates for Technical Jobs, Class II, and Skilled Jobs, Class I, interviews, and psychiatric tests of memory / proficiency.
necessary, for all classes of jobs. When selected, provision should be made for suitable training, and the candidates may be allowed option in selecting jobs to the extent that the exigencies of the factory permit.

Aptitude Test and Selection of Personnel

We have validated our Battery of Aptitude Test and the Verbal Intelligence Test with reference to Technical Jobs, Class II and Skilled Jobs Class I. But it can be validated for Skilled Jobs, Classes I and II, separately. We should select 50 men from each of these classes, with superior technical abilities, and administer the test to those in Class I in English, and to those in Class II in the vernacular, and find out the intercorrelation of these with the proficiency scores for technical abilities. If the multiple correlation of these with the criterion is high enough, say .70, we can use these tests for purposes of selection. It would be safe to lay down the mean obtained for each class as the minimum for the eligibility of a candidate.

We can get the best prediction of proficiency in theoretical ability by multiplying the standardized scores of the eligible candidates by the weights for the Verbal and Aptitude Tests as obtained by Pivotal Condensation (Aitken's Method), e.g. A. scores 52 in the Aptitude Test and 60 in the Verbal Test. We can predict his proficiency score thus:-

\[
\text{Predicted score of } X \text{ in Proficiency:} \\
= \frac{52 - 35.746}{12.87} \times .7549 + \frac{60 - 49.298}{23.070} \times .1095 \\
= 1.263 \times .7549 + .464 \times .1095 \\
= .9534 + .0508 = 1.0042
\]

Standardized Score of X in Proficiency.
Proficiency Score of X: 1.0042 \times 11.9 (5\text{ of Proficiency Scores})
+ 48.0 (Mean of Proficiency)
\equiv 11.94998 + 48.0
\equiv 60.0/100 approximately.

But mere theoretical knowledge is not enough in a factory. We must have some measure of practical ability too (see the Occupational psychograph for different classes) or potentiality for practical ability. To this end we administered Pass Along, Peg Board, Unscrewing and Nuts and Bolts Tests to about 80 workers in the Unskilled class. But it was very difficult to get Proficiency scores for even 50 to judge the effectiveness of the battery, and hence we could not determine the validity of these tests. Nor was it possible to administer them to the population to whom the Aptitude Test was administered. They could not be spared from their supervisory jobs a second time for individual testing. However, we held that tests of practical ability are indispensable for determining the suitability of new entrants in all grades and would include them in our Second Survey.

As the plan for a Second Survey is mainly determined by our analysis of the Occupation and Test results in the First Survey, it would not be out of place to indicate it in brief:

1. A more advanced Group Aptitude Test as a supplementary to our Aptitude Test to those in Technical Jobs, Class II, and in Skilled Jobs, Classes I and II, in the manner suggested in (2) below.

2. Individual psychological tests to assess Manual Dexterity, Perceptual Speed or Reaction, and Stereotyped Movements (see Occupational Psychographs pages 39, 102, 107, 109). These will be administered to a random sample obtained with the help of Fisher and Yates Table, of 100 from the Unskilled,
50 from the Skilled and 50 from the Technical grades. These numbers will be picked out from 300 Unskilled, 150 Skilled and 75 Technical men, whom the management ranks\(^1\) between 60-80 on a percentile scale of proficiency, taking into consideration both their trade skill and desirable personality traits. We shall then find out if the scores of these three groups are significantly different, and correlate each of the tests with the other and with proficiency for each group separately.

(3) Our Group Aptitude Test, Group Intelligence Test and Pass Along Test to those in Technical and Skilled jobs, and Pass Along Test alone to the Unskilled.

(4) Assessment of Personality Traits through biographical details, inventories, short term observation during group activities, psychiatric examination, if necessary, and interview.

We have tentatively posited four qualities, Self-Confidence, Emotional Stability, Industry and Leadership, for assessment (see pages 92, 101, 117). The plan was adopted for the selection of these was to pick out the most successful workers in different grades and study them closely at the works, and then make inquiries from them as to what qualities made them advance in their line.

Our observations led us to form the following conclusions about these qualities of Personality\(^2\) in the superior staff of the Tatas:

\[\text{Self-confidence /}\]

---

1. Now that the Directors of the Company have invited a team of psychologists from the Government of India to help them in the problem of selection, it should not be difficult to persuade the management to get such a list made for us.

2. The "entire system of relatively permanent tendencies, "both physical and mental, that are distinctive of a given "individual, and determine his characteristic adjustments "to his material and social surroundings" - Burt. (The British Journal of Educational Psychology, 1945, Vol.15, p.107).
Self-confidence is very much linked up with cognitive abilities. It is an abiding feeling in the people that they know their job and are up to any situation on the technical side.  

A supervisor who works hard sets an example to those under him. If he has the necessary technical skill and self-confidence, industry is the one thing that will win him the respect of his subordinates. He is present to help the workers in cases of breakdown and toils to improve their lot by arranging technical training and providing recreational facilities.

Most of those who possessed these two qualities had emotional stability as well. One of the important features of emotional stability is the avoidance of elation and depression. There are bound to arise ugly situations in one's life in a factory, particularly in a country like India which is torn with communal bickerings and provincialism. One has to keep one's temper unruffled; and though one knows the mischief-monger, there should be no hasty admonition or drastic action prompted by annoyance.

As for Leadership, we found this closely associated with the above qualities and prestige (dominance or influence) which the most successful supervisors had over their workers. Though it is not easy to distinguish between what is innate and what is acquired, part of it is in most cases due to the high level of abilities of an individual and his position. But it is arguable whether he could have acquired his position without some innate qualities which made his advance possible.

---

3 "Persons of specially high abilities are probably by nature rather more adaptable than the average".- Human Nature and the Social Order: by E.L. Thorndike. Macmillan, 1942, p.91.

4 See Chapter III, p.96.
We may now sum up our contemplated programme for testing different grades of workers in the Second Survey in a tabular form:

<table>
<thead>
<tr>
<th>Tests</th>
<th>Technical Jobs Class II</th>
<th>Skilled Jobs Class I</th>
<th>Skilled Jobs Class II</th>
<th>Unskilled Jobs Class I</th>
<th>Unskilled Jobs Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.I. (Eng.)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>V.I. (Ver.)</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pass Along</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Aptitude:</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Group I</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Group II</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Indian Psy.</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>E</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

✓ Test to be administered.

**Personality Traits.** These should be assessed with the help of questionnaires or inventories; and the information so obtained should be supplemented by Service Records and, if necessary, by administering such personality tests as the psychologists may consider necessary.

For purposes of selection from new candidates, short term observation, lasting for about a week, and the interview, are the best method of making an assessment of the qualities of personality. We give below a skeleton of the main features of the aids recommended.

**Service Record.** This will be maintained by the management and should contain entries under the following heads:

(a) Conduct (i) with reference to the subordinates;
(ii) with reference to the superiors.

In the case of adverse remarks, it is best to obtain the explanation of the person concerned and to file it along with the record.

(b) Ambition and Initiative with special reference to the
the use made of opportunities. These entries would relate to the schemes the man might have suggested for improvement or the steps he might have taken to avert troubles either in the plant or to nip in the bud trouble among the workers, etc.

(c) Persistence: (i) To improve one's qualification one may either take professional examinations or contribute papers to professional associations:

(ii) To increase one's utility to the factory. This may be done by working out some improved scheme with the sanction of the management, or improvement in the methods of operation.

(d) Leadership experience.

(An attempt should be made at the interview to obtain an explanation from the candidate about the difference between his own story and that contained in his record.)

Short Term Observation

Short term observation is directed towards making note of the qualities, needed in the jobs the candidates are likely to fill, as they manifest themselves in the course of group activities. These activities are so devised that they bring to the surface in the candidates engaged in them most, if not all, these traits which are bipolar. It requires experience and quick power of observation to watch the behaviour and interpret it with a view to assessing it.

The chief points to be noted are:

Effective Intelligence.-- It is very different from intelligence as tested by the Verbal Group Intelligence Test and is used to describe the candidates' powers to handle practical situations carefully and swiftly by the prompt application of theoretical principles; that is, it is an expression to describe effective intellectual powers. Most of the Science and Engineering graduates would score high on the popularly called Intelligence Tests, and in the case of the
the graduate apprentices we tested in the Technical Institute, Jamshedpur, they tended to bunch closely round a central figure, i.e. 65/100. But the same would not be true of the effective use of their theoretical knowledge of Engineering. According to Wilson, "the candidate's record of achievement "(both its range and its quality) and his intelligence score, "are immediate pointers to a zone within which his effective "intelligence assessment may be expected to lie."^5

"The Technical Prowess" consists in the extent and colour of the candidate's achievement in relation to Engineering jobs he is likely to fill, and his relation to the technical field, particularly the latest developments.

Persistence is the capacity to stick "at things doggedly and faithfully, when solutions are not easy"

Energy.— This is partly determined by physical clues, like smartness, manner and bearing in group situations, and the degrees of urgency and of resonance which characterize the voice.

Influence or Dominance over the group.— Ability to order workers about the jobs the candidate is to get executed through winning the willing cooperation of a large majority and their goodwill.

Personal Attitudes relate to the normal behaviour in different situations which may be marked by cooperativeness or by impatience or individualism and tendency to take offence on the slightest provocation. Further it covers the tendency to be dependent or to stand on one's feet and also the ability to mix with others of the same class and general acceptability in the group.

From these notes the Board of Selection can draw certain legitimate inferences:

(a) The probable attitude of the candidate to those

---

5 Occupational Psychology, October 1945.
in subordinate positions.

(b) Adaptability to varying situations in the course of group activities.

(c) Understanding of the human and technical aspects of the job.

(d) Extent of the possession of qualities of self-confidence, industry, emotional stability and leadership.

The Importance of Short Term (about a week) Observation.

An interview is likely to be of a short duration, ranging from 30 minutes to 1½ hours, and does not provide occasion for obtaining a comprehensive profile of a candidate who has not been in the service of the factory. But we want to know as much as we can about a person whom we are going to entrust with administrative jobs. An observation lasting for about a week provides an opportunity for getting a comprehensive picture of the candidate. He is placed in a variety of situations likely to occur in the factory and is observed by quite a few experts. The chances, therefore, are that the overall estimate at the end of the interview would do justice to the candidate and serve the higher interests of the factory itself. However, the observation should be as unobtrusive as possible.

An interview, without a short term observation on the lines suggested above, has one great handicap. Some candidates who may have gift of speech and a capacity for the presentation of a well reasoned out case, may not be very effective in a practical setting. Mere interview does not help us to sort them out. Some of the most promising graduates in Engineering were not found much good at practical activities by the psychologists in the "Tisco"\(^6\), whereas some persons who put up a poor show at an interview are /

\(^6\) Tisco. Tata Iron and Steel Company.
are most effective when handling men and when they are in situations requiring tact and prompt action.

Group activities during a period of about a week give an indication of what has been described as Social Intelligence of a candidate. And social intelligence is an asset in Higher Executives and Administrative Officers of the factory. Three-fourths of the labour trouble in the "Tisco" would not have arisen and provided a fertile soil to the Communists for sowing discord if an appreciable number of the higher executives had treated the low paid and ill clad workers with ordinary courtesy and had condescended to listen patiently and with sympathy to their tale of woe and unbearable poverty at home.

We give below in skeleton an indication of the group tasks that would be best suited for the selection of the personnel for Technical Jobs, Class II, and Skilled Jobs Class I.

1. Physical endurance tests, suited to the factory conditions, e.g. fitting up a complicated machine with the help of the group; lifting heavy material from a slope, etc.


3. Attending to serious accidents without occasioning considerable upset among the workers.

4. Organising a prevention of accident campaign with the help of lectures, placards and slogans.

5. Initiating a group of unskilled workers into the working of a complicated machinery with the help of the most commonplace language, diagrams and improvised models.

6. Organising an indoor recreational activity for Unskilled workers, Class II.

The Selection programme should invariably begin with an explanatory talk about the selection procedure, and this should /
should be followed by a question hour in which the questions put by the candidates should be answered by the psychologist. The candidates should then be asked to fill in the biographical details and the personality inventory. Thereafter the testing and the group activities programme should be taken, and the interview and the examination of a candidate by a psychiatrist where necessary would conclude it.
The interview is the stage for the global assessment (see p.22) of each candidate. It would also provide clues for the modification and improvement of the technique used. Etymologically the expression means "meeting of persons especially for the purpose of discussion". But in Vocational Psychology the expression has a definite significance and is applied to "the time-honoured method of 'sizing-up' a person's characteristics."¹ The psychologist approaches the interview with a definite plan of attack and this is made possible by the psychograph relevant to the occupation, and when the interview is for some specific job or jobs within an occupation (e.g. the job of steel blower in the group of Technical Jobs, Class II) by the job psychograph. It is thus hoped that the candidates so selected would be, at the worst, good risk, possibly the best and the most suited. It is very difficult to validate the technique of interview. (1) The technique itself is not, and cannot be rigid.² In fact interview is a device to minimise the imperfections that may result from placing too much reliance on the objective tests which do not take account of the handicaps peculiar to an individual. They presuppose uniformity of conditions in which tests are administered /

¹ Talents and Temperaments: by Macrae, 1932, p.92. According to Franklin Fearing: "Interviewing involves the social interaction in a face-to-face situation between two or more persons organized for the purpose of obtaining information from, or making appraisals of, or modifying the behaviour of one of the number." - Studies in Personality - McGraw Hill Book Co., 1942.

² "....... the question that faces the interviewer is 'what is the most profitable way in which I can use the time at my disposal" - Misselbrook "Occupational Psychology" - April 1946, p.86.
administered and this is an ideal by no means within human
reach at present. Statistically we may succeed in getting
much the same average and standard deviation on two occasions
for the same or parallel forms of tests, but a score to score
correspondence has been beyond the reach of testers so far.
The interview takes into account the individual in his
biosphere, that is, in his peculiar environment. It attempts
to discover the personality of an individual as "the
"functioning whole or unity of habits, dispositions and
"sentiments that mark off any one member of a group as being
"different from any other member of the same group." 3 The
next step is to find out how far, having due regard to the
requirements of the job or occupation, allowance could be
made for the peculiarities or idiosyncrasies of the individual.
The interviewer is guided by clues in the course of interview
and hence he cannot tie himself down to any rigid procedure.
(2) He depends upon the follow-up and that is the
only method of validating his improvised technique. In fact
the follow-up enables him to modify and improve his technique.
But there is a snag here. He cannot maintain that the
argument between his results and the follow-up, even in a
large percentage of cases, is a complete proof of validity.
The most cogent method of proof is that of Agreement and
Difference. And he is not in a position to establish that
all those he rejects would have failed on the job or in the
occupation. 4
Hence we are justified in maintaining that a rigid
validation

3 "Personality: A Psychological Interpretation" by Gordon W.
Allport - Henry Holt & Company - 1931 - p. 45. (Schoen
quoted by Allport).

4 A better plan would be not to make the final choice at the
interview. The interview should aim at consolidating
the data regarding a candidate and preparing his probable
individual psychograph. He should then be observed at
his job or as a trainee for a certain period and then a
final selection made. However, it is a time-consuming
plan for a factory like the Tatas and is not likely to
find acceptance. And hence we omit it in our discussion.
validation of the technique of interview is a fond hope, not realised so far. And in the absence of anything better, the Method of Agreement is the only way of finding justification for the technique employed. Whether this satisfies the rigid scientific criterion or no, it is what should, and does, suit the management.

There are three important aspects of Interview as understood by us:— (a) the interviewer; (b) the subject; (c) the purpose which determines the relationship between the interviewer and the interviewed.

(a) The interviewer is the most important of the three, the more so as he has to evolve his own technique. Allport suggests the following qualifications of a good judge — (i) Experience, with a minimum age of 30 years. He must have a rich store of experience of human nature in its varied and more intricate forms. We may enlarge upon this by adding a few practical propositions. To the theoretical and synthetic study of psychology (i.e. a study which has enabled the reader to evolve his own approach to human problems by discovering a sort of centroid factor from amongst the medley of conflicting schools of thought in psychology), he must add a wide study of human nature in the environment one is to work in as depicted in the recognised masterpieces of novelists, playwrights and biographers. And all this must be sifted by actual contacts with human nature at different stages of growth and in different situations in the industry concerned (see p. 162 Experience as Welfare Officer). There is one fact that a psychologist would do well to bear in mind: "Recent evidence and recent trends in theorising have drawn attention away from the remote control of instinctive early conditioning and habit formation; and have pointed to the decisive role that the present ego-structure (personality would be a better expression) plays in directing human conduct."5

"conduct." It is well nigh impossible to lay down more than the barest skeleton for the guidance of an interviewer. But we can suggest a line of training when the psychologist has acquainted himself with the past details and the present ego-structure of a candidate. He should (or rather would) recall cases from his experience or reading where he could discover some precedent how men and women of a similar type had acted in split situations, economic, social or sexual. This would enable him to evolve a hypothesis about the future action of the candidate and to verify it by such tests or conversation or questionnaire as he may think suitable; or, in the words of Dreyer, clues should be tactfully followed up.

No person can be considered to be a safe interviewer unless he knows thoroughly the jobs for which he interviews the candidates. The jobs or the family of jobs are best studied by frequent visits to the plant and by studying the principles of its working. The men in these are best studied by working early in one's career as psychologist in the capacity of welfare officer (see page 161 - studying human nature in the industry concerned) and thus dining in the small hall with workers, say, twice a week, arranging recreations for them, and participating in their feasts and festivities in such a manner that one gets insight into their lives without making oneself cheap. Talking of Indian labour, in particular, we would suggest a close study of the workers who resort to wine shops to drown their worries due to domestic upsets or to get over the fatigue or boredom of duty hours while at their jobs. The knowledge so obtained will be of great help both to the welfare officer and to the interviewer in discovering how far a better pay or relief from monotony (say in the case of crane drivers, by providing music and other /.

6 "One of the foundation-stones of a personnel selection officer's claim to be considered a specialist is his or her knowledge of jobs in civilian life and in the Service." Mr. MSELbrook—"Occupational Psychology", April 1946.
other recreations and means of relaxation during the alternating hour of rest) would redeem a worker from his addiction to drink. Thus if drinking is a substitute to a lower grade worker for cocktails and club life, it should not be considered a disqualification for employment or promotion. The forms of social recreation differ from individual to individual and social and religious taboos should not be given undue weight. In a country like India which is passing through religious and social turmoil, it is absolutely necessary for the interviewer to be on his guard against personal or social or religious prejudices. Further, there should always be associated with the psychologist the "representatives of the practical interests involved, the interest of both of the management (which is now invariably "the case in the Tisco) and of the workers." Thus the candidate is ensured assessment from three supplementary points of view, working in close cooperation. Truly does Klages remark, "understanding is possible only by virtue of "some similarity between the perceiving self and the perceived "object; and as dissimilarity grows, understanding gives way "to a failure to understand." The plan suggested here ensures this. The psychologist has familiarised himself with the social and economic background of the class to which the worker belongs, the representative of the management is an expert in the technical knowledge which the candidate should possess, and be competent in, to make practical use of, and the representative of the workers ensures a corrective to the diagnosis of the psychologist and the expert by pointing out where they expect more than the actualities of the environment.

X Tata Iron & Steel Co.
7 "The Psychology of Industry" by Dreyer, 1921, p. 40.
8 Quoted in "Personality: a Psychological Interpretation" by G.W. Allport, p. 512.
environment in the factory would justify and in some cases may pitch the standard expected of the workers higher than the psychologist or the expert because of his anxiety to keep the reputation of his class of workers high. The cooperation of these three ensures similarity of background between the interviewers and the interviewed.

The other qualities of competent interviewers may be summed up thus: (i) superior effective intelligence; (ii) insight, i.e., the realisation of the interviewer's own anti-social tendencies, hypocrisies and inconsistencies and complex motives; (iii) complexity, i.e., many-sidedness and depth of understanding which enable a person to comprehend complex and subtle persons; (iv) detachment, i.e., certain asocial trends in the make-up of the interviewer which enables him to appreciate the social set-up of the candidate, but not to identify himself with it. He may be quite fond of a certain class of people because they pursue the same hobby (e.g., play chess) but he never allows himself to be completely identified with all that is in the atmosphere of the Chess Club. In fact his close association is with the few well tried members, rather than with the whole lot; (v) forensic skill - the capacity to develop a conversation which puts the candidate on his mettle without getting lost in it himself. It is not the capacity for cross examination but of leading on the conversation by giving it turns which unconsciously force the candidate to state facts in spite of himself.

(b) The Interviewed. - We cannot lay down any standard for candidates, except the minimum qualifications for eligibility. The biographical data, the record of academic attainment, the intelligence, the aptitude, and the psychological tests would give an overall picture of the mental /

9 The questionnaire would differ from one group to another. Its contents are to be decided by the psychologists engaged in the work of selection.
mental level of the candidate and the expert and the representative of the workers can supplement the results by personal inquiries. But it is the qualities of personality that will often baffle the interviewers. (We have already suggested in Chapter VI(A) how to assess these qualities). The assessment is tentative, however, and we may have to elicit a lot of information regarding the situations which might have tended to mar the development of certain qualities and how far they can be cultivated now. What effect the economic motivation would have on the candidate if employed? We can have something of the specific personality deficiencies of the candidate if we could link up the success or failure with some specific intellectual or personality traits. "Thus, "if a subject demonstrates that he possesses excellent vocabulary and information, but is very poor on comprehension, "we must conclude that he is not able to utilize to a full extent in life-situations his verbal facility and general knowledge, and we will be justified in considering that we "deal with a case of impaired judgment." We are inclined to think that "justified" is too strong an expression to use till we have had a first hand contact with the subject in the interview. It would be better to say "we have reason to suspect". As Rapaport himself points out, endowment, degree of maturation, educational environment, schooling and cultural predilection have to be assessed in the final appraisement of intelligence and we would add of personality. We would recommend that the test results of the candidate should be studied by the interviewers in advance, and query marks placed by each of them independently, and then they should be pooled together and discussed. The common ones would not occasion any difficulty, but those where there is a conflict should be raised /

raised by the interviewer or interviewers concerned, and the dissenting interviewer or interviewers should also attempt a substantiation of their views.

(c) The purpose of the interview will be the main factor in determining the procedure. Thus if the candidates to be selected are for recruitment, the results of Intelligence, Aptitude and Psychological tests will be as material as the assessment of Personality. And the interview is bound to be a long one, with a maximum limit of not more than 1½ hours. But if the object is placement in the different jobs in the same Occupational group, the procedure would be a short one consisting of an inquiry into personal likes and dislikes, possession of specific qualities particularly needed for that job (e.g. training in driving for crane drivers) and the capacity for adjustment to the social environment of the specific job. A man may be able to control a small group but not a large one, or may be good for being second in command only. In the cases of promotion the test results to be considered would be very few if the higher grade presupposes the abilities in the lower grade for which the man has already been tested. It is mostly the previous record with reference to the duties in general and those traits which would be most in demand in the higher job that would be material.

However, there are certain points of technique that may safely be recommended for all kinds of interviews:

(i) Motivation.- The extent to which the candidate is actuated either by the economic incentive or the urge to find a field for his technical abilities, or both, should be determined as fully as possible. A Science graduate may like to

11 Mr Misselbrook suggests that "the candidates should be "prepared for the interview and see it in the context of "the things they had been asked to do." He recommends an introductory and explanatory talk and an information chart which could be studied by the candidate at leisure.- Occupational Psychology, April 1945, p. 86. See also MANAGEMENT AND THE WORKER by E.T. ROTHBLISBERGER, WILLIAM J. DICKSON AND HAROLD A. WRIGHT - HARVARD UNIV PRESS - 1946 (CHAPTER IV).
to work in the chemical laboratory of the factory rather than work as First Hand in the Steel Making Shop, though the latter may bring him production bonus over and above his salary.

(ii) The interviewer should inspire the subject with a sense of trust in his fairness and willingness to take the most generous view. This is where the superior intelligence and the complexity of the interviewer are most needed. He must be able to conjure up the fullest possible content for the statements of the candidate. This would enable him to discover something positive in the response and he should give the candidate credit for it. But this process also opens out the relevant fields for investigation - and the causes of deficiency or inaccuracy often lie there, e.g. in an interview arranged to explore personality the interviewed was requested to give his uppermost impression of a person he had known fairly closely for quite a few months. The response was: - "He is struggling with himself and others." The next step was to accept the statement at its face value and to find out if the feeling was personal or one which was shared by others. It turned out that the feeling was personal. Asked to explain "struggle", the subject was not in a position to make up his mind as to what he meant. The fact of the matter was that the man under discussion had created a prejudice in the mind of the subject by his long-winded talk on quite a few social problems and the disparagement of certain personalities. In his generosity the subject refrained from expressing dissent on such occasions /

12 "It is essential that a man coming to the interview should be put at ease, so that he could talk freely and display adequately his basic attitudes," - Mr.isselbrook, Occupational Psychology - April 1942 - p.89.

13 "It was often useful to adopt a policy of indirect approach by the use of oblique questions. A frontal attack did not always produce the required information; often indeed it induced an antagonistic attitude. Both of these difficulties could be overcome by approaching the topic from, as it were, an "angle". - Ibid.p.89.
occasions, but harboured a feeling of resentment. It was in this content that the many small differences that would be treated lightly otherwise were magnified. X, the subject of discussion, was indiscreet in his talks, the subject of the interview unnecessarily resentful. The expression "struggling" therefore implied readiness to animadversion, and not getting into the way of others, as the opinion of the subject would suggest. The conclusion justified by this content is that both these persons were unusually sensitive, each for a different reason. So far as this interview is relevant to our discussion regarding technique, the implication is that the interviewer should be tactful to work up to the root causes.

We agree with Murray when he pleads that more time and thought be given to "training psychologists in sensitivity and accuracy, and less time, if need be, to the perfecting of mechanical instruments." It is the sensitivity of the psychologist that can help him to probe in different directions as the interview proceeds and get at helpful pointers to the make-up of personality. To ensure an uninterrupted session, it would be preferable, we would rather say imperative, to have a stenographer concealed from view. This enables the interviewers not to lose sight of the hares they have started and at the end of the interview they have a full account of the conversation.

(iii) Terminology. But this is not enough. We have to reduce these explorations into an accurate language. By "accurate" we mean the summing up of different responses under their appropriate heads. For example, the responses set forth at page 167 may be arranged thus:

---


15 See the above illustration.
The subject's uppermost global impression of his friend X.

Struggling with himself and others

Analysis of 'struggling' -

Conflict within himself and in conflict with other people

Traits: (i) Endocathexation (the cathexation of thought or emotion for its own sake - a preoccupation with inner activities: feelings, fantasies, generalizations, theoretical reflections, artistic conceptions, religious ideas - withdrawal from practical life.

(ii) Supra Aggressive (attacking or impeaching the authority of others).

Inference regarding these based on personal feeling only. Hence supra aggressiveness relates to one person only. And endocathexation refers to preoccupation of X with his social conventions and leaders.

Similar traits in the subject of the interview but repressed out of politeness or consideration for the feelings of an acquaintance.

Results - X impulsive; the subject of the interview deliberative in social dealings. The ratio between the two progressive - as X grew more impulsive; the subject of the interview grew more deliberative.

This analysis in more or less technical terminology is more helpful in understanding human behaviour than everyday and hackneyed language. The attempts of H.A. Murray in this direction are commendable. The only difficulty about his terminology is its labyrinth, arising from the specification of all shades of differences and its coinage. The expressions are neither Latin as in Medicine and Biology nor English. However, a practising psychologist can pick and choose and thus build up his own terminology and get it accepted for the purposes.

16 The expression describes predominance and not the complete absence of the opposite trait.

17 Explorations in Personality.
purposes of use at the interview by his colleagues.\textsuperscript{18}

(iv) Test Aids.\textsuperscript{19} The interviewers should be able to
decide upon testing aid when in doubt about their progress
during the course of interview. A note may be made of the
doubtful points and the tests may be administered after a
sufficient respite to the subject or subjects, and the results
may be used for final decision. These devices may consist
of sensori-motor learning; thematic apperception test
(Morgan and Murray - to be adapted to Indian conditions).
With increasing experience many others may be added to the
list.

When the interviewers have arrived at their findings
there will often be points which require a reference to the
psychiatrist. In order to facilitate the work of the
psychiatrist, there should be a medical examination of the
candidates considered eligible by the board of interviewers;
and the necessary entries should be made on the folder
containing biographical details from the standard application
letters of the candidates. Besides the usual examination
of the chest, internal organs, urine, eyesight, hearing, etc.
the following information should also be obtained:-

(1) Family history if there is any suspected mental
or physical defect which may be partly hereditary.

(ii) Personal history, with special reference to past
illnesses and bereavements and sexual adjustment.

(iii) History of the present illness if any.

The cases intended for reference to the psychiatrist
will then be sent up for another interview by him. Besides
such other information as he may elicit from the candidate,
the following should invariably be obtained and recorded.

1. General intelligence, knowledge and judgment as
   assessed /

\textsuperscript{18} Note on page 179

\textsuperscript{19} The use of trade-tests in interview - Mr Misselbrook,
Occupational Psychology, page 91.
assessed by the first board of interviewers.

2. General attitude towards social and cultural environment.

3. Attitude towards life, with special reference to emotional reaction in relation to the occupation he is to enter in the factory; prevalence of any specific mood, and the likelihood of developing any pathological symptoms (occupational syndromes) under the strain of fatigue, monotony or work in trying temperatures at the furnaces.

When all the necessary data have been collected the last step is the ranking of the selected candidates. The candidates have been quantitatively assessed for the different tests administered and the interviewers have these before them at the time of interview. It is best to rank candidates in the various tests used. Since all these candidates have come up to the minimum found empirically necessary for good risk in a particular occupation, we have to find out the correlation of the standardized scores in different tests with proficiency, using the weights obtained with the help of PIVOTAL CONDENSATION. The candidates may now be arranged in the descending order of their standardized scores in proficiency, e.g.

<table>
<thead>
<tr>
<th>I. Ranking according to Totals</th>
<th>II. Ranking according to standardized scores in Proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>B</td>
<td>A'</td>
</tr>
<tr>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>

A situation like this is quite conceivable, for though high scores in tests for which regression coefficients are not high may increase the total, they do not necessarily imply a high standardized score in proficiency. Statistically a higher rank in II implies greater suitability for employment; and these men are likely to prove more acceptable to the management than those lower down.

Ranking /
Ranking II is again altered in the light of the assessment of the interviewers. The important point is how to reduce the qualitative assessment of different interviewers into a quantitative one. Since the proceedings of each interview have been taken down by the stenographer, the assessment comes at the end of interviews. The important heads under which the interview is conducted have already been decided upon by the board. The proceedings of each interview are analyzed into the technical language we have suggested at page 169 and the material thus obtained is allocated to the different heads, the information elicited by each interviewer is indicated by his name in the margin. Each of the interviewers makes a brief memorandum of his own to record his personal impressions re facial appearance, dress, gait, mannerism, style of speech and such other details as strike him as significant. He then proceeds to make his global assessment—that is, his quantitative estimate of the candidate as a whole in relation to the occupation he seeks employment in or the job or jobs in which he is to be placed or to which he is to be promoted. Say his quantitative assessment is 75/100. He then proceeds to distribute these 75 marks over different heads thus:

If the man were as high under each head as he is in the total, he should be getting 75% marks under each. Supposing there are five heads,—Then he should be credited with 75% marks under each. But the interviewer thinks that the dispersion of marks cannot be so uniform, and so he proceeds to make the necessary adjustments without altering the total. He scrutinizes the proceedings and his own notes and makes the necessary adjustments as shown in the table below:—/
The quantitative estimates of the different interviewers under each head should be pooled together and the average obtained.

Candidate 'X'.

<table>
<thead>
<tr>
<th>Interviewers:</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>80</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>II</td>
<td>60</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>III</td>
<td>80</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>IV</td>
<td>80</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>V</td>
<td>75</td>
<td>70</td>
<td>50</td>
</tr>
</tbody>
</table>

Total: 375 330 350 1085 352

\[
\frac{75\%}{66\%}{70\%} = \frac{15}{9} = \frac{70.0\%}{70.0\%}
\]

These totals in percentages are added to the predicted proficiency scores of each candidate and the grand total thus obtained becomes the basis of a third ranking:

<table>
<thead>
<tr>
<th>Prof. Scores</th>
<th>Interview Assess.</th>
<th>Grand Total</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>(75/100)</td>
<td>75</td>
<td>150 P</td>
<td>P I</td>
</tr>
<tr>
<td>(60/100)</td>
<td>70</td>
<td>130 Q</td>
<td>Q II</td>
</tr>
<tr>
<td>(55/100)</td>
<td>60</td>
<td>115 R</td>
<td>R III</td>
</tr>
<tr>
<td>(55/100)</td>
<td>50</td>
<td>105 S</td>
<td>S IV</td>
</tr>
<tr>
<td>(55/100)</td>
<td>65</td>
<td>120 T</td>
<td>T V</td>
</tr>
</tbody>
</table>

If there are marked discrepancies in the estimates of the interviewers, there are three ways of dealing with these:

(a) The personal equation of the interviewer who under-estimates or overestimates a candidate (under-estimate/over-estimate relative to the majority) may be responsible for the discrepancy. In that case the President of the Board of Interviewers should look into the Personality Assessment of
of the interviewer himself and find out if it is the expert knowledge or some twist or peculiarity in his make-up that is responsible for discrepancy. And most often than not an explanation will be found in this personal equation. In such circumstances the president should decide for himself the quantitative increase or reduction that is justified so far as that interviewer is concerned and he should make it.

This raises an important issue: Should the interviewers themselves be subjected to the examination of their personality. We think it is absolutely necessary that an appraisal of their personalities be made over a year or every alternate year. No man is perfect, and it is a failing of human nature to be more charitable to, and in some cases excessively condemnatory, of one's own faults and weaknesses than those of others. One may well point out to us (psychologists), physician heal thyself. And since we are investigating facts about human nature we should have a factual statement of our own personality from well meaning quarters and compare it with our own estimate of ourselves. We do not lay down any procedure, but plead for the recognition of the principle advocated here.

(b) If the discrepancy arises from the suspicion of some psychotic or neurotic symptom in the candidate, the president should invite the opinion of the psychiatrist on that definite issue and correct or accept the assessment of the interviewer, on the basis thereof. If the assessment of the interviewer is correct, the assessment of other interviewers should be revised.

(c) The candidate may be called in for the elucidation of differences among the interviewers, and the necessary information obtained either in the course of a fresh session or by administering some accepted test.

This completes the main steps in the technique of selection /
selection at the interview. If there are cases that are high in ranking, but there are marked signs of emotional disturbances or anxiety neurosis, they should, as suggested above, be accepted only if approved by the psychiatrist as good risk; and even then should be employed subject to taking a course of psychiatric treatment and final certification by the psychiatrist as practically cured. So far as factory work is concerned, the criterion of complete fitness would be "a state of optimum functional efficiency" which means that the organism is mentally and physically fitted to stand hazards incidental to factory work; e.g., continued strain of overwork on occasions, or deleterious effect of certain poisons and irritants or bacterial infection. Part of the susceptibility of a worker to diseases is due to physical weakness, but it is being increasingly recognized that it is often mostly due to psychological damage. Thus miners' nystagmus is largely, if not entirely, of psychological origin. Duodenal ulcer may be the result of an anxiety state.

The procedure set forth here is intended for the candidates to Skilled Jobs and Technical Jobs (see Chapter III) It cannot be extended in its fullness to Unskilled Workers Classes I and II. The immensity of number would make such an attempt difficult if not impossible. We would propose that all those who satisfy the requirements of the tests intended for this grade of workers (see Chapter VI) be employed on a temporary basis. The first appointment in this grade in the Tata is usually temporary. It would be best to arrange groups of 10 or 15 to be interviewed and medically examined every day. The interview in the case of these people would be short. The interviewers would take down brief notes and administer such tests as they may consider necessary to gain certainty.

---

certainty about doubtful traits of personality. But in their case the Selection Board should send its recommendation regarding ranking to the Psychiatrist to whom the medical officer sends up his report too. In view of the fact that most of the employees in Unskilled Class II and quite a few in Unskilled Class I live in slums and frequent wine shops and houses of ill repute or contact promiscuous relations, the need for as clean a record of physical and mental fitness as is possible to obtain in the environment is imperative. And hence the final ranking should be left to the psychiatrist. The insistence on this will serve as a deterrent to many men and women seeking employment in the factory.

The most insidious of the diseases, peculiar to the slums, are incipient tuberculosis which occasions anxiety states, spermatorrhoea among young men and leucorrhoea among women, gonorrhoea and syphilis among both. Both spermatorrhoea and leucorrhoea occasion depression and nervous debility, and tend to make the sufferer extremely changeable in mind. The power of concentration diminishes, and as malnutrition is rather the rule than exception in slums, men and women suffering from these cannot pull their weight in the factory; and the management would be well advised not to employ them if the report of the medical officer and psychiatrist is adverse. Gonorrhoea and syphilis most often result from promiscuous relations and their effect on mind and body is to occasion neurotic conditions. Sex has been shrouded with taboo in India and the wastage in production through the employment of such men and women in the factory is very great. In fact it would be a commendable step to find out the incidence of such diseases in workers in Unskilled Jobs, Classes I and II in the Tatas through medical examination, and then to get them examined for their mental condition by the psychiatrist. We could thus grade such people /
people and find out the extent to which men and women suffering from these diseases could be taken into employment without appreciable depreciation in their output. And these data may enable us to work out some sort of norms for new entrants. Thanks to quack doctors in the factory area, it is only the worst cases that come to the notice of the medical officers.

Some Practical Hints

We may now suggest some methods for the technical experts and even psychologists to improve their capacity for interviewing and for assessing the relevant traits with a fair measure of correctness.

I. Aids to the development of capacity for interview.

Those aspiring to train themselves for interview should contact the best ten men in each important grade of jobs, e.g. Technical, Skilled and Unskilled, every year, and discuss with them informally the qualities they consider as essential for a successful worker. This will make their theoretical approach to the problem of selection realistic. There is always a danger that one may talk learnedly about human nature and yet know so little of the actualities about it. We would recommend an apprenticeship of two years with experienced interviewers before one takes up the job independently.

II. The preparation and study of what Moore describes as Termination Record Blank should be of immense help to the interviewers in a factory. Exit interviews are absolutely necessary in a country like India where public opinion being weak, nepotism and favouritism tend to demoralise services. From what we have seen of the Tata Iron and Steel Company, we feel confident in recommending exit interviews by the management for the preparation of the Termination Record.
Name: ..............................................................
Department: ...................................................
Section: ...........................................................
Date of Employment: ...........................................
Date of Leaving: ...................................................
Jobs employed in: Period Reason for Transfer

Cause or Causes for leaving: (Strike out the redundant.)
Voluntary. At foreman's request. Because of lack
of work. Old age. Ill health. Removal from
Dislike for fellow workers. Disagreement with
Company's policy. Too great a strain on some part of
his body. From physical working conditions.
Rates of pay. Other grievances (to be specified).

Was he reported unsatisfactory for any of the following
reasons: irresponsible; unreliable; uncooperative;
a complainer; an agitator .........................
(Strike out the irrelevant, and add when necessary.)

What was his statement of his reason for leaving?

What is his attitude towards the Company?
(i) Would he want to work again in the same department?
(ii) Has he any suggestions for improving working conditions,
irregularities, rates of pay, supervision, training,
e etc.? Yes ( ); No ( ).

If so, what?

What does he plan to do? (New job) .........................
(No plans) .........................

Would the factory re-employ him? Yes ( ); No ( ).
We commend the following for general use:

(a) S.S. (the stimulus situation) - the tendency or 'potency' in the environment.

Press (Lewin's Valence)

(b) Need - a hypothetical force or drive or propensity in the individual.

(c) Actone - description of a bodily movement per se, abstracted from its effect.

(d) Theme - Press - Need combination.

(e) Regnant Processes - the mutually dependent processes that constitute dominant configurations in the brain - Conscious/Unconscious.

(f) Mental Set or determining tendency

(g) Need - Perseverate - a state of high inducibility.

(h) Cathected object - an object that works a need is said to "have cathexis".

(i) Empathy - we feel something. Projective - we imagine that the other person feels the same.

(j) Emotionality/Placidity

(k) Endurance.

(l) Exocathectation/Endocathectation.

(m) Intracactive/Extraceptive.

(n) Impulsion/Deliberation.

(o) Motone/Vernone.

(p) Egocentric/Sociocentric.

(q) Infraactive/Supraactive.

(r) Infrafiliation/Supraagression.

(s) Blamavoidance (super ego). Infra Reference - integration and conflict.

(t) Infra avoidance - dependence, counter action.

(u) Harmavoidance - anxiety, fearful attitude.

(v) Exhibition - self-displaying attitude.
CHAPTER VII.

TRAINING

Training may be broadly divided into (1) Training for Industry, and (2) Training within Industry. The Tata Iron and Steel Company has had a scheme for Training for Industry since 1921, but has attempted little under (2) so far. A reference to the Occupational Psychographs (Chapter III) would show that we considered the possession of certain abilities and personality qualities as essential for employment in the jobs within the purview of different occupations. We also expressed the hope that when a fuller survey had been made we might be in a position to get group factors as a result of the Factor Analysis of the data which might make our psychographs exact. Some of the traits symbolised by the groups factors may be innate and others acquired, but unless allowed to develop in a congenial environment they may not produce the desired result. Once secure in the job a person may grow lethargic and fail to keep the promise of early days or, failing guidance, may grow easily self-satisfied.

The importance we attached to the Cumulative Record for promotion will be an urge to be active and painstaking to most, and the programme of training within industry will enable each entrant to make the best of his abilities. Training within Industry takes many forms according to the class of workers for whom it is intended.

At the lower end, it is Introduction Training for the benefit of the new entrants. When it is intended for those in position of authority, like Foremen and Assistant Foremen in the Skilled Jobs, Class I, it is training for Foremanship. And at the higher level, viz. for General Foremen, Assistant Superintendent and Superintendent, it is training for the Higher Executives. It is in this sense that we /
we shall use these expressions in the sequel. We adopt the following classification for our programme of training within industry:

**Occupational Level** | **Nature of Training**
---|---
New Entrants
| Introduction Training.
| Introduction Training.
| Training in Foremanship
| Training for Higher Executives.

**Introduction Training.** - When the candidates have been selected for Unskilled Jobs, Classes I and II, and served their period of apprenticeship (they would be on a two years' period of probation). Most of these in Class II are and would for some time continue to be illiterate. The percentage of literacy in India is only 17% and it would take a generation to spread mass education. But it is in the interest of industry that a large percentage of its workers in Unskilled Jobs Class II be literate. Hence the factory should make provision for adult education for beginners in the evening classes and enlist, if possible, the cooperation of the Trade Union. The Tatas run an Education department, and it should not be a difficult task to organise adult education. An attempt in this direction was made before the last War, but failed for lack of enthusiasm on the part of illiterate workers.

We think the best plan would be to organise propaganda for education through the Trade Union and after an illiterate worker has passed a certain preliminary examination, corresponding to Standard I of the primary schools, he should be allowed two afternoons free each week to attend adult school classes in the precincts of the factory itself. This, along with the incentive that promotion to jobs in Class I is conditional on the attainment of a certain standard of literacy and performance in the Selection tests and a clean cumulative record /
record would spur a large percentage to exert themselves. The factory cannot shirk the responsibility for mass education, particularly as it employs thousands of illiterate workers from different provinces. The residence of a worker in Jamshedpur from outside the Bihar Provinces does not count towards the period of domicile necessary for acquiring the rights of citizenship in Bihar; and though the factory is situated in this province its government is not legally or morally bound to include the workers of the factory from outside Bihar in its programme for mass literacy.

However, the most important part of training relates to immediate duties and it would consist of -

(a) Explanatory talks relating to the hierarchy of grades of employment in the factory with special reference to Classes I and II in the occupational level - Unskilled Jobs; the facilities for adult education; the leave and conditions of advancement; provision for recreational activities; educational facilities for their children; social and health services; rates of pay; Provident Fund and Bonus and the apprenticeship scheme.

(b) Apprenticeship Scheme. - The new entrants to Class II work for a month\(^1\) under proper supervision. During the first week they are given practical training in the stereotyped movements\(^2\) required for the job or jobs they are to fill and the /

---

\(^1\) The management cannot afford to allow long periods for training within industry for this class of workers, both because of the cost and the need for a large intake of men in Unskilled Jobs Cl,II each day.

\(^2\) The instruction process - (a) show him how to do it; (b) explain key points; (c) let him watch you do it again; (d) let him do the simple parts of the job; (e) help him do the whole job; (f) let him do the whole job, but watch him; (g) put him on his own. - The Training within Industry Report, 1940-45. (War Manpower Commission Bureau of Training, Training within Industry Service - Washington, D.C., Sept, 1945)
the broad principles underlying the operations they are to perform are explained to them. For the next three weeks they work at regular jobs under the guidance of supervisors, there being one supervisor for 30 workers in Unskilled Jobs, Class II. Thereafter they are on probation till the end of the second year of their service.

(c) When the aspiring workers have attained a certain minimum of general education, they are offered facilities for elementary technical education, say, fitters, turners, electricians, pattern makers, machinists, finishers, millwrights, painters, etc. The duration of this course should ordinarily be three years and those found eligible for it should be allowed two afternoons off to attend the classes on the precincts. Thus it may be possible to attain balance between Capacities, Interests, and Opportunities.

---

experienced or trained hands no scheme of technical education is needed for them.

The introduction training consists of (a) and (b), but we feel that in the present conditions of India provision for general and technical education should be part and parcel of training within industry. In the case of Unskilled Workers Class II, Training within Industry comes first, but for its continued effectiveness provision for education, general and technical, is absolutely necessary. This is the only way to stabilise the gains of a month of training under the Apprenticeship scheme and make the best use of incentives suggested in the explanatory talks.

Skilled Jobs, Class II. The entrants to these jobs are men who have received a measure of technical education which would enable them to obtain insight into the operations of the machinery in their charge in a short time. As in the case of Unskilled Jobs, Classes I and II, so here Training within Industry would include explanatory talks, but the programme of practical training will be more extensive for Skilled Jobs, Class II. The selected candidates have satisfied the conditions of the psychographs for their occupational level, but have to receive training in the special skill that the job or jobs they have to fill would require. Hence they should serve a period of apprenticeship for six months during which the Technical Institute should arrange a course for training in special skills of the jobs in Class II. The training would consist of actual work in the departments, to which they are attached, under a supervisor for four hours a day, say, from 0800

1 T.W.I. has found it helpful to consider the following definitions:
Education is for the rounding-out of the individual and the good of society; it is general, provides background, increases understanding.
Training is for the good of plant production - it is a way to solve production problems through people; it is specific and helps people to acquire skill through use of what they have learned.
0300-1200; and three hours, say from 1400-1700, would be devoted to theoretical work. The entrants will offer their choice of the jobs in the Occupational level they have been selected for after three months of training. The final choice will be made by the management after consulting the record of the apprentice and his preference and with due regard to the exigencies of the factory. For the rest of the period the apprentices will receive intensive training in the job or jobs allotted to them and will work in shifts. They will, however, be spared two days a week for lectures on:

i. How to reduce waste of material through spoilage;
ii. How to promote reliable and competent performance;
iii. How to minimize the time necessary to attain proficiency;
iv. How to make the best possible use of men, materials, machine and factory space;
v. How to organise work by planning ahead, controlling flow of work, measuring output, simplifying processes, and maintaining quality;
vi. Professional etiquette, ethics and cultivation of healthy social relations inside the department and inter-departmental dealings;
vii. Habit formation, with special reference to industry and emotional stability.

The entrants to Class I will occupy supervisory jobs, and the programme of their training would be of three months' duration if they have been promoted from Class II. If they have come in by direct recruitment, they will go through the programme intended for Class II in about a month's time, and then enter upon the training intended for Class I.

The apprentices in Class I will be given intensive training in supervision. The object of this would be:

(i) How to select workers for assignment to different duties;
(ii) How to train operatives in improved methods;
(iii) How to give orders, secure discipline, settle grievances;
(iv) /

How to delegate responsibility, provide incentives, build team work;

How to reduce labour turnover, improve working conditions, prevent accidents;

How to build up a high professional character by maintaining self-improvement, developing insight into the factors affecting smooth working or the causes of breakdown, and how to help the operatives with suggestions.

They will be attached as assistants to the foremen of the section in which they are to work and would work in the day shift on four days a week. The other two days would be devoted to supervisory training. The actual contact would make the training realistic and they would have a chance to discuss day to day problems with the technical experts and psychologists in the tutorial classes. The lectures will be delivered by experts in the Technical Institute, Assistant Superintendents and Superintendents and the Industrial Psychologist. All of them are in touch with the actualities in the factories and are therefore best fitted to discuss the problems in a realistic manner.

The entrants to jobs in Class I and II will be placed on two years' probation after serving their period of apprenticeship.

Technical Jobs Class II. - New entrants to these jobs would receive the training for Higher Executives. As with the foregoing two forms of training - Introduction and Foreman - there will be explanatory talks to begin with. The training provided by the Technical Institute to the graduate apprentices now is part of training within industry.

After selection the graduate apprentices attend during the first year the Technical Institute, Jamshedpur, and the works, in alternate weeks for their theoretical and practical training. The practical work in the laboratory is on pyrometry, metallurgy, testing of steel, fuels, and chemical analysis of iron and steel, and on mechanical and

electrical

1. Ibid - P67.
electrical engineering.

The second year is mainly spent in the works, but the apprentices attend evening classes in metallurgical processes, works maintenance, cost accounting and industrial economy three times a week. These classes are conducted by the experienced officers of the Company and the lectures are devoted to the methods in the Tatas. All the apprentices are given a general training in all the departments of the works during the first six months, the last six months are devoted to specialized training in one particular department. The training during these two years is mainly in (a) job instructions - how to perform different jobs in their occupational level\(^1\) (b) job methods\(^2\) - how to eliminate waste by economizing time and energy in the operations.

But there is no provision for training in job relations and personnel management. And this is what is imperatively needed. The objects of such training are:

(i) Control through accurate records so that they may be available for immediate use and are sufficiently adequate and complete to permit definite action by the management both in respect of the upkeep and operation of the plant and the staff employed under the foremen.

(ii) Cultivation of emotional stability as an attitude of the mind which would urge the officer to investigate facts before action and "to accept the fundamental facts open-mindedly /

---

1 See P.M.E.2.

2 The four steps of Job Methods are:

Step i. Break down the job - that is, have details about material handling, machine work, and hand work.

Step ii. Question every detail regarding materials, machines, equipment, tools, product design, layout, workplace, safety, housekeeping.

Step iii. Develop the new method -
1. Eliminate the unnecessary details.
2. Combine details when practical.
3. Rearrange for better sequence.
4. Simplify all necessary details.

Step iv. Apply the new method.
"open-mindedly without prejudice and to reject the trivial and "superficial."

(iii) Inculcation of the qualities of leadership, e.g. training to organize routine work by delegating authority with discretion and to improvise in emergency, to eliminate favouritism and ensure an impartial deal to all, to be persuasive and explanatory in giving orders, and yet be firm.

Morton sums up (ii) and (iii) thus:

(a) A sound indication of thorough supervisory attributes, i.e. steady consistence;
(b) Firm control of temper;
(c) Consideration for subordinates;
(d) Fairness and impartiality of treatment;
(e) Capacity for accepting personal responsibility;
(f) The assertion of authority by implication rather than by forceful imposition;
(g) The use, instead of abuse, of authority.¹

As in the case of the foremen, so here it is men like superintendents and assistant superintendents who can be most /

¹ Ibid, p.79. (THE NEW FOREMANSHIP)

The Training Within Industry Report suggests the following steps for Job Relations:-

1. Get the Facts.
   Review the Record.
   Find out what rules and plant customs apply.
   Talk with individuals concerned.
   Get opinions and feelings.
   Be sure you have the whole story.

2. Weigh and Decide.
   Fit the facts together.
   Consider their bearing on each other.
   What possible actions are there?
   Check practices and policies.
   Consider objective and effect on individual, group, and production.
   Do not jump at conclusions.

3. Take Action.
   Are you going to handle this yourself?
   Do you need help in handling?
   Should you refer this to your Supervisor?
   Watch the timing of your action.
   Do not "pass the buck".

4. Check Results.
   How soon will you follow up?
   How often will you need to check?
   Watch for changes in output, attitudes and relationships.
   Did your action help production?
most helpful in giving lectures on these subjects and they should be assisted by the psychologist and the psychiatrist. The psychologist and the psychiatrist should be able to discover the strong and weak points of the candidates both from the records filed and the observations made at the time of selection and by reason of their day to day contact with the apprentices. They can help them in the most formative years of their career to build up desirable patterns of behaviour.

It is usual now to provide courses for would-be administrators in the training within industry - both in the U.S.A. and Great Britain. But it will be some time before the Tatas select men for administrative posts direct. At present the posts of assistant superintendent, superintendent, general superintendent and works manager are filled by promotion from the higher executive, and by the time men reach these posts they have acquired sufficient practical experience. Hence we think it unnecessary to press for it.

But if training within industry is to succeed, we must have a well trained staff for coaching the new entrants. Teaching is an art and particularly when it is the qualities of personality that are to be developed in the candidates selected a highly trained staff is a positive necessity. The following are the qualities we would wish a member of the teaching staff to possess.

(1) The person who instructs must be respected, experienced, and competent.

(2) He should have received training as teacher in a training college in methods of teaching.

(3) He must be an expert in his own line, Engineering or Metallurgy.

(4) He must have enough knowledge of psychology to appreciate the group factors under which the personality traits
of the supervisory staff might be grouped and to develop the qualities which a psychological interpretation of the factors may be said to symbolise.

There is unfortunately no training college for training technical and personnel instructors in India. But the need for such an institution is imperative. However, the psychologist in the service of the factory may be of great assistance to the staff of instructors in guiding them to study the literature on Pedagogy and by giving them talks on some of its broad features. What is needed is an earnest effort on the part of the management.

Perhaps the best method would be the Project Method and discussion with the apprentices individually and in conference. The practical and theoretical work should be done in the form of assignments and the trainees should keep a diary indicating their difficulties in the practical work and the administrative problems they may be faced with in the factory. These problems are discussed individually, and the psychologist and the instructors help the trainees to solve them. The common features are discussed in a conference.

In short, the training of the supervisory staff will fall under two heads:

(a) Technical - Theoretical and Practical.

(b) Personnel Management. The subjects for lectures under this head may be divided into the following groups:

1. General Principles of Foremanship and Supervision.
3. Elements of Labour Management.

The Tatas have not been oblivious of the importance of training, but it suffered from two handicaps: (i) it was not equally efficient for all occupational levels; (ii) the aspect relating to personnel management was ignored. We shall discuss briefly the provision for training for industry which /
which the Tatas have developed and contemplate to remodel and offer our own suggestions about certain improvements which the schemes on the anvil call for.

The Technical Institute, Jamshedpur, was established in 1921 "with the object of training suitable Indians for responsible positions in the operating departments of the works"; and in 1927 the factory had two classes of training for apprentices: (1) for superior posts; and (2) for skilled workmen. There were two grades of superior posts, 'A' and 'B'. Apprentices in both the grades were trained with the ultimate object of filling superior posts such as superintendents, assistant superintendents and foremen. The distinction between 'A' and 'B' was rather thin; and there was a further discrimination within A - 'A2' and 'A1'. The minimum qualifications required for admission to 'A2', 'A1' and 'B' classes were:

<table>
<thead>
<tr>
<th>Class of Apprentices</th>
<th>Admission Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>'A2' class</td>
<td>An Honours or First Class degree or diploma in Mechanical or Electrical Engineering or Metallurgy of a recognized Indian or foreign university, technical institute, or college, accompanied by six months continuous practical experience after graduation in an Iron and Steel works abroad.</td>
</tr>
<tr>
<td>'A1' class</td>
<td>An Honours or First Class degree or diploma in Mechanical or Electrical Engineering or Metallurgy of a recognized Indian or foreign university, technical institute or college, preferably accompanied by works experience abroad.</td>
</tr>
<tr>
<td>'B' class</td>
<td>A degree or diploma in Mechanical or Electrical Engineering or Metallurgy of a recognized Indian or foreign university, technical institute or college.</td>
</tr>
</tbody>
</table>

Note - The age limit was 27 for graduates of foreign universities and 24 years for graduates of Indian universities. This classification into 'A2', 'A1' and 'B' grades has
has now been abolished and so also the distinction between the graduates of foreign universities or institutes and home ones. The age limit is now 24 years. All the graduate apprentices now draw a stipend of Rs. 75 (25-10) a month as against Rs. 200 to 'A', Rs. 75 to 'A', and Rs. 50 to 'B' a month previously.

We have already discussed the present-day scheme of training at pages 864/18.

Besides this, the Tatas had two other schemes of training for industry.

(1) 'C' Class Apprentice—Recruitment to this class was by selection, but preference was given to youths whose parents or guardians were employees of the Steel Company. Candidates were required to pass an entrance examination, a medical examination, and an Intelligence test. Usually 75 admissions were made each year. The minimum admission qualification was success at the Middle English examination. The age limit ranged from 15-18 years.

Training: A combined theoretical and practical training, extending over five years, was given. During the first four years they attended the apprentice school for two days a week for theoretical training and the works for the remaining four days, for practical training. The school course comprised general education, elementary science and technology as required in the works.

The programme of works training was so planned as to give apprentices a general training in the various shops and the electrical department of the Company. In the final year they specialized in one particular department where they worked full time.

The following stipends were allowed:

<table>
<thead>
<tr>
<th>Year</th>
<th>Stipend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td>Rs. 0-8-0 a day, i.e. 8d.</td>
</tr>
<tr>
<td>2nd</td>
<td>0-10-0</td>
</tr>
<tr>
<td>3rd</td>
<td>0-12-0</td>
</tr>
<tr>
<td>4th</td>
<td>0-14-0</td>
</tr>
<tr>
<td>5th</td>
<td>1-0-0</td>
</tr>
</tbody>
</table>

Drastic /
193.

Drastic changes have been made in this course and the period of training has been cut down to two years. The conditions of admission now are: Indian nationality; minimum educational qualification; English Middle, i.e. passing Standard VIII or its equivalent; age not less than 15 and not more than 18.

They are trained for the jobs of turner, machinist, fitter (general), blacksmith, welder, transportation and traffic control.

The selected candidates are given a combined theoretical and practical course of two years at the Technical Institute and the works of the Company. During the first two months of the course all apprentices, irrespective of the trades to which they would be finally assigned, are given a common basic training. At the end of this, a specific trade is assigned to each apprentice, and during the remaining period of apprenticeship the special training is confined to that particular trade only. The allotment of a specific trade depends upon the progress of a candidate during his basic training and upon the requirements of the works in the different trades.

The following maintenance allowance is allowed:

- 1st year Rs. 0- 3-0 8d per day.
- 2nd " Rs. 0-10-0 10d "

The jobs for which this class of apprentices are trained are covered by skilled jobs, Class II. We have made provision for the training of entrants in Unskilled jobs, Class II for these jobs if they are anxious to advance themselves. As the number of technical schools is growing in India of today and Mr. Kutar has a scheme of vocational education in Janshedpur, we suggest that this scheme of training be dropped and its place taken by training within industry for Skilled Workers Class II.
(2) The Jamshedpur Technical Night School. - It is on a fee-paying basis and is supported by the Company and the Bihar Government. There are trade courses of one year duration and include subjects like foundry practice, armature winding, electrical wiremen course, drawing, workshop practice, general science, locomotive, etc. The school hours are 1815-2015, and lectures are delivered once a week.

The utility of this scheme is undoubted. But it will be merged in the classes we have recommended at page 183.

As said earlier in this thesis a large percentage of workers in the Unskilled Jobs Classes I and II are illiterate. This is an extremely unsatisfactory state of affairs. But the percentage of literacy in India is only 17% and hence the preponderance of illiterate workers is inevitable. We have suggested adult schools at page 181 for the benefit of the aspiring men in Unskilled Jobs Class II. But with the expansion of education we can look forward to literate young men for Unskilled Jobs, Class I. As for Skilled Jobs, Class II, the acceptance of the proposal of Mr. P.H. Kutar, General Superintendent, TISCO, submitted to the management in September, 1945, will go a long way to promote technical education in schools for this class of employees. The broad features of his proposals are:

1. Introduction of vocationalism in the high schools run by the factory.


The institution of a polytechnic will serve a real need and would be of great help both to the factory and its employees. Rightly does Mr. Kutar remark: "The case for the recruitment of a major portion of prospective employees from the local institutions, mainly maintained by the Tatas, is indispensable. Both for considerations of easy accessibility /
"accessibility and the suitable environmental make-up of the "younger generation bred up in Jamshedpur, it will be in our "interest to draw increasingly on the local material for our "future requirement of workers." The technical education of young men in their pliant years in the settings of an industrial town, combined with visits to the factory, will impart an industrial sense to them. Mr. Kutar observes: "Our own experience with our 'C' class apprentices has "confirmed that when a boy has attained 12 years of age, "factory conditions do not change his mentality. The hard "core of his mental make-up, whether right or wrong, remains. "The result is that we have a large number of employees who, "being misfits, are always discontented, are prone to acts of "indiscipline and are ready to foment trouble in the lower "ranks."

Mr. Kutar has also suggested the founding of an engineering and metallurgical institution in or in the close vicinity of Jamshedpur so that the factory might arrange courses of study of the university standard and draw candidates from it for its graduate apprenticeship. This proposal is in keeping with the practice in the U.S.A. to have engineering and metallurgical institutions near the large centres of such industries. His recommendations are:

(i) Six years' course after matriculation.
(ii) Teaching and examination on the American lines.
(iii) Watch over the students by the factory.
(iv) Jamshedpur should be made the centre of attraction to science-minded matriculates all over the country so that the factory may have the opportunity to attract the best brains in India and utilize them for the improvement of industry.
(v) There should be courses in Mechanical and Electrical Engineering and Metallurgy.
(vi) /
(vi) Admission to different courses should be by previous records and administration of Intelligence and Aptitude tests.

The Polytechnic we suggested would naturally be a feeder to this Institute and the biographical records of the students would be a fairly correct index of their personality traits. These records would extend from the primary stage to the time of their graduation, i.e., from the age of about 9 to 21 or 22. The students who are not found satisfactory for advanced studies will have certificate courses in different trades of the factory and would on obtaining the certificate be eligible to recruitment to Skilled Jobs, Class II.

This institution will also serve as the Research Department of the factory. The factory is already running one and it might be amalgamated with the proposed institute for the benefit of both the post-graduate students and the factory itself.

One of the drawbacks of the existing technical institutions and colleges in India is that the professors and lecturers in them are not in the front rank of industries and industries do not look up to them for consultation. Thus both the theoretical and practical work at these places is more or less out of touch with the realities in factories. The closeness of the institution proposed by Mr. Kutar to the factory and its control by the management will remedy this great defect. Above all the contacts with the executives of the factory will foster a healthy industrial outlook.

Attached to this institution should be a department of research in industrial psychology and it should work out patterns for training the Unskilled Classes II and I in their jobs.

---

1 The main steps to evolve such patterns would consist of:
   (a) **Analysis** of the difficulties encountered in training.
   (b) **Plan** - organizing, thinking through, weighing and deciding what to do, seems a logical next step.
   (c) **Trials**.
   (d) **Evaluation** of the plan through follow-up.
jobs and solutions of the problems of personnel management. We said in Chapter I that placement in any occupational level is more a problem of vocational guidance rather than selection and this department will draw up schemes for guidance of selected candidates to different jobs according to their technical abilities and personality traits. e.g. the qualities of leadership will differ from one family of jobs to another (leadership in the pit is different in so many ways from leadership in the cast house) and methods have to be devised to discover men who are capable of developing into outstanding leaders in different sections, and then to help them in the process of development. Another fruitful line of investigation would be pupil personnel work which would enable the authorities of the Polytechnic and the Technical Institute to develop the most suitable environment for industrial training, sense of duty and cultivation of the qualities of leadership.

We have attempted in the pages of this thesis to consolidate the data collected during our first survey and have discussed the lines on which a second survey should proceed to have a comprehensive picture of the workers in the different occupational levels from the technical and psychological points of view. We have also indicated in this chapter a plan for the fostering of desirable qualities through the influence of the environment at the Polytechnic and the Technical Institute. India is embarking on a great industrial programme and we trust the plan suggested here may be a step towards the expansion of the Iron and Steel factory on lines up to date technically and psychologically.

1. PRINCIPLES AND TECHNIQUES OF VOCATIONAL GUIDANCE by GEORGE E. MYERS, FIRST EDITION. McGRAW-HILL BOOK CO., INC., NEW YORK & LONDON. 1941 - P32.
2. Ibid - P47.
BIBLIOGRAPHY

INDUSTRY

1. DEARDEN, JOHN: Iron & Steel To-day, Oxford, 1939.
10. Looking Forward - Sigmund Pumps (Great Britain) Ltd., Team Valley, Gateshead.

JOURNALS

1. AMERICAN JOURNAL OF PSYCHOLOGY (THE) - 1904
2. BRITISH JOURNAL OF PSYCHOLOGY (THE) Vol. XIII. - 1909
3. BRITISH JOURNAL OF PSYCHOLOGY (THE) Vol. X. 1919
4. BRITISH JOURNAL OF PSYCHOLOGY (THE) Vol. XXIII. - 1933
5. BRITISH JOURNAL OF PSYCHOLOGY, (THE) Vol. XXVI. - 1936
8. BRITISH JOURNAL OF EDUCATIONAL PSYCHOLOGY (THE) - June 1946.
9. OCCUPATIONAL PSYCHOLOGY - 1946.
1. ALEXANDER, W.P.; Intelligence, Concrete & Abstract - A Study in Differential Traits - Camb. 1935.

2. BURT, Cyril: The Factor of Mind, Univ. of London Press - 1940.


5. HOLZINGER, KARL J.: Statistical Resume of the Spearman Two-Factor Theory - The Univ. of Chicago Press.


10. THURSTONE, L.L.: Factorial Studies of Intelligence - Univ. of Chicago - 1941.

11. THURSTONE, L.L.: A Factorial Study of Perception - The Univ. of Chicago, 1944.


13. WOLFE, DAEL: Factor Analysis to 1940 - Psychometrika Monograph No. III.


APPENDIX A.

INTELLIGENCE TEST FOR 11+

PERCEPTION

A. Spatial

Q 1. Material: A card with figures and numbers. (See below).

![Card with figures and numbers]

Time:

Say:— "There is a circle, a triangle, and a rectangle and certain numbers on this card, now listen and answer the questions I ask you."

Ask these questions:-

(1) Tell me the number which is in the circle and triangle but not in the square.

(2) Tell me the number which is in the circle and square and not in the triangle.

(3) Tell me the number which is in the circle, triangle and square.

Q 2. Say:— "I shall read you a sentence and then ask questions on it. Listen carefully."

Read:— C is west of B: B is west of A.

Ask this question:— Is A to the North, South, East or West of C?

Time allowed:

B. Time

Q 3. Material: A card with a letter written to be read by the subject. (See below).

My dear Rama,

Thanks for your letter which I received on Saturday, that is, the day before yesterday. We will be glad to come to your place but will not be able to reach there till 8 p.m., exactly one hour late for the party. I hope you will not mind.

Yours sincerely,

KUMTI.

November 2, 1944.

q 1. Capt. S. Lall's Test for 11+ (unpublished)
q 2. Burt's Reasoning Test.
Time allowed: ½ minute.

Procedure: When the subject has read the given card then ask the following questions. Give instructions before giving the card.

Say:— "Read this card very carefully as I shall ask questions on it."

Ask the following questions:—

(1) On what day did Kunti reply to Rama's letter?
(2) On what date did Kunti receive Rama's letter?
(3) At what time will the party at Rama's place begin?

MEMORY

A. Digits

Q 4. Say:— "Listen and say these numbers after me." 9 6 8 4 7 5 1

Time allowed: ½ minute.

B. Sentences and Syllables

Q 5. Procedure:

Say:— "Now listen and be sure to say exactly what I say."

(a) "At the summer camp the children get up early in the morning to go swimming."

(b) "Yesterday we went for a ride in our car along the road that crosses the bridge."

C. Memory for Design

Q 6. Material: Card with design. (See below).

![Card with design]

Time /

Q 4 Burt pp. 60
Q 5. Terman and Merrill pp. 109
Time allowed: \( \frac{1}{2} \) minute.

Procedure: Say,- "A card with a design in three colours will be exposed to you for 15 seconds. Then you will be asked to reproduce the design."

**IMAGINATION**

**A. Filling in the blanks**

Q 7. Material: Card with sentences in which blanks are to be filled in, e.g.

(a) Honest girls do not tell ...........

(b) Food is ............ in the kitchen.

Say,- "Read these sentences and tell me what word should be written in each blank space."

Time allowed:

Q 8. Giving the next series -

(i) Material: Card with incomplete series of numbers, e.g.

(a) 2, 3, 5, 7, ... ...

(b) 2, 6, 9, ... ...

(c) 11, 22, 33, 44, ... ...

(d) 515, 424, 333, 242, ...

Procedure: Say to the subject,- "Look at these number series in each line. They are incomplete. You are to tell me the appropriate number for each blank space."

Time allowed:

(ii) Material: Card with incomplete series of designs, e.g.

(a) \[ \square \square \square \square \square \square \square \square \]

(b) \[ \square \square \square \square \square \square \square \]

(c) \[ \square \square \square \square \square \square \square \square \square \]

Procedure: Say to the subject,- "Study the designs given on this card which you will find incomplete, and complete them."

Q 9. **Mixed Letters.** Complete the design appropriately in each series.

Material: Card with mixed letters, e.g.

(a) d b r a e

(b) t e a f

(c) e t a

(d) d o f o
Say, "You will find some letters on this card which have been jumbled up. They make a word. Give the word."

REASONING

A. Mathematical

Q 10. Material: Card with a problem, e.g.

In a school a third of the school play football and a third play cricket.

Procedure: Give the card to the subject, and say, "Read it carefully because I shall ask you questions on it."

Time allowed:

Ask these questions when the subject has finished reading the card:

(a) Are there any who play neither football nor cricket?
(b) Are there any who play both?

B. Logical Reasoning

Q 11. Verbal absurdities 3. Time:

Procedure: Read each statement and after each one ask, "What is foolish about that?" "Why is it foolish?"

(a) A judge said to the prisoner, "You are to be hanged and I hope it will be a warning to you."
(b) A well known railway had its last accident five years ago and since that time only one person has been killed in an accident.
(c) When there is an accident the last carriage of the train is usually damaged most so they have decided that it will be best if the last carriage is always taken off before the train starts.


Material: Two pictures - "The Cat": "Rat on the Table"

Procedure: Show the picture to the subject and ask, "What is foolish about these pictures?"

Ballard: Mental Tests pp.99
Q 11. 1 Terman and Merrill Measuring Intelligence p.108
Q 12. 2 Army Beta Test,

Terman and Merrill p.108
C. Pedigree tree

Q.13. Material: Card with a pedigree tree, e.g.

Beni Prasad

Reva     Kailash     Rikta
Rama     Chandra     Sohan     Malti     Ajay     Vijaya     Kunti

Procedure: Give the card to the subject and say, - "Study it carefully and answer my questions."

Time allowed:

Ask these questions:

(1) How many granddaughters has Beni Prasad?
(2) What is Reva to Ajay?
(3) What relation is Rikta to Reva?

D. Definition and generalization

Q.14. Time allowed:

Procedure: Read the following words out one by one to the subject and say, - "What is meant by .......... ?"

(a) Connection.
(b) Compare
(c) Conquer
(d) Obedience
(e) Revenge.
INTELLIGENCE TEST FOR 14+

PERCEPTION

A. Spatial

Q.1. Material: Card with figure, e.g.

![Figure](image_url)

Time:

Say this after showing the figure to the subject—
"Point out a spot which may be inside the triangle and outside the circle and outside the square."

B. Orientation

Q.2. Procedure: Read the following directions distinctly emphasising the critical words:

(a) "What direction would you have to face so that your left hand would be towards the East?"

(b) "Suppose you are going West, then turn to your right, what direction are you going?"

(c) "Suppose you are going North, then turn to your left, then turn right, what direction are you going now?"

(d) "Suppose you are going South, then turn left, then turn right, then left again, what direction are you going now?"

(e) "Suppose you are going North, then turn left, then left again, then right again, what direction are you going now?"

C. Time

Q.3. Material: Card with a problem, e.g.

I saw an aeroplane take off ten minutes before the school closed. When I met the headmaster at 12 noon he told me that his watch stopped 20 minutes after the taking off of the plane. It showed 10.50.

Time allowed:

Procedure: Give these instructions before giving the card. Say—"Read this card carefully because I will ask you a question on it." When the subject has finished reading the card then ask this question:—"When did the school close?"

MEMORY

Q.1. Spearman The Abilities of Man pp.177.

Q.2. Terman and Merrill Measuring Intelligence pp.175.
MEMORY

A. Digits

Q 4. Say, - "Listen and say these numbers after me."

96, 34, 51, 98, 21, 79

Time allowed:

B. Syllables or sentences

Q 5. Procedure: Say, - "Now listen and be sure to say exactly what I say." Then read the following: - "The other morning I saw in the street a tiny yellow dog."

"Little Maurice has spoilt his new apron."

C. Memory for designs

Q 6. Material: Card with a design, e.g.

Time allowed:

Procedure: Say, - "A card with a design in three colours will be exposed to you for 15 seconds, then you will be asked to reproduce the design."

IMAGINATION

Q 7. Filling in the blanks

Material: Card with sentences in which blanks are to be filled in, e.g.

(a) The soldiers took shelter in the trenches because they expected an .......... 

(b) If we work .......... hard we are sure to .......... in the examination.

Say /
Say, "Read these sentences and tell me what word should be written in each blank space."

Time allowed:

B. Giving the next series

Q 8. Material: Card with incomplete series of numbers, e.g.

7, 8, 11, 12, 15, 16, .... ....
231, 342, 453, 564, .... ....
51, 6, 61, 62, .... ....
2, 9, 18, 23, .... ....

Procedure: Say to the subject, "Look at these number series in each line. They are incomplete. You are to tell me the appropriate number for each blank space."

Time allowed:

(ii) Material: Card with incomplete series of designs. (See below).

(a) X X O O X X O O X X
(b) X O X X O X X O X
(c) X O X O X X C X C X X O X X C

Procedure: Say to the subject, "Study the design given on this card. You will find that it is incomplete. Complete the designs appropriately in each series."

Time allowed:

C. Mixed words

Q 9. Material: Card with mixed words, e.g.

(a) So school late I ran for the I was
(b) Indira very hard stood first because she worked

Procedure: Say to the subject, "You will find some words on this card which have been mixed up. You are to give the sentences in the correct form."

Time allowed:

REASONING

A. Mathematical

Q 10. Procedure: The problem is given orally and may be repeated if necessary.

(a) A mother sent her son to the river to bring back exactly 2 plats of water. She gave him a 5-pint can and a 3-pint can. Show me how the boy can measure out /

Q 9. (ii) Army Beta Test.
Q 10. Terman and Merrill Measuring Intelligence pp.175-176
out exactly 2 pints of water using nothing but these two cans and not guessing at the amount. You should begin by filling the 5-pint can and you must bring back exactly 2 pints of water.

Using the same formulae for (b) and (c) -

(b) 8-pint can and 5-pint can to get 11 pints. Begin by filling the 8-pint can.

(c) 4-pint can and 9-pint can to get 3 pints. Begin by filling the 4-pint can.

Time allowed: 3 minutes for each.

B. Logical Reasoning

Q 11. (1) Verbal Absurdities -

(a) When men are pure, laws are useless: when men are corrupt, laws are broken. Therefore we should have no laws.

(b) If a man is single, he is unhappy because he has no one to take care of, and if he is married he is unhappy because he has to take care of a wife.

(c) A man said to his friend,- "If I should ever grow desperate I will commit suicide, but I will never choose a Friday to do so because Friday is a bad day."

Q 12. (2) Picture Absurdities 2.

Material: Two pictures. (See below). "The Scale" "Wind Direction".

Procedure: Show the picture to the subject and ask, "What is foolish about these pictures."

Q 13. /

Q 12. Army Beta Test.
C. Pedigree Tree


```
+-----------------+    +-----------------+    +-----------------+
| Lal Mohan       |    | Shanti Raman    |    | Chandrika Prasad|
|                 +    +-----------------+    +-----------------+
| Mukut Behari    |    |                 |    |                 |
|                 +    +-----------------+    +-----------------+
| Hakim Mohan Phul|    | Radha           |    | Shriman Tej      |
| Chand Chand Chand|    | Prema           |    | Narain Narain   |
|                 +    +-----------------+    +-----------------+
| M: Married      |    |                 |    |                 |
|                 +    +-----------------+    +-----------------+
| M: Married      |    |                 |    |                 |
|                 +    +-----------------+    +-----------------+
| Chandra Shiva   |    | Bala            |    |                 |
| Bibbo           |    |                 |    |                 |
|                 +    +-----------------+    +-----------------+
| M: Married      |    |                 |    |                 |
|                 +    +-----------------+    +-----------------+
| M: Married      |    |                 |    |                 |
```

N.B. M stands for marriage.

Procedure: Give the card to the subject. Let him study it and then ask the following questions:

(a) How many great-grandchildren has Lal Mohan?
(b) How many cousins has Tej Narain?
(c) How many nieces has Mukut Behari?
(d) What relation is Malti to Radha?
(e) Who is Shiv Dulari to Tej Narain?
(f) Whom did Radha marry?

Q. 14. Definition and Generalization

Time allowed:

Procedure: Read the following words one by one and say, -
What is meant by -
(a) Kindness
(b) Justice
(c) Charity
(d) Generosity
(e) Independence
(f) Authority.

Burt: Mental and Scholastic Tests p. 64
DUMMY TEST

1. Write the number of the correct answer. — Horse is a
   1. vegetable. 2. ship. 3. bird. 4. animal.

2. Which direction are you facing when you are observing the
   setting sun?

3. Write the letters over the figures which bear the same
   relation as —

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td>9</td>
<td>15</td>
<td>27</td>
<td>34</td>
</tr>
</tbody>
</table>

4. Mohan is Sohan's uncle; Prabhu is Mohan's grandfather;
   what is Prabhu to Sohan? Write the bare relationship.

5. Write the next number — 3 7 11 15 ...

6. Write the number of the extra —
   1. motor car; 2. steam boat; 3. tramway; 4. motor cycle; 5. camel.

7. Write the numbers of the words that make the best sense of
   the following: — If the Army is to fight under modern
   (elephants 1
   (equipment 4
   (movements 5
   (aeroplanes 3
   (condition, then (boats 2 must support it in its
   (messing 6

ANSWER SHEET.

1. animal
2. West
3. c. d.
4. great grandfather
5. 19
6. 5
7. 3 5
MANUAL OF INSTRUCTIONS

1. Do not begin the test till you are asked to.

2. All answers must be written on the Answer Sheet. The answer will be indicated by a number or a letter or a symbol or a word which must be written in the space provided for it against the question in the Answer Sheets.

3. The test is a time limit one and credit will be given for answering the largest number of questions within the time allotted.

4. Do not linger over questions which you find too difficult.

5. Do not erase answers; if they are wrong cut them out and write the correct answer beside it.

6. No explanatory questions will be entertained.

ITEMS

I. Observation

A. Environmental

1. Look up the digits of your fingers and say how many digits has your index finger.

2. Write the digit which does not occur more than once in the following:
   (a) 3, 1, 7, 5, 3, 7, 1.  (b) 4, 2, 3, 3, 1, 2, 4.

3. Write the number of the correct answer.
   When you enter my house you will find a window in the wall on your right. When the sun sets it shines straight through this window on the wall opposite. What direction are you facing when you stand in the doorway and look across the street? (North, south, east, west).

4. I saw an aeroplane take off ten minutes before the school closed. When I met the headmaster at 12 noon he told me that his watch had stopped 20 minutes after the taking off of the plane. It showed 10.50. When did the school close?

5. Write the number of the group which contains four multiples of 2 (two).
   (1) 765432; (2) 897321; (3) 547619; (4) 816437
   (5) 571932; (6) 413792; (7) 642175; (8) 276418.

6. Write the number of the usual correlation of the following from among the words given at the end -
   (a) Distillery  (b) Perfumery  (c) Totalitarianism  (d) Carnival  (e) Blitz.
   (1) Mangoes.  (2) Army.  (3) Drugs.  (4) Wine.  (5) Chemicals

7. /
A. Environmental - contd.

7. Write the numbers of the peculiarities of India in the following regions from among the words given below -
   (a) South India
   (b) Assam
   (c) Frontier Provinces
   (d) Sind
   (e) Madras Coast.


8. Draw a line (in the Answer Sheet) from the corner marked A passing across the first square, between the second and the sixth squares, between the sixth and the seventh squares, under the seventh square, between the 11th and the 12th squares, and across the 16th square to the corner marked B.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

9. Read these words and think what their meaning would be if they were in the right order. -
   (1) people. (2) church. (3) dance. (4) go. (5) to. (6) to.
   If the statement is untrue, give the number of the word which makes it wrong, but if the statement is true put a cross.

10. (a) Look at the following figure. - If \( ab \) is greater than \( bc \), write nothing; if not put down a cross.

    \[
    \begin{array}{c}
    a \quad \downarrow \\
    \text{ towards } \\
    b \quad \uparrow \\
    \text{ c}
    \end{array}
    \]

   (b) Look at \( PQ \). If they are in a straight line put down a cross; if not leave the blank unmarked.

11. Give the number of the extra word in the following:
   (a) (1) Charity. (2) Kindness. (3) Benevolence. (4) Revenge
      (5) Love.
   (b) (1) Coal. (2) Bread. (3) Cake. (4) Paper.

12. Write the words you would insert in the following blank spaces.
    Gram is a measure of ............ ; cubic centimetre is a measure of .............

13. Write the number of the correct answer. -
    Anatomy deals with - (1) circulation of blood. (2) nursing.
    (3) gland action. (4) bony structure.

14. Match the expressions under A. with appropriate symptoms under B., and write the number of the correct symptom
A. Environmental - contd

against each.

2. Pthisis. 2. Inability to see distant things.
3. Asphyxiating gas. 3. Inflammation of the membranes of the brain.
5. High blood pressure. 5. Weakened nerves.

15. Write the number of the correct answer. -
What organ rids the body of its poison?
(1) kidneys. (2) lungs. (3) heart. (4) brain. (5) liver.

16. Write the number of the country where the midnight sun is visible.
(1) South Africa. (2) New Zealand. (3) Tierra del Fuego.
(4) Norway.

17. Give the number of the correct answer. - The higher we go the colder it is because
(1) we are nearer the sun; (2) the mother earth is not hot;
(3) of higher altitude. (4) rarefied atmosphere.

18. Suppose you are going west, then turn to your right; what direction are you going now?

19. Suppose you are going south, then turn left, then turn right,
and then turn left again; what direction are you going now?

20. Write the number of the correct answer. - Mohan is to the left of Sohan, and I am to the left of Mohan.
Who is in the middle? (1) Mohan. (2) Sohan. (3) I.

21. Write the number of the dissimilar in the group. -

22. Match the effects with the causes, and write the number of the correct answer against each.

1. The heat of the sun in the equatorial regions.
1. Movement of the hot water on the sea surface in the cold regions.
2. Rarefied atmosphere.
2. Lower reading of the barometer.
3. Deflection of light.
3. Stick appears bent in a vessel full of water.
4. The trees give out oxygen.
4. Good to walk in a shady grove of pine trees in the morning.
5. Subsoil water is pure.
5. Tube wells are good in malarial regions.
6. The earth rotates from the west to the east.
6. London time is behind Bombay time.
7. Water has upthrust.
7. We swim in the river.
8. Heated air rises.
8. Good to have ventilators.
B. Biological (Similarity and Dissimilarity)

23. Write the number of the word you would insert in the blank space.
   Milk is ............ (1. solid, 2. liquid, 3. gas).

24. Write the word you would insert in the blank space.
   Alps are to ............. what the Himalayas are to Asia.

25. Write the word you would insert in the blank space.
   Piston is to the ............. what the heart is to the body.

26. Write the letters over the figures with the same relation as:
   4 is to 16 as 32, 47, 63 is to 183, 132, 184.

27. Write the word you would insert in the blank space.
   (a) Health is invigorating, sickness is .............
   (b) Cradle is to baby, as stable is to .............
   (c) Debt is a liability; income is an .............

28. Write the number of the word that is dissimilar.

29. Write the number of the correct opposite from among the words given in the brackets.
   The way is long, but the time is ............. (1. over, 2. short, 3. up).

30. Write the number of the word which is dissimilar.
   1. Loud. 2. Low. 3. Whisper. 4. Tick.

C. Relations

31. Y's (1. sister; 2. mother; 3. uncle) is his (4. aunt's; 5. brother's; 6. grandmother's 7. wife's) (8. sister; 9. cousin; 10. daughter).

32. Lal Mohan

<table>
<thead>
<tr>
<th>Mukut Behari</th>
<th>Shanti Raman</th>
<th>Chandrika Pd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hakim Mohan Phul</td>
<td>Radha Prema Bala</td>
<td>Shriman Tej Malti</td>
</tr>
<tr>
<td>Chand Chand Chand</td>
<td>Radha Prema Bala</td>
<td>Shriman Tej Malti</td>
</tr>
<tr>
<td>M: Narvid G</td>
<td>M: Y</td>
<td>M: Z</td>
</tr>
<tr>
<td>Narain Narain</td>
<td>Narain Narain</td>
<td></td>
</tr>
<tr>
<td>ChandraShiv Bibba</td>
<td>Kala Dulari</td>
<td></td>
</tr>
</tbody>
</table>

From the above diagram write the answers (in one word or figure only) of the following questions:-

(1) How many great grandchildren had Lal Mohan?
(2) How many cousins has Tej Narain?
(3) Who is Shiv Dulari to Tej Narain?
(4) How many nieces has Mukut Behari?
(5) What relation is Malti to Radha?
(6) Whom did Radha marry?

II. Number

33. Write the number you would put within the brackets.
   8-5-1 20-(..)-1.

34. Write the next number in the following:
   1, 2, 6, 24, ...........

35. /
35. Write the next number in the following:
   1, 3, 5, 9; 7, 9, 11, 27; 13, 15, 17, ........
36. Write the next number in the following:
   3, 7, 15, 31, ............
37. Write the number which comes next in the following:
   9, 3, 7, 6, 7, 9, ........
38. Write the number which comes next in the following:
   7, 5, 5, 7, 5, 5, ........
39. Write the number which is extra in the following:
   3, 7, 26, 31, 13, 17.
40. Write the number which is extra in the following:
   8, 2, 16, 32, 64.
41. If two pencils cost 5d, how many pencils can you buy for 50d.
   (10, 15, 20, 30, 35).
42. Write two numbers whose sum is 19 and whose difference is 5.
43. Write the number which when multiplied by 9 and to whose product if 7 are added gives 70.

III. Memory and Imagination

44. If February comes after January make two crosses; if not make one.
45. In your mind without writing them down you have to arrange the words of each line below in the proper order, and then give the number of the middle word of this order:
   (a) 1. cotton. 2. fabric. 3. coat. 4. yarn. 5. warp and woof.
   (b) 1. pupil. 2. professor. 3. monitor. 4. lecturer. 5. reader.
   (c) 1. Big Ben. 2. sundial. 3. watch. 4. clock. 5. time piece.
46. Give one word for:
   1. Mind and science.
   3. Body and science.

IV. Verbal

47. Write the number of the word from amongst the words given within the brackets which you would insert in the blank space:
   Nuts are good too if they are well ..............
   (1. nourished. 2. broken. 3. ground. 4. chewed).
48. Write the number of the word from amongst the words given in the brackets which will so complete the second sentence as to bring out the meaning of the first sentence:
   The master changed his mind.
   The master .............. (1. formed. 2. altered. 3. fixed) his mind.
49. /
49. Here are four sentences which have been cut into parts. Write the number of the right part against each:

1. A red rose 1. makes the room brighter.
2. A judge with his wig 2. is often a cause of shipwreck.
3. A window 3. sits in the court of law.
4. A stormy sea 4. is very good for children.

50. Write the number of the correct answer:
An analogy is (1) an exaggeration; (2) a short statement of a general truth; (3) a parallel.

51. Write the number of the words or phrases that make the best sense of the following sentence:

A man writing on 1st January 1922 said my sister who (1) died (4) 1898
(2) was born on the 15th November (5) 1950 will be
(3) was married (6) 1900
(7) twenty-five (10) year.
(8) thirty-three years old next (11) November.
(9) thirty-four (12) month.

V. Moral Antitude

52. Write the number of the correct answer:
If you see broken glasses in the street -
(1) Pick them up,
(2) Do nothing about them,
(3) Tell the policeman about it,
(4) Try to find out the man who did it.

Extras

1. What colour is half-way between black and white?
2. What colour is half-way between red and blue?
3. If we mix blue and yellow paints, what colour do we get?
4. What colour do we get by mixing red with yellow?
MANUAL OF INSTRUCTIONS

1. Do not begin the test till you are asked to.
2. All answers must be written on the Answer Sheet. The answer will be indicated by a number or a letter or a symbol or a word which must be written in the space provided for it against the question in the Answer Sheet.
3. The test is a time limit one and credit will be given for answering the largest number of questions within the time allotted.
4. Do not linger over questions which you find too difficult.
5. Do not erase answers; if they are wrong cut them out and write the correct answer beside it.
6. No explanatory questions will be entertained.

ITEMS

I. Observation
A. Environmental

1. Look up pages 1, 3, 4, and write the number of the page you are at.
2. Write the digit which occurs more than once in the following: 4, 7, 1, 9, 5, 2, 4, 8, 3, 6, 0, 4.
3. I started from the school and walked 100 yards; I turned to the right and walked 50 yards; I turned to the right again and walked 100 yards. How many yards was I from the school?
4. I heard the school clock strike yesterday 10 minutes before the gun was fired. I did not count the strokes, but I am sure that it struck an odd number. I did not come to the school in the morning and the school clock stopped at 5 minutes to 5 in the afternoon. When do you think the gun was fired?
5. Write the number of the group of the digits in which there are both 1 and 7, and the total is an even number:
   (1) 954178; (2) 16379; (3) 814576; (4) 384712; (5) 359471; (6) 762491; (7) 937415.
6. Write after each word the name of the object of which it is a part as in the first two examples:
   (1) Page - book; (2) Blade - knife; Leaf, finger, spokes, inch, letter.
7. Write the figures with even number of digits on the right hand side and with odd number on the left - 2, 17, 89, 647, 5894.
8. A. Write the number which lies in the space both in the triangle and the square.
   B. Write the number which is inside the square but outside both the circle and the triangle.
9. In the following words find one letter which is contained in only three of the words, and then write the number over the remaining word, which does not contain that letter.

Heap, April, Drake, Lark.

10. In the picture given you are looking at the reflection of a clock and some words in a mirror:
(a) What do the words say?
(b) What would be the actual time if you could turn round and look at the clock itself.

11. Look at the given circles. If a machine gun can shoot more bullets per minute than a rifle, then write the number of the second circle; if not put a cross.

12. Write the words you would insert in the blank spaces:

1 __________ expands bodies: 2 __________ contracts them.

13. Write the number of the correct answer:

Geology deals with - (frogs, mines, stratification).

1 2 3

14. Match the substance with its properties and write the number of correct property against each:

<table>
<thead>
<tr>
<th>Substances</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Nitrogen</td>
<td>2. May readily be turned into solid, liquid or gaseous forms.</td>
</tr>
<tr>
<td>3. Oxygen</td>
<td>3. When introduced into colourless lime water, it turns it milky.</td>
</tr>
<tr>
<td>5. Phosphorous</td>
<td>5. Even though it is liquid a solid iron ball does not sink in it.</td>
</tr>
<tr>
<td>7. Mercury</td>
<td>7. In its presence ice does not melt at the usual temperature.</td>
</tr>
<tr>
<td>8. Water</td>
<td>8. Burns when it comes in contact with air.</td>
</tr>
</tbody>
</table>

15. Write the number of the correct answer: It is necessary to clean the finger nails before taking meals because

1. They may be dirty.
2. There is a sort of poison in the nails.
3. There is a sort of liquid produced in the nails.
4. It is a good custom.

16. Write the number of that which is most important on a passport:

1. The colour of your eyes.
2. The town of your destination.
3. The names of your parents.

17. Write the number of the correct answer: A planet differs from the stars in that -

1. /
1. It is larger.
2. It moves in an orbit.
3. It twinkles a bit more.
4. Has wings round it.

18. Which direction would you have to face so that your left hand could be towards the east?

19. Suppose you are going north, then turn to your left, then turn right: what direction are you going now?

20. Write the number of the correct answer: Rama is to my right, Lakshman is to Rama's right. Who is in the middle? (1) Rama. (2) Lakshman. (3) I.

21. Write the number of the incorrect crop in the following classification: RABI (1) wheat. (2) gram. (3) tobacco. (4) rice. (5) barley.

22. Match the effects with the causes, and write the number of the correct answers against each:

<table>
<thead>
<tr>
<th>Causes</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bending of the sun’s rays by the rain drops.</td>
<td>1. Eclipse.</td>
</tr>
<tr>
<td>2. Earth’s turning upon its axis in its revolution about the sun.</td>
<td>2. Evaporation of water.</td>
</tr>
<tr>
<td>3. Sun’s rays shining hot and the air being dry.</td>
<td>3. Floating of substance.</td>
</tr>
<tr>
<td>4. The passing of the Moon between the earth and the Sun.</td>
<td>4. Appearance of the rainbow.</td>
</tr>
<tr>
<td>5. Excess of the water vapour in the atmosphere.</td>
<td>5. Succession of day and night</td>
</tr>
<tr>
<td>6. Change of the position of the moon with relation to the Sun and the Earth.</td>
<td>6. Appearance of the phases of the Moon.</td>
</tr>
<tr>
<td>7. Earth’s revolving on its axis at an angle of $23^\circ$ degrees.</td>
<td>7. Rain, snow, hail.</td>
</tr>
<tr>
<td>8. Substances being lighter than the weight of an equal volume of water.</td>
<td>8. Succession of Seasons.</td>
</tr>
</tbody>
</table>

B. Bipolar (Similarity and Dissimilarity)

23. Write the number of the word you would insert in the blank space: Ink is .......... (1. solid; 2. liquid; 3. gas)

24. Write the word you would insert in the blank space: Yanktskiang is to .......... what the Ganges is to India.

25. Write the word which you insert in the blank space: Blood is to the body what sap is to the .......... 

26. Write the letters over the figures which bear the same relation as: 

a b c x y z
3 is to 9 as 27, 30, 43, is to 60, 75, 81.

27. /
27. Write the word you would insert in the blank space:
   (a) A rabbit is timid, a lion is ............
   (b) A philosopher is contemplative, a soldier is ............
   (c) Library is to books as greenhouse is to ............

28. Write the number of the word that is dissimilar:
   (1) Tobacco  (2) Cigar  (3) Cigarette  (4) Opium.

29. Write the number of the correct opposites from amongst the words given in the brackets which you would insert in the blank space: The end of the book ought to be as good as the ............ (1) middle (2) beginning (3) cover.

30. Write the number of the word which is dissimilar:

C. Relations

31. Write the numbers of the appropriate relations:
   Z's (1. father  2. uncle  3. brother) is his (4. mother's  5. sister's  6. grandmother's), (7. daughter  8. brother  9. son).

32. Mr & Mrs Sharie  Mr & Mrs Dube  Mr & Mrs Shukla

Vidyavati Ramesh Copal Pushpa Shubhala Krishna Mohan Kaynak Prabhavati
Harish Shaktuntala Suresh

From the above diagram write the answers (in one word or figure only) of the following questions:

1. What is Suresh's surname?
2. What relation is Shakuntala to Krishna?
3. What relation is Shakuntala to Suresh?
4. What relation is Shakuntala to old Mr Dube?
5. How many aunts has Suresh?
6. How many uncles has Harish?

II. Number

33. Write the number you would put within the brackets: 9-6-2 10-(......)-2.

34. Write the next number in the following series: 1,4,16, .......

35. Write the next number in the following series: 123,6,456,15,789 .......

36. Write the next number in the following series: 5,7,11,17, .......

37. Write the number which comes next in the following series: 1,3,9,27,81,243, .........

38. Write the number which comes next in the following series: 17,15,13,11,9,7, .........

39. Write the number which is extra in the following series: 7,31,28,35,14,27 .........

40. Write the number which is extra in the following series: 18,30,6,24,22,12, .........

41. /
41. If a boy's wage is 20 shillings a week and he spends 14 shillings a week, how many weeks will it take him to save 300 shillings.

42. Write the number which when divided by 7 gives 6 as quotients and 5 as remainder.

43. What is the greatest number that will divide 64 and 76 and leave a remainder 4 in each case.

III. Memory and Imagination

44. If you had your breakfast today, write y for yes, if not write n for no.

45. In your mind without writing them down you have to arrange the words of each line below in the proper order and then give the number of the middle word of this order.
(a) 1. paragraph; 2. volume; 3. chapter; 4. sentence; 5. letter.
(b) 1. house; 2. street; 3. room; 4. town; 5. country.
(c) 1. general; 2. sergeant; 3. captain; 4. private; 5. corporal.

46. Write the number of the extra: 1. cunning; 2. sharpwitted; 3. tender; 4. charitable; 5. nefarious.

IV. Verbal

47. Write the number of the word from amongst the words given within the brackets, which you would insert in the blank space: Sound Ripe .......... is excellent as food. (1. marmalade; 2. mutton; 3. fruit).

48. Write the number of the word from amongst the words given in the brackets which will complete the second sentence so as to bring out the meaning of the first sentence: The jewels are quite safe. The jewels are quite .......... (1. rare; 2. hidden; 3. secure).

49. Here are four sentences which have been cut into two parts. Write the number of the right part against each:
1. Ripe fruit 1. makes blots on the paper.
2. Wrinkled face 2. is put in the van.
3. A scratchy pen 3. has a sweet smell.
4. A heavy trunk 4. is generally a sign of old age.

50. Write the number of the correct answer: A paradox is a - 1. statement that seems to contradict itself. 2. a particular kind of metaphor. 3. earthly story with a heavenly meaning. 4. a kind of bird.

51. Write the numbers of the words or phrases that make the best sense of the following sentence:
If today was 2. Saturday then the day 5. after tomorrow would be 6. preceding
3. Sunday
7. Thursday.
9. Wednesday.
V. Moral Aptitude

52. Write the number of the correct answer: "People who live in glass houses must not throw stones" means -
1. Do not put all your eggs in one basket.
2. Those who have faults should not criticise others.
3. An hour may destroy what it has taken years to do.
FORM A.

GROUP INTELLIGENCE TEST (Verbal)

Time = 45 minutes.

MANUAL OF INSTRUCTIONS

1. Credit will be given if answers are completed before the given time.

2. Read each page of the test.

3. Do not waste your time over the questions which you find difficult. Pass on to the next.

4. Write the answers only on the Answer Sheet and in the spaces intended for them. Write nothing on the question paper.

5. Write neatly. Do not rub off answers or over-write them. If your answer is wrong, cut it out and write the correct one above it.

6. No calculation or scribbling is permitted.

7. Complete the entries on the top of the Answer Sheet.

8. Follow closely the method of answering the Buffer Test.

BUFFER TEST

1. My house is to the east of yours and yours to the south of Karim. To which side of Karim does my house lie?

2. Mohan is elder to Sohan by 3 years and Jagan is younger to Mohan by 2 years. Jagan was born in 1921. What is the age of Sohan now?

3. Write the appropriate word in the Answer Sheet to complete the pattern: -
   Navy; Ship; Air Force

4. Give the number of the best reason: Holidays are a relief to the workers because -
   (a) They are observed all over the province
   (b) They come every year
   (c) They break the monotony of work.

5. Write the next two digits: - 25, 30, 37, 46, ______

6. Write the word which does not belong to the group: -
   nail, kite, thumb, hand, foot.

7. Give the number of the figure which completes the pattern on the left.

   \[
   \begin{array}{cccc}
   + & \div & - & + \\
   \div & + & \times & - \\
   \end{array}
   \]

   1 2 3 4

BUFFER ANSWER SHEET

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>South-east</td>
<td>5</td>
<td>57 70</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>6</td>
<td>Kite</td>
</tr>
<tr>
<td>3</td>
<td>Aeroplane</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>(c)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Suppose you are going north, then turn to your left, and then to your right. What direction are you going now?

2. Mohan is to the left of Sohan and I am to the left of Mohan. Who is in the middle?

There is a circus in the quadrangle; in the centre of the quadrangle there is a pole. At about 100 yards north-east of the pole is the cage of a lion. The arena for performance is in the north-west of the pole. To the south of the pole are seats for the audience in a semi-circle. Ram is seated right to the south of the pole. Behari and Daljit are seated north-west and north-east of the quadrangle respectively.

3. On which side of Ram is Behari seated?

4. Which direction is Behari facing when watching the performance?

5. On which side of Daljit is the cage of the lion?

6. If the lion's cage is moved towards south-west, on which direction of the arena is it?

7. Write the number which lies in the square, triangle, circle, and the semi-circle.

8. Write the number which lies in the circle and the semi-circle.

9. Write the number which lies in the semi-circle and triangle.

10. Write the number which lies in the triangle, circle and semi-circle.

11. Write the number which lies in the circle and the triangle.

12. Mohan was born in June 1910. His father is 30 years younger to the grandfather of Mohan. The grandfather of Mohan was born in 1860. When was Mohan's father born?

13. I heard the school clock strike yesterday 10 minutes before the gun fired. I did not count the strokes; but I am sure it struck an odd number. I did not come to the school in the morning and the school clock stopped at five minutes to five in the afternoon. When do you think the gun was fired?

14. /
14. Kartik, the eighth month of the Hindu calendar, corresponds to October of the Christian calendar. Kartik ended on the 20th of October this year. The lunar month of Hindu calendar consists of 30 days. When did Chait begin according to the Christian calendar? (Hindu months: Kartik, Aghan, Pus, Magh, Phagun, Chait).

15. Two trains left Allahabad station at 7 p.m., and were running in opposite directions. One was mail, the other passenger, their respective speeds being 50 and 30 miles. The guards of both will have rest after 150 miles. How many hours after the relief of the guard of the mail train would the guard of the passenger have his? Half an hour is taken by stoppages in the case of both trains.

16. Two persons start for a race of half a mile at the same time. Both take 10 minutes to reach the end, but one of these X had a bad fall and spent half of the time in getting restarted. How many minutes did Y take in actual running?

17. Write 'e' in the Answer Sheet if the lines between ab and cd are of the same length in the following figures. Otherwise put a cross.

18. Which of the four figures on the right best completes the pattern on the left?
26. If March comes after April make two crosses, if not make one.
27. If Sunday comes after Saturday and before Monday make one cross, if not two.
28. If summer comes before autumn make two crosses, if not one.
29. If afternoon comes before evening make one cross, if not two.
30. If infancy comes earlier than old age make two crosses, if not one.

Which is the first in the ascending order?

31. day, hour, minute, second.
32. grandfather, grandson, father, great grand aunt.
33. inch, furlong, mile, yard, foot.

Write the number which occurs more than once:
34. 21, 25, 28, 32, 25, 31.
35. 211, 607, 819, 769, 607, 925, 863.

Write the letter which occurs more than once in each of the words:
37. Pansophic.
38. Honour.

Write the word which occurs more than once:
39. My face is clean but my hands are dirty.
40. The farther we go the higher is the summit.

Give one word for the following:
41. The place a river rises from.
42. The place beyond which a railway line does not go.
43. The capacity to remember what is taught.
44. A place where money is coined.
45. The form of government in which representatives of the people have a voice in the matter of the State.
46. The song which voices the national sentiment of the people.
47. The representative body which has the power to frame laws in the State.
48. The agreement which temporarily suspends fighting in a war.

Write the next two letters in the following patterns:
49. a b c d . .
50. a c d f . .

Give /
Give the number of the word which does not belong to
the same class as the others:-
51. 1 wheel; 2 spoke; 3 handle; 4 tie; 5 mudguard.
52. 1 sympathy; 2 piety; 3 truthfulness; 4 ignorance; 5 tall.
53. 1 give; 2 lend; 3 lose; 4 keep.

Give the number of the correct alternative:-
54. Branch is a part of - 1 book; 2 house; 3 tree; 4 table.
55. Name the class to which the following belong: -
mouth, arm, legs, hand, head.
Write (in the Answer Sheet) the appropriate word to
fill in the blank:-
56. Wheat is ground into ............... by the mills.
57. When the corn is ripe, it is cut with ............... 
58. We have noes to smell and eyes to ............... 
59. These brads are not fresh, they are ............... 
60. We eat and drink to ............... our bodies.

Arrange the following into a sentence and say if the
statement is true or false:-
61. Lions strong are African
62. Making is bread valuable wheat for
63. Envy and malice traits are good and commendable
64. Live dangerous is near a volcano to it not 
65. The colder you nearer to is to poles the are it 
Write (in the Answer Sheet) the appropriate word to
fill in the blanks:-
66. The shorter the day the longer the ............... 
67. ............... is the last month of the Christian year.
68. A ............... train has an engine and carriages.
Write the word which gives the correct relationship:
same or opposite:-
69. Wet dry
70. summit top
71. former latter
72. lax strict
73. accept reject
74. dissent differ
75. accumulate dissipate

Look /
Look up each row of the numbers below and write the two digits that should come next:

76. 3 4 5 6 7 8 .
77. 5 9 13 17 21 25 .
78. 3 9 12 13 16 17 .
79. 2 3 5 8 12 17 .
80. 81 27 9 3 1 1/3rd .

Below are given some questions. Three answers are given for each question. You are to look at the answers carefully and give the number of the best answer.

81. Cats are useful animals because
   (a) they catch mice
   (b) they are gentle
   (c) they are afraid of dogs.

82. Leather is used for shoes for
   (a) it is produced in all countries
   (b) it wears well
   (c) it is an animal product.

83. Streets are sprinkled in summer
   (a) to make the air cooler
   (b) to keep the temperature down
   (c) to keep dust down.

84. A kite flies because
   (a) it has a tail
   (b) it is made of light material
   (c) it has bright colours.

85. High mountains are covered with snow because
   (a) they are nearer the clouds
   (b) the sun seldom shines on them
   (c) the air is cold there.

Name the fourth word or number in the following:

86. Prince : princess :: king :
87. Gun : shoots :: knife :
88. Water : drink :: bread :
89. Quarrel : enemy :: agreement :
90. 7 : 35 :: 9

Sohan has a sister Leela, a brother Mohan and a cousin Rama. Answer the following questions:

91. Who is Mohan's sister?
92. Who is Rama's female cousin?
93. Who is Mohan's brother?
94. How many brothers has Leela?
95. How many cousins has Rama?
96. Mohan is taller than Rahim and Rahim is much taller than Krishna. Who is the smallest of the three?
97. Write the number of appropriate relations -
   Zora’s (1 father; 2 grandfather; 3 uncle) is her
   (4 mother’s; 5 sister’s; 6 grandmother’s) (7 daughter;
   8 son; 9 sister).
98. A cyclist rode a mile on an old fashioned bicycle which had
    a big wheel in front and a small wheel behind. Which wheel
    went round the larger number of times?
99. If you buy two dozens of oranges at 14 annas each dozen and
    one seer of almond (Badam) at 23 annas a seer, how much
    change should you get from a five-rupee note?
100. A man takes 20 minutes to walk from his house to the railway
     station. His son also takes 20 minutes. How long would
     they take if both of them walked together?
**FORM A.**

**Key.**

<table>
<thead>
<tr>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father's or Guardian's Name:</td>
</tr>
<tr>
<td>Occupation of Father or Guardian:</td>
</tr>
<tr>
<td>Date of Birth:</td>
</tr>
<tr>
<td>Place of Residence:</td>
</tr>
<tr>
<td>Name of School or College:</td>
</tr>
<tr>
<td>Standard studying in or standard passed:</td>
</tr>
</tbody>
</table>

**Jobs you aspire in descending order:**

<table>
<thead>
<tr>
<th>Qu.</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>North</td>
</tr>
<tr>
<td>2.</td>
<td>Mohan</td>
</tr>
<tr>
<td>3.</td>
<td>Left</td>
</tr>
<tr>
<td>4.</td>
<td>North</td>
</tr>
<tr>
<td>5.</td>
<td>Right</td>
</tr>
<tr>
<td>6.</td>
<td>South</td>
</tr>
<tr>
<td>7.</td>
<td>5</td>
</tr>
<tr>
<td>8.</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>8</td>
</tr>
<tr>
<td>10.</td>
<td>9</td>
</tr>
<tr>
<td>11.</td>
<td>1</td>
</tr>
<tr>
<td>12.</td>
<td>1890</td>
</tr>
<tr>
<td>13.</td>
<td>3.10 p.m.</td>
</tr>
<tr>
<td>14.</td>
<td>18th Feb.</td>
</tr>
<tr>
<td>15.</td>
<td>2 hours</td>
</tr>
<tr>
<td>16.</td>
<td>10 minutes</td>
</tr>
<tr>
<td>17.</td>
<td>e</td>
</tr>
<tr>
<td>18.</td>
<td>X</td>
</tr>
<tr>
<td>19.</td>
<td>X</td>
</tr>
<tr>
<td>20.</td>
<td>e</td>
</tr>
<tr>
<td>21.</td>
<td>4</td>
</tr>
<tr>
<td>22.</td>
<td>3</td>
</tr>
<tr>
<td>23.</td>
<td>3</td>
</tr>
<tr>
<td>24.</td>
<td>2</td>
</tr>
<tr>
<td>25.</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Qu.</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.</td>
<td>X</td>
</tr>
<tr>
<td>27.</td>
<td>X</td>
</tr>
<tr>
<td>28.</td>
<td>XX</td>
</tr>
<tr>
<td>29.</td>
<td>X</td>
</tr>
<tr>
<td>30.</td>
<td>XX</td>
</tr>
<tr>
<td>31.</td>
<td>Second</td>
</tr>
<tr>
<td>32.</td>
<td>Grandson</td>
</tr>
<tr>
<td>33.</td>
<td>Inch</td>
</tr>
<tr>
<td>34.</td>
<td>25</td>
</tr>
<tr>
<td>35.</td>
<td>607</td>
</tr>
<tr>
<td>36.</td>
<td>none</td>
</tr>
<tr>
<td>37.</td>
<td>p</td>
</tr>
<tr>
<td>38.</td>
<td>c</td>
</tr>
<tr>
<td>39.</td>
<td>my</td>
</tr>
<tr>
<td>40.</td>
<td>the</td>
</tr>
<tr>
<td>41.</td>
<td>source</td>
</tr>
<tr>
<td>42.</td>
<td>terminus</td>
</tr>
<tr>
<td>43.</td>
<td>memory</td>
</tr>
<tr>
<td>44.</td>
<td>mint</td>
</tr>
<tr>
<td>45.</td>
<td>democracy</td>
</tr>
<tr>
<td>46.</td>
<td>anthem</td>
</tr>
<tr>
<td>47.</td>
<td>Legislature</td>
</tr>
<tr>
<td>48.</td>
<td>armistice</td>
</tr>
<tr>
<td>49.</td>
<td>e.f.</td>
</tr>
<tr>
<td>50.</td>
<td>g.i.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Qu.</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.</td>
<td>4</td>
</tr>
<tr>
<td>52.</td>
<td>5</td>
</tr>
<tr>
<td>53.</td>
<td>4</td>
</tr>
<tr>
<td>54.</td>
<td>3</td>
</tr>
<tr>
<td>55.</td>
<td>Human body</td>
</tr>
<tr>
<td>56.</td>
<td>Flour</td>
</tr>
<tr>
<td>57.</td>
<td>Sickle</td>
</tr>
<tr>
<td>58.</td>
<td>See</td>
</tr>
<tr>
<td>59.</td>
<td>Stale</td>
</tr>
<tr>
<td>60.</td>
<td>nourish</td>
</tr>
<tr>
<td>61.</td>
<td>true</td>
</tr>
<tr>
<td>62.</td>
<td>true</td>
</tr>
<tr>
<td>63.</td>
<td>false</td>
</tr>
<tr>
<td>64.</td>
<td>false</td>
</tr>
<tr>
<td>65.</td>
<td>true</td>
</tr>
<tr>
<td>66.</td>
<td>night</td>
</tr>
<tr>
<td>67.</td>
<td>December</td>
</tr>
<tr>
<td>68.</td>
<td>cat</td>
</tr>
<tr>
<td>69.</td>
<td>opposite</td>
</tr>
<tr>
<td>70.</td>
<td>same</td>
</tr>
<tr>
<td>71.</td>
<td>opposite</td>
</tr>
<tr>
<td>72.</td>
<td>opposite</td>
</tr>
<tr>
<td>73.</td>
<td>opposite</td>
</tr>
<tr>
<td>74.</td>
<td>same</td>
</tr>
<tr>
<td>75.</td>
<td>opposite</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Qu.</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>76.</td>
<td>9, 10</td>
</tr>
<tr>
<td>77.</td>
<td>29, 33</td>
</tr>
<tr>
<td>78.</td>
<td>20, 21</td>
</tr>
<tr>
<td>79.</td>
<td>23, 30</td>
</tr>
<tr>
<td>80.</td>
<td>1/9, 1/27</td>
</tr>
<tr>
<td>81.</td>
<td>(a)</td>
</tr>
<tr>
<td>82.</td>
<td>(b)</td>
</tr>
<tr>
<td>83.</td>
<td>(c)</td>
</tr>
<tr>
<td>84.</td>
<td>(b)</td>
</tr>
<tr>
<td>85.</td>
<td>(c)</td>
</tr>
<tr>
<td>86.</td>
<td>queen</td>
</tr>
<tr>
<td>87.</td>
<td>cuts</td>
</tr>
<tr>
<td>88.</td>
<td>cat</td>
</tr>
<tr>
<td>89.</td>
<td>friend</td>
</tr>
<tr>
<td>90.</td>
<td>45</td>
</tr>
<tr>
<td>91.</td>
<td>Leela</td>
</tr>
<tr>
<td>92.</td>
<td>Leela</td>
</tr>
<tr>
<td>93.</td>
<td>Sohan</td>
</tr>
<tr>
<td>94.</td>
<td>two</td>
</tr>
<tr>
<td>95.</td>
<td>three</td>
</tr>
<tr>
<td>96.</td>
<td>Krishna</td>
</tr>
<tr>
<td>97.</td>
<td>3, 6, 8</td>
</tr>
<tr>
<td>98.</td>
<td>small wheel</td>
</tr>
<tr>
<td>99.</td>
<td>14 annas</td>
</tr>
<tr>
<td>100.</td>
<td>20 minutes</td>
</tr>
</tbody>
</table>
FORM B.

GROUP INTELLIGENCE TEST (Verbal)
Time - 45 minutes

MANUAL OF INSTRUCTIONS

1. Credit will be given if answers are completed before the given time.

2. Read each page of the test.

3. Do not waste your time over the questions which you find difficult. Pass on to the next.

4. Write the answers only on the Answer Sheet and in the spaces intended for them. Write nothing on the question paper.

5. Write neatly. Do not rub off answers or over-write them. If your answer is wrong, cut it out and write the correct one above it.

6. No calculation or scribbling is permitted.

7. Complete the entries on the top of the Answer Sheet.

8. Follow closely the method of answering the Buffer Test.

BUFFER TEST

1. My house is to the east of yours and yours to the south of Karim. To which side of Karim does my house lie?

2. Mohan is elder to Sohan by 3 years and Jagan is younger to Mohan by 2 years. Jagan was born in 1921. What is the age of Sohan now?

3. Write the appropriate word in the Answer Sheet to complete the pattern:
   Navy : Ship :: Air Force :

4. Give the number of the best reason: Holidays are a relief to the workers because -
   (a) They are observed all over the province
   (b) They come every year
   (c) They break the monotony of work.

5. Write the next two digits:-- 25 30 37 46 ...

6. Write the word which does not belong to the group:-
   Nail kite thumb hand foot.

7. Give the number of the figure which completes the pattern on the left.
   \[ \begin{array}{cccc}
   + & \div & \div & \times \\
   \div & + & \div & + \\
   \end{array} \]
   \[ \begin{array}{cccc}
   1 & 2 & 3 & 4 \\
   \end{array} \]

BUFFER ANSWER SHEET

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>South-east</td>
<td>5</td>
<td>57 70</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>6</td>
<td>Kite</td>
</tr>
<tr>
<td>3</td>
<td>Aeroplane</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>(c)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Suppose you are going south, then turn to your right and then to your left. What direction are you going now?

2. Ram is to my right, Sona is to Ram's right. Who is in the middle?

Sohan goes to Calcutta and has to stay in Darbar Hotel 500 yards from Howrah station. He has received the following instructions to reach the place:

The train will stop at platform No.1, the engine facing east. As you get down from the train you will see an exit to the south. At the outer end of the exit you will be facing west. Go 100 yards south of the exit and you will face Morris Hotel, then turn left and walk straight and you will reach Darbar Hotel.

3. On which direction of the exit is Morris Hotel?

4. On which side of you is the train you came by when you reach the end of the exit?

5. On which direction is Darbar Hotel if you stand facing the entrance of the Morris Hotel?

6. In which direction is the railway exit from the entrance of the Darbar Hotel?

7. Write the number which lies in both the squares, circle and triangle.

8. Write the number which lies in both the squares, the circle and semi-circle?

9. Write the number which lies in the triangle, one of the squares and the circle.

10. Write the number which lies in the circle and one of the squares.

11. Write the number which lies in the circle, one of the squares and semi-circle.

12. Zakir was married in December 1916, exactly at the age of 36, his wife was 5 years older to him and would celebrate her next birthday in December next. When was she born?

13. I heard the school clock strike 16 minutes before the teacher came to my class in the third period. I was doing Geography /
Geography in this period with this teacher. The period ended at 1 p.m. When did the school begin? Every period is of 40 minutes.

14. Muharram coincided with the month of December this year. Each lunar month consists of 23 days. Muharram ended on the 29th December. On which date did the new year day of the Arabic month fall? (Muharram is the last month of the Arabic calendar).

15. Two motor cyclists A and B started in opposite directions at 9 a.m., one to the north and the other to the south. The first was travelling at a speed of 50 miles an hour, the second at 40 miles. They would have rest after a run of 200 miles. Both would have rest for half an hour in these runs. How many hours after the rest of A would B rest?

16. Two hounds started a chase at the same hour. One overtook its quarry in 20 minutes and the other in 25 minutes, the first having stopped for half of the time because of an accident on the way. How much time did the second hound take in actual running?

Write 'e' in the Answer Sheet if the lines between ab and cd are of the same length in the following figures. Otherwise put down 'u'.

17. a———> b
18. a———b c———d
19. a———b c———d
20. Give the number of the figures on the right which best completes the pattern on the left.

21.
22.
23. ++———-———-++
24. ><——HICL
25. []———/
26. /
26. If August comes before September make two crosses, if not one.

27. If 4 p.m. comes after 3 a.m. on the 30th of December make one cross, if not make two.

28. If 500 A.D. comes after 500 B.C. make one cross, if not two.

29. If leap year comes after every two years make two crosses, otherwise one.

30. If birth comes before death make one cross, otherwise two.

Which is first in ascending order?

31. seer maund chhatak tola
32. plant seed flower blossom fruit
33. chapter paragraph sentence letter word.

Write the number which occurs more than once -

34. 12 25 30 41 52 41 6
35. 534 896 927 532 534 672 679.

Write the letter which occurs more than once -

36. Patriot
37. pragmatic
38. colour.

Write the word which occurs more than once -

39. Boys and girls like sunshine but do not like rain in winter.
40. The sooner we leave a plague-stricken area the safer it is.

Give one word for the following -

41. the place coal comes from:
42. the place where electricity is generated:
43. the capacity to find out the how and why of things:
44. the place where two rivers meet:
45. the head of a republican form of Government:
46. the right of the eldest son to succeed to the property or land of his father:
47. the person who represents a government in another place:
48. administration of a State during the minority of their ruler.

Write the next two letters in the following series -

49. P Q R S
50. L O P R

Give /
Give the number of the word which does not belong to the same class as the others -

51. 1. motor car; 2. tonga; 3. cycle; 4. aeroplane; 5. cart; 6. tram.
53. 1. flourish; 2. prosper; 3. thrive; 4. abound; 5. multiply; 6. diminish.
54. Name the right word from among the alternatives - Flower is a part of (plant, school, river, home).
55. Name the class to which the following belong - Father, child, wife, sister, husband.

Write the appropriate word (in the Answer Sheet) to complete the sentence:

56. Books are printed in the _________
57. When the rain has fallen the field is tilled with a _________
58. We have legs to walk and stomach to _________ food.
59. These fruits are not ripe, they are _________
60. We work hard at our books to _________ our examinations.

Arrange the following words, mentally into a sentence, and say whether the sentence is true or false.

61. Months coldest are summer
62. Taking is fruits good health for
63. Plague terrible cholera scourges are
64. Stand is dangerous it crossing railway to near
65. The warmer you nearer to is to equator the are it the not.

Write the appropriate word in the Answer Sheet to complete the following sentences.

66. The longer the night the shorter the _________
67. _________ is the first month of the Christian calendar.
68. An _________ has two wings, propeller and rudder.

Write 'same' or 'opposite' which gives the correct relationship - same or opposite.

69. cold - hot
70. assembly - gathering
71. before - after
72. collect - distribute
73. debase - degrade
74. /
74. Specific - General
75. Aggravate - Irritate

Look up each row of the number below and write the two digits that should come next -

<table>
<thead>
<tr>
<th>76.</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>.</th>
<th>.</th>
</tr>
</thead>
<tbody>
<tr>
<td>77.</td>
<td>27</td>
<td>27</td>
<td>23</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>78.</td>
<td>19</td>
<td>16</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>6</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>79.</td>
<td>29</td>
<td>28</td>
<td>26</td>
<td>23</td>
<td>19</td>
<td>14</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>80.</td>
<td>3</td>
<td>6</td>
<td>16</td>
<td>18</td>
<td>36</td>
<td>.</td>
<td>.</td>
<td></td>
</tr>
</tbody>
</table>

Below are given some questions. Three answers are given to each question. You are to look at the answers carefully, then put down the number of the best answer.

81. Pencils are carried more often than fountain pens because -
   (a) they are brightly coloured
   (b) they are cheaper
   (c) they are not so heavy.

82. Paper is used for writing because -
   (a) it is cheap
   (b) it can be preserved
   (c) it can be burnt at will.

83. Clocks are common enough in offices because -
   (a) we like to hear them strike
   (b) they have hands
   (c) they tell us time.

84. Freezing water bursts pipes because -
   (a) cold makes the pipe weak
   (b) water expands on freezing
   (c) ice stops the flow of water.

85. If the earth were nearer the sun -
   (a) the stars would disappear
   (b) our months would be longer
   (c) the earth would be warmer.

Insert the fourth term in the following -

86. January : February : : 1 is to ________

87. Shoe : foot : : hat ________

88. Fire : heat : : ice ________

89. Granary : wheat : : library ________

90. 5 : 25 : : 8 ________

Zahid /
Zahid had an aunt Raziya, an uncle Khalid and a sister Zuhra. Answer the following questions:

91. Who is Khalid's wife?
92. Who is Zuhra's aunt?
93. Who is Khalid's nephew?
94. How many male relations has Zuhra?
95. How many female relations has Raziya?
96. Lachhman is smaller than Zubaida and Zubaida is smaller than Krishna, who is the tallest of the three?
97. Write the number of appropriate relations:
   Lachman's (1. mother; 2. grandmother; 3. aunt) is his (4. father’s; 5. sister’s; 6. mother’s) (7. son; 8. daughter; 9. sister).
98. An engine has four small wheels and four big wheels and has run a distance of 50 miles; which of the two types of wheels went round the largest number of times (big or small).
99. If you buy three dozens of eggs at two annas per egg and one pau of ghee at one seer a rupee, how much more would you require if you are given only three rupees to make purchases with?
100. A fort has provision to last her army of 400 men for three months. There are only 200 men in the garrison during the first fortnight and when they leave the same number of soldiers arrive. How long will the provision last?
<table>
<thead>
<tr>
<th>Qu. Answer</th>
<th>Qu. Answer</th>
<th>Qu. Answer</th>
<th>Qu. Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. south</td>
<td>26. XX</td>
<td>51. 4</td>
<td>76. 2, 1</td>
</tr>
<tr>
<td>2. ram</td>
<td>27. X</td>
<td>52. 2</td>
<td>77. 15, 15</td>
</tr>
<tr>
<td>3. south</td>
<td>28. X</td>
<td>53. 6</td>
<td>78. 4, 1</td>
</tr>
<tr>
<td>4. right</td>
<td>29. X</td>
<td>54. plant</td>
<td>79. 9, 1</td>
</tr>
<tr>
<td>5. east</td>
<td>30. X</td>
<td>55. family</td>
<td>80, 38, 76</td>
</tr>
<tr>
<td>6. N.W.</td>
<td>31. Tola</td>
<td>56. press</td>
<td>81. (B)</td>
</tr>
<tr>
<td>7. 5</td>
<td>32. seed</td>
<td>57. plough</td>
<td>82. (A)</td>
</tr>
<tr>
<td>8. 6</td>
<td>33. letter</td>
<td>58. digest</td>
<td>83. (C)</td>
</tr>
<tr>
<td>9. 4</td>
<td>34. 41</td>
<td>59. raw</td>
<td>84. (B)</td>
</tr>
<tr>
<td>10. 3</td>
<td>35. 534</td>
<td>60. pass</td>
<td>85. (C)</td>
</tr>
<tr>
<td>11. 9</td>
<td>36. T</td>
<td>61. False</td>
<td>86. 2</td>
</tr>
<tr>
<td>12. 1875</td>
<td>37. A</td>
<td>62. true</td>
<td>87. head</td>
</tr>
<tr>
<td>13. 11 a.m.</td>
<td>38. 0</td>
<td>63. true</td>
<td>88. water</td>
</tr>
<tr>
<td>14. 30th Dec.</td>
<td>39. like</td>
<td>64. true</td>
<td>89. books</td>
</tr>
<tr>
<td>15. 1 hour</td>
<td>40. the</td>
<td>65. false</td>
<td>90. 64</td>
</tr>
<tr>
<td>16. 25</td>
<td>41. mine</td>
<td>66. day</td>
<td>91. Razia</td>
</tr>
<tr>
<td>17. e</td>
<td>42. power house</td>
<td>67. Jan.</td>
<td>92. Razia</td>
</tr>
<tr>
<td>18. u</td>
<td>43. reasoning</td>
<td>68. aeroplane</td>
<td>93. Zahid</td>
</tr>
<tr>
<td>19. u</td>
<td>44. confluence</td>
<td>69. opposite</td>
<td>94. two</td>
</tr>
<tr>
<td>20. u</td>
<td>45. President</td>
<td>70. same</td>
<td>95. one</td>
</tr>
<tr>
<td>21. 3</td>
<td>46. Promigenatur/y</td>
<td>71. opposite</td>
<td>96. Krishna</td>
</tr>
<tr>
<td>22. 2</td>
<td>47. ambassador</td>
<td>72. opposite</td>
<td>97. 3, 6, 9</td>
</tr>
<tr>
<td>23. 2</td>
<td>48. Regency</td>
<td>73. same</td>
<td>98. small</td>
</tr>
<tr>
<td>24. 3</td>
<td>49. T.U.</td>
<td>74. opposite</td>
<td>99. 1/12/-</td>
</tr>
<tr>
<td>25. 4</td>
<td>50. S.V.</td>
<td>75. same</td>
<td>100. 2 months</td>
</tr>
</tbody>
</table>
# Appendix C

FACILITY VALUE OF TEST ITEMS OF FORM A, AND FORM B, ADMINISTERED TO 50 BOYS AND 40 GIRLS

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Form</th>
<th>Girls</th>
<th>Boys</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>18</td>
<td>47</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>26</td>
<td>41</td>
<td>67</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>32</td>
<td>45</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>35</td>
<td>47</td>
<td>82</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>12</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>12</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>12</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>2</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>A</td>
<td>21</td>
<td>44</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>19</td>
<td>48</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>20</td>
<td>42</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>19</td>
<td>46</td>
<td>65</td>
</tr>
<tr>
<td>9</td>
<td>A</td>
<td>17</td>
<td>46</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>19</td>
<td>46</td>
<td>65</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
<td>21</td>
<td>44</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>23</td>
<td>47</td>
<td>70</td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td>19</td>
<td>40</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>21</td>
<td>44</td>
<td>65</td>
</tr>
<tr>
<td>12</td>
<td>A</td>
<td>26</td>
<td>22</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>22</td>
<td>28</td>
<td>50</td>
</tr>
<tr>
<td>13</td>
<td>A</td>
<td>12</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>16</td>
<td>13</td>
<td>29</td>
</tr>
<tr>
<td>14</td>
<td>A</td>
<td>9</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>9</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>A</td>
<td>14</td>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>13</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>16</td>
<td>A</td>
<td>11</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>12</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>17</td>
<td>A</td>
<td>22</td>
<td>25</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>19</td>
<td>38</td>
<td>57</td>
</tr>
<tr>
<td>18</td>
<td>A</td>
<td>19</td>
<td>13</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>15</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>19</td>
<td>A</td>
<td>22</td>
<td>33</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>17</td>
<td>34</td>
<td>51</td>
</tr>
<tr>
<td>20</td>
<td>A</td>
<td>22</td>
<td>26</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>13</td>
<td>30</td>
<td>43</td>
</tr>
</tbody>
</table>

21 /
<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Form</th>
<th>Girls</th>
<th>Boys</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>A</td>
<td>22</td>
<td>23</td>
<td>50</td>
</tr>
<tr>
<td>21</td>
<td>B</td>
<td>14</td>
<td>30</td>
<td>44</td>
</tr>
<tr>
<td>22</td>
<td>A</td>
<td>18</td>
<td>33</td>
<td>51</td>
</tr>
<tr>
<td>22</td>
<td>B</td>
<td>13</td>
<td>34</td>
<td>47</td>
</tr>
<tr>
<td>23</td>
<td>A</td>
<td>17</td>
<td>21</td>
<td>33</td>
</tr>
<tr>
<td>23</td>
<td>B</td>
<td>13</td>
<td>24</td>
<td>37</td>
</tr>
<tr>
<td>24</td>
<td>A</td>
<td>19</td>
<td>19</td>
<td>38</td>
</tr>
<tr>
<td>24</td>
<td>B</td>
<td>7</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>25</td>
<td>A</td>
<td>11</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td>25</td>
<td>B</td>
<td>11</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>26</td>
<td>A</td>
<td>24</td>
<td>34</td>
<td>58</td>
</tr>
<tr>
<td>26</td>
<td>B</td>
<td>29</td>
<td>39</td>
<td>63</td>
</tr>
<tr>
<td>27</td>
<td>A</td>
<td>24</td>
<td>37</td>
<td>61</td>
</tr>
<tr>
<td>27</td>
<td>B</td>
<td>26</td>
<td>37</td>
<td>63</td>
</tr>
<tr>
<td>28</td>
<td>A</td>
<td>24</td>
<td>34</td>
<td>58</td>
</tr>
<tr>
<td>28</td>
<td>B</td>
<td>25</td>
<td>26</td>
<td>51</td>
</tr>
<tr>
<td>29</td>
<td>A</td>
<td>23</td>
<td>43</td>
<td>66</td>
</tr>
<tr>
<td>29</td>
<td>B</td>
<td>26</td>
<td>37</td>
<td>63</td>
</tr>
<tr>
<td>30</td>
<td>A</td>
<td>24</td>
<td>36</td>
<td>60</td>
</tr>
<tr>
<td>30</td>
<td>B</td>
<td>23</td>
<td>31</td>
<td>59</td>
</tr>
<tr>
<td>31</td>
<td>A</td>
<td>18</td>
<td>38</td>
<td>56</td>
</tr>
<tr>
<td>31</td>
<td>B</td>
<td>20</td>
<td>42</td>
<td>62</td>
</tr>
<tr>
<td>32</td>
<td>A</td>
<td>8</td>
<td>38</td>
<td>46</td>
</tr>
<tr>
<td>32</td>
<td>B</td>
<td>19</td>
<td>37</td>
<td>56</td>
</tr>
<tr>
<td>33</td>
<td>A</td>
<td>15</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>33</td>
<td>B</td>
<td>22</td>
<td>33</td>
<td>44</td>
</tr>
<tr>
<td>34</td>
<td>A</td>
<td>19</td>
<td>40</td>
<td>59</td>
</tr>
<tr>
<td>34</td>
<td>B</td>
<td>16</td>
<td>41</td>
<td>57</td>
</tr>
<tr>
<td>35</td>
<td>A</td>
<td>20</td>
<td>41</td>
<td>61</td>
</tr>
<tr>
<td>35</td>
<td>B</td>
<td>16</td>
<td>44</td>
<td>60</td>
</tr>
<tr>
<td>36</td>
<td>A</td>
<td>12</td>
<td>47</td>
<td>59</td>
</tr>
<tr>
<td>36</td>
<td>B</td>
<td>21</td>
<td>49</td>
<td>70</td>
</tr>
<tr>
<td>37</td>
<td>A</td>
<td>24</td>
<td>52</td>
<td>76</td>
</tr>
<tr>
<td>37</td>
<td>B</td>
<td>22</td>
<td>52</td>
<td>74</td>
</tr>
<tr>
<td>38</td>
<td>A</td>
<td>25</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>38</td>
<td>B</td>
<td>21</td>
<td>52</td>
<td>73</td>
</tr>
<tr>
<td>39</td>
<td>A</td>
<td>24</td>
<td>50</td>
<td>74</td>
</tr>
<tr>
<td>39</td>
<td>B</td>
<td>20</td>
<td>54</td>
<td>74</td>
</tr>
<tr>
<td>40</td>
<td>A</td>
<td>24</td>
<td>50</td>
<td>74</td>
</tr>
<tr>
<td>40</td>
<td>B</td>
<td>21</td>
<td>48</td>
<td>69</td>
</tr>
<tr>
<td>41</td>
<td>A</td>
<td>10</td>
<td>33</td>
<td>43</td>
</tr>
<tr>
<td>41</td>
<td>B</td>
<td>10</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td>42</td>
<td>A</td>
<td>6</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>42</td>
<td>B</td>
<td>9</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>Serial No.</td>
<td>Form</td>
<td>Girls</td>
<td>Boys</td>
<td>Total (%)</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>-------</td>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td>43</td>
<td>A</td>
<td>9</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>43</td>
<td>B</td>
<td>2</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>44</td>
<td>A</td>
<td>9</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>44</td>
<td>B</td>
<td>1</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>45</td>
<td>A</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>45</td>
<td>B</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>46</td>
<td>A</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>46</td>
<td>B</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>47</td>
<td>A</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>47</td>
<td>B</td>
<td>3</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>48</td>
<td>A</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>48</td>
<td>B</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>49</td>
<td>A</td>
<td>23</td>
<td>42</td>
<td>65</td>
</tr>
<tr>
<td>49</td>
<td>B</td>
<td>20</td>
<td>44</td>
<td>64</td>
</tr>
<tr>
<td>50</td>
<td>A</td>
<td>12</td>
<td>21</td>
<td>33</td>
</tr>
<tr>
<td>50</td>
<td>B</td>
<td>9</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>51</td>
<td>A</td>
<td>15</td>
<td>28</td>
<td>43</td>
</tr>
<tr>
<td>51</td>
<td>B</td>
<td>13</td>
<td>24</td>
<td>37</td>
</tr>
<tr>
<td>52</td>
<td>A</td>
<td>18</td>
<td>29</td>
<td>47</td>
</tr>
<tr>
<td>52</td>
<td>B</td>
<td>16</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>53</td>
<td>A</td>
<td>13</td>
<td>18</td>
<td>31</td>
</tr>
<tr>
<td>53</td>
<td>B</td>
<td>11</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>54</td>
<td>A</td>
<td>16</td>
<td>36</td>
<td>52</td>
</tr>
<tr>
<td>54</td>
<td>B</td>
<td>17</td>
<td>33</td>
<td>55</td>
</tr>
<tr>
<td>55</td>
<td>A</td>
<td>15</td>
<td>26</td>
<td>41</td>
</tr>
<tr>
<td>55</td>
<td>B</td>
<td>12</td>
<td>31</td>
<td>43</td>
</tr>
<tr>
<td>56</td>
<td>A</td>
<td>12</td>
<td>32</td>
<td>44</td>
</tr>
<tr>
<td>56</td>
<td>B</td>
<td>13</td>
<td>38</td>
<td>51</td>
</tr>
<tr>
<td>57</td>
<td>A</td>
<td>3</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>57</td>
<td>B</td>
<td>7</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>58</td>
<td>A</td>
<td>22</td>
<td>30</td>
<td>52</td>
</tr>
<tr>
<td>58</td>
<td>B</td>
<td>8</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>59</td>
<td>A</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>59</td>
<td>B</td>
<td>4</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>60</td>
<td>A</td>
<td>3</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>60</td>
<td>B</td>
<td>11</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td>61</td>
<td>A</td>
<td>9</td>
<td>29</td>
<td>38</td>
</tr>
<tr>
<td>61</td>
<td>B</td>
<td>12</td>
<td>33</td>
<td>45</td>
</tr>
<tr>
<td>62</td>
<td>A</td>
<td>16</td>
<td>27</td>
<td>42</td>
</tr>
<tr>
<td>62</td>
<td>B</td>
<td>11</td>
<td>29</td>
<td>40</td>
</tr>
<tr>
<td>63</td>
<td>A</td>
<td>7</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>63</td>
<td>B</td>
<td>12</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>64</td>
<td>A</td>
<td>11</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>64</td>
<td>B</td>
<td>13</td>
<td>21</td>
<td>34</td>
</tr>
<tr>
<td>65</td>
<td>A</td>
<td>11</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td>65</td>
<td>B</td>
<td>7</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>Serial No.</td>
<td>Form</td>
<td>Girls</td>
<td>Boys</td>
<td>Total (%)</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>-------</td>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td>66</td>
<td>A</td>
<td>13</td>
<td>38</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>20</td>
<td>44</td>
<td>64</td>
</tr>
<tr>
<td>67</td>
<td>A</td>
<td>13</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>18</td>
<td>39</td>
<td>55</td>
</tr>
<tr>
<td>68</td>
<td>A</td>
<td>3</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>16</td>
<td>18</td>
<td>29</td>
</tr>
<tr>
<td>69</td>
<td>A</td>
<td>11</td>
<td>18</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>17</td>
<td>21</td>
<td>38</td>
</tr>
<tr>
<td>70</td>
<td>A</td>
<td>10</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>13</td>
<td>16</td>
<td>29</td>
</tr>
<tr>
<td>71</td>
<td>A</td>
<td>10</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>17</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>72</td>
<td>A</td>
<td>10</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>16</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>73</td>
<td>A</td>
<td>10</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>74</td>
<td>A</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>9</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>75</td>
<td>A</td>
<td>7</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>5</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>76</td>
<td>A</td>
<td>15</td>
<td>37</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>15</td>
<td>42</td>
<td>57</td>
</tr>
<tr>
<td>77</td>
<td>A</td>
<td>16</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>14</td>
<td>35</td>
<td>49</td>
</tr>
<tr>
<td>78</td>
<td>A</td>
<td>13</td>
<td>27</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>79</td>
<td>A</td>
<td>12</td>
<td>22</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>80</td>
<td>A</td>
<td>9</td>
<td>17</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>9</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>81</td>
<td>A</td>
<td>17</td>
<td>36</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>20</td>
<td>35</td>
<td>55</td>
</tr>
<tr>
<td>82</td>
<td>A</td>
<td>15</td>
<td>21</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td>31</td>
<td>41</td>
</tr>
<tr>
<td>83</td>
<td>A</td>
<td>15</td>
<td>28</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>21</td>
<td>28</td>
<td>49</td>
</tr>
<tr>
<td>84</td>
<td>A</td>
<td>13</td>
<td>24</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>13</td>
<td>36</td>
<td>49</td>
</tr>
<tr>
<td>85</td>
<td>A</td>
<td>10</td>
<td>32</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>20</td>
<td>32</td>
<td>52</td>
</tr>
<tr>
<td>86</td>
<td>A</td>
<td>18</td>
<td>21</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td>32</td>
<td>42</td>
</tr>
<tr>
<td>87</td>
<td>A</td>
<td>10</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>14</td>
<td>24</td>
<td>33</td>
</tr>
<tr>
<td>Serial No.</td>
<td>Form</td>
<td>Girls</td>
<td>Boys</td>
<td>Total (%)</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>-------</td>
<td>------</td>
<td>-----------</td>
</tr>
<tr>
<td>88</td>
<td>A</td>
<td>16</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>89</td>
<td>A</td>
<td>7</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>15</td>
<td>28</td>
<td>43</td>
</tr>
<tr>
<td>90</td>
<td>A</td>
<td>13</td>
<td>24</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>13</td>
<td>29</td>
<td>42</td>
</tr>
<tr>
<td>91</td>
<td>A</td>
<td>16</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>16</td>
<td>32</td>
<td>48</td>
</tr>
<tr>
<td>92</td>
<td>A</td>
<td>7</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>14</td>
<td>32</td>
<td>46</td>
</tr>
<tr>
<td>93</td>
<td>A</td>
<td>17</td>
<td>25</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>12</td>
<td>32</td>
<td>44</td>
</tr>
<tr>
<td>94</td>
<td>A</td>
<td>17</td>
<td>25</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>14</td>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td>95</td>
<td>A</td>
<td>12</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>14</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>96</td>
<td>A</td>
<td>10</td>
<td>23</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>7</td>
<td>27</td>
<td>34</td>
</tr>
<tr>
<td>97</td>
<td>A</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>98</td>
<td>A</td>
<td>4</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>7</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>99</td>
<td>A</td>
<td>13</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>9</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td>100</td>
<td>A</td>
<td>12</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>10</td>
<td>23</td>
<td>33</td>
</tr>
</tbody>
</table>
# Selection of Items from Forms A & B

<table>
<thead>
<tr>
<th>No. of Test Item</th>
<th>Paintal's Test Item</th>
<th>Facility Value</th>
<th>Form A Item No.</th>
<th>Form B Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td>67</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>82</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>38</td>
<td>31</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>89</td>
<td>16</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>90</td>
<td>13</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>91</td>
<td>3</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>62</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>65</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>65</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
<td>70</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>65</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>49</td>
<td>50</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>84</td>
<td>29</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>87</td>
<td>24</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>80</td>
<td>36</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>35</td>
<td>26</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td>27</td>
<td>57</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td>30</td>
<td>40</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>19</td>
<td>28</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>29</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>38</td>
<td>50</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>22</td>
<td>39</td>
<td>51</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>23</td>
<td>40</td>
<td>38</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>44</td>
<td>38</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>25</td>
<td>42</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>32</td>
<td>63</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>63</td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>28</td>
<td>37</td>
<td>55</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>29</td>
<td>14</td>
<td>56</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>30</td>
<td>19</td>
<td>60</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>31</td>
<td>20</td>
<td>62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>21</td>
<td>56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>22</td>
<td>47</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>34</td>
<td>24</td>
<td>59</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>35</td>
<td>26</td>
<td>61</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>36</td>
<td>4</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>2</td>
<td>76</td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>38</td>
<td>3</td>
<td>75</td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>39</td>
<td>5</td>
<td>74</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>40</td>
<td>6</td>
<td>74</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>41</td>
<td>92</td>
<td>43</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>42</td>
<td>94</td>
<td>23</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>43</td>
<td>95</td>
<td>10</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>44</td>
<td>93</td>
<td>24</td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>45</td>
<td>97</td>
<td>7</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>46</td>
<td>98</td>
<td>6</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>47</td>
<td>96</td>
<td>10</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>48</td>
<td>99</td>
<td>5</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>49</td>
<td>25</td>
<td>65</td>
<td></td>
<td>49</td>
</tr>
<tr>
<td>50</td>
<td>26</td>
<td>34</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>No. of Test Item</td>
<td>Rating's Test Item</td>
<td>Facility Value</td>
<td>Form A. Item No.</td>
<td>Form B. Item No.</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>51</td>
<td>60</td>
<td>43</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>59</td>
<td>47</td>
<td>52</td>
<td>53</td>
</tr>
<tr>
<td>53</td>
<td>31</td>
<td>25</td>
<td>54</td>
<td>55</td>
</tr>
<tr>
<td>54</td>
<td>62</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>32</td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>35</td>
<td>24</td>
<td>57</td>
<td>56</td>
</tr>
<tr>
<td>57</td>
<td>35</td>
<td>52</td>
<td>58</td>
<td>57</td>
</tr>
<tr>
<td>58</td>
<td>36</td>
<td>24</td>
<td>59</td>
<td>58</td>
</tr>
<tr>
<td>59</td>
<td>34</td>
<td>26</td>
<td>60</td>
<td>59</td>
</tr>
<tr>
<td>60</td>
<td>69</td>
<td>45</td>
<td>61</td>
<td>62</td>
</tr>
<tr>
<td>61</td>
<td>69</td>
<td>40</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>70</td>
<td>25</td>
<td>63</td>
<td>64</td>
</tr>
<tr>
<td>63</td>
<td>76</td>
<td>29</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>64</td>
<td>74</td>
<td>35</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>75</td>
<td>30</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>73</td>
<td>26</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>67</td>
<td>79</td>
<td>17</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>49</td>
<td>57</td>
<td></td>
<td>76</td>
</tr>
<tr>
<td>69</td>
<td>50</td>
<td>49</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>51</td>
<td>45</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>52</td>
<td>40</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>53</td>
<td>34</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>43</td>
<td>55</td>
<td></td>
<td>81</td>
</tr>
<tr>
<td>74</td>
<td>47</td>
<td>41</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>46</td>
<td>49</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>45</td>
<td>49</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>44</td>
<td>52</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>64</td>
<td>42</td>
<td></td>
<td>86</td>
</tr>
<tr>
<td>79</td>
<td>67</td>
<td>38</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>66</td>
<td>39</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>63</td>
<td>43</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>65</td>
<td>42</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>83</td>
<td>54</td>
<td>48</td>
<td></td>
<td>91</td>
</tr>
<tr>
<td>84</td>
<td>55</td>
<td>46</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>56</td>
<td>44</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>57</td>
<td>36</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>58</td>
<td>24</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>88</td>
<td>81</td>
<td>34</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td>100</td>
<td>12</td>
<td>97</td>
<td>99</td>
</tr>
<tr>
<td>90</td>
<td>92</td>
<td>33</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>86</td>
<td>27</td>
<td></td>
<td>99</td>
</tr>
<tr>
<td>92</td>
<td>83</td>
<td>33</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
### Intelligence Test by Dr. Bensicher

<table>
<thead>
<tr>
<th>Name</th>
<th>T.No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Department</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pay</th>
<th>Age</th>
<th>Date of birth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of first employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Department of first employment</th>
<th>Designation on first employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Educational Qualifications:

**a** General:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**b** Technical:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

### Practical Experience:

**a** Before joining Tatas:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**b** Experience in Tatas Works:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

---

(To be filled by the Departmental Head)

### Proficiency Score:

**I. Intelligence**

1. Intelligence (verbal):

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

2. Intelligence (practical):

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

3. Memory:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

4. Imagination - constructive:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

5. Reasoning - (drawing of inferences from the given data)

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

6. Power of observation:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

**II. Aptitude**

1. Manual Dexterity:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

2. Foresight:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

3. Planning & Perseverance:

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>
INSTRUCTIONS:

1. Credit will be given for completing the paper before the scheduled time.

2. Carefully read every question before attempting to answer it.

3. If you find a question difficult, do not waste time over it. Leave it at the first attempt and come back to it if you have time left.

4. Do not write anything on the question paper. Neither written calculations nor any scribbling is permissible anywhere. The answers are to be worked out mentally without any written aid.

5. For the answers, a separate answer sheet is provided. Each question is numbered and the same numbers are reproduced in the answer sheet and sufficient blank space is provided opposite each number for the answer. Put the answer in its correct place.

6. Write neatly. Do not rub off answers or over-write them. If you think that your answer is wrong, cut it out and write the correct one by the side of it.

7. Follow closely the method of answering the buffer test.
1. My house is to the east of yours and yours to the south of Karim's. To which side of Karim's does my house lie?

2. Mohan is elder to Sohan by 3 years and Jagan is younger to Mohan by 2 years. Jagan was born in 1921. What is the age of Sohan now?

3. Write the appropriate word in the answer sheet to complete the pattern:

Navy : Ship : Air Force :

4. Give the number of the best reason.

Holidays are a relief to the workers because -

(a) They are observed all over the province.
(b) They come every year.
(c) They break the monotony of work.

5. Write the next two digits:

23, 30, 37, 46, — —

6. Write the word which does not belong to the group:

Nail, Kite, Thumb, Hand, Foot.

7. Give the number of the figure, which completes the pattern on the left.

\[ \text{BUFFER ANSWER SHEET} \]

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>South-East.</td>
</tr>
<tr>
<td>2.</td>
<td>23</td>
</tr>
<tr>
<td>3.</td>
<td>Aeroplane</td>
</tr>
<tr>
<td>4.</td>
<td>(c)</td>
</tr>
<tr>
<td>5.</td>
<td>87 70</td>
</tr>
<tr>
<td>6.</td>
<td>Kite</td>
</tr>
<tr>
<td>7.</td>
<td>2</td>
</tr>
</tbody>
</table>
1. Suppose you are going south, then turn to your right and then to your left. What direction are you going now?

2. Ram is to my right, Sena is to Ram's right. Who is in the middle?

3. There is a circus in the quadrangle; in the centre of the quadrangle there is a pole. At about 100 yards north-east of the pole is the cage of a lion. The arena for performance is in the north-west of the pole. To the south of the pole are seats for the audience in a semi-circle. Ram is seated direct to the south of the pole. Behari and Daljit are seated south-west and south-east of the quadrangle respectively.

4. On which side of Ram is Behari seated?

5. Which direction is Behari facing when watching the performance?

6. If the lion's cage is moved towards south-west, on which side of the arena is it?

7. Write the number which lies in both the squares, circle and triangle.

8. Write the number which lies in both the squares, the circle and semi-circle?

9. Write the number which lies in the triangle, one of the squares and the circle.

10. Write the number which lies in the circle and one of the squares.

11. Write the number which lies in the circle, one of the squares and the semi-circle.

12. Zakir was married in December 1916, exactly at the age of 36, his wife was five years older to him and would celebrate her next birthday in December next. When was she born?

13. I heard the school clock strike yesterday ten minutes before the gun fired. I did not count the strokes, but I am sure it struck an odd number. I did not come to the school in the morning and the school clock stopped at five minutes to five in the afternoon. When do you think the gun was fired?
14. Kartik, the seventh month of the Hindu calendar, corresponds
to October. Kartik ended on the 20th of October this year.
The lunar month of Hindu calendar consists of 30 days. When
would Chait begin according to the Christian calendar?
(Hindu months: Kartik, Aghan, Pus, Magh, Phagun, Chait)

15. Two trains left Allahabad station at 7:00 p.m. and were
running in opposite directions. One was mail, the other was
passenger; their respective speeds being 50 and 30 miles.
The guards of both will have rest after 150 miles. How many
hours after the relief of the guard of the mail would the
guard of the passenger have his? Half an hour is taken by
stoppages in the case of both trains.

16. Two hounds started a chase at the same hour. One overtook
its quarry in 20 minutes and the other in 25 minutes, the
second having stopped for 1/5 of the time because of an
accident on the way. How much time did the second hound
take in actual running?

Write 'J' in the answer sheet if the lines between
ab and cd are of the same length in the following figures.
Otherwise put down 'U'.

17. a ← ─── → b

18. a ─── b
    c ─── d

19. a
    b
    c
d

20. a
    a
    d
    c
    b
d

Which of the four figures on the right best completes the
pattern on the left? Give its number.

21. △ : △ : : :

22. △ : △ : : :
23. 24. 25.

26. If August comes before September make two crosses, if not, make one.
27. If 4 p.m. comes after 3 p.m. on the 30th of December, make one cross, if not, make two.
28. If summer comes before autumn make two crosses, if not one.
29. If afternoon comes before evening make one cross, if not two.
30. If infancy comes earlier than old age make two crosses, if not one.

31. Which is first in the ascending order?
   Seer, mound, chhatak, tola.
32. Plant, seed, flower, blossom, fruit.
33. Inch, furlong, mile, yard, foot.

Write the number which occurs more than once:
34. 21, 25, 28, 32, 25, 31.
35. 211, 607, 819, 769, 607, 925, 863.

Write the letter which occurs more than once in each of the words:
36. Patriot.
37. Pensophic.
38. Honour.

Write the word which occurs more than once:
39. My face is clean but hands are dirty.
40. The farther we go the higher is the summit.
Give one word or expression for:

41. The place a river rises from.
42. The place where electricity is generated.
43. The capacity to remember what is taught.
44. The place where two rivers meet.
45. The form of government in which representatives of the people have the last word.
46. The song which voices the national sentiment of the people.
47. The person who represents a government in another state.
48. The agreement which temporarily suspends fighting in a war.

Write the next two letters in the following series:

49. a b c d...
50. L O P R...

Give the number of the word which does not belong to the same class as the others:

51. Wheel, Spoke, Handle, Tie, Mudguard, Tram.

52. Sympathy, Piety, Truthfulness, Ignorance, Tall, Japan.

53. Flourish, Prosper, Thrive, Abound, Multiply, Diminish.

Name the right word from among the alternatives:

54. Flower is a part of (plant, school, river, home).

Name the class to which the following belong:

55. Father, Child, Wife, Sister, Husband.

Write the appropriate word (in the answer sheet) to complete the sentence:

56. Books are printed in the _________
57. When the rain has fallen the field is tilled with a _________
58. We have noses to smell and eyes to _________
59. These fruits are not ripe they are _________
60. We work hard at our books to _________ our examinations.

Arrange the following words, mentally into a sentence and say whether the statement is true or false:

61. Months coldest are summer
62. Taking is fruits good health for
63. Envy and malice traits are good and commendable.
64. Stand is dangerous if crossing railway to near.
65. The colder you nearer to is to poles the are it.

Write the appropriate word in the answer sheet to complete the following sentences:
66. The longer the night the shorter the -------
67. -------- isthe first month of the Christian calendar.
68. A ---------- has an engine and carriages.

Write the word which gives the correct relationship - same or opposite:
69. Cold - hot
70. Assembly - gathering
71. Before - After
72. Collect - distribute
73. Accept - reject
74. Specific - General
75. Aggravate - Irritate.

Look up each row of the numbers below and write the two digits that should come next:
76. 8 7 6 5 4 3
77. 27 27 23 23 19 19
78. 19 16 14 11 9 6
79. 29 28 26 23 19 14
80. 3 6 8 16 18 36

Below are given some questions. Three answers are given to each question. You are to look at the answers carefully, then put down the number of the best answer.
81. Pencils are carried more often than fountain pens because:
   (a) they are brightly coloured
   (b) they are cheaper
   (c) they are not so heavy.

82. Paper is used for writing because:
   (a) it is cheap
   (b) it can be preserved
   (c) it can be burnt at will.

P.T.O.
33. Clocks are common enough in offices because:—
   (a) we like to hear them strike
   (b) they have hands
   (c) they tell us time.

34. Freezing water bursts pipes because:—
   (a) cold makes the pipe weak.
   (b) water expands on freezing
   (c) ice stops the flow of water.

35. If the earth were nearer the Sun
   (a) the stars would disappear
   (b) our moons would be longer
   (c) the earth would be warmer.

   Insert the fourth term in the following:—

36. January : February :: 1 is to ...........

37. Shoe : foot :: hat : ...........

38. Fire : heat :: well : ...........

39. Granary : wheat :: library : ...........

40. 5 : 25 :: 8 : ...........

   Zahid had an aunt Raziya, an uncle Khalid and a sister
   Zuhra. Answer the following questions:—

41. Who is Khalid's wife?

42. Who is Zuhra's aunt?

43. Who is Khalid's nephew?

44. How many male relations has Zuhra?

45. How many female relations has Raziya?

46. Lachman is smaller than Zubaida and Zubaida is smaller
   than Krishna, who is the tallest of the three?

   Write the number of appropriate relations:—

47. Lakshman's (mother, grandmother, aunt) is his (father, sister's,  
   mother's) (son, daughter, sister).

48. An engine has four small wheels and four big wheels and has  
   run a distance of 50 miles which of the two types of wheels  
   (big or small) went round the larger number of times?

49. If you buy two dozens of oranges at 14 annas each dozen and  
   one seer of almond (badan) at 8 annas a seer, how much  
   change should you get from a five-rupee note?

50. A fort has provision to last its army of 400 men for a month.  
   There are only 200 men in the garrison during the first  
   fortnight and when they leave the same number of soldiers  
   arrive. How long will the provision last?
THE TATA IRON & STEEL CO. LTD., JAMSHEDPUR.

Group Test of Intelligence
(Dr. Bhansidhar)

ANSWER SHEETS

WRITE IN BLOCK LETTERS

<table>
<thead>
<tr>
<th>Name</th>
<th>Department</th>
<th>T.No.</th>
<th>Designation</th>
<th>Date of birth</th>
<th>Province</th>
<th>Educational qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of the last school attended</th>
<th>Name of the last College attended</th>
<th>Father's Name</th>
<th>Father's Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post you aspire in the order of choice

1.                                  2.            3.          

Proficiency

---

<table>
<thead>
<tr>
<th>S.No. of question</th>
<th>Answer</th>
<th>S.No. of question</th>
<th>Answer</th>
<th>S.No. of question</th>
<th>Answer</th>
<th>S.No. of question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.xxx</td>
<td>SOUTH</td>
<td>2.xxx</td>
<td>RAM</td>
<td>3.xxx</td>
<td>LEFT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.xxx</td>
<td>NORTH</td>
<td>5.xxx</td>
<td>RIGHT</td>
<td>6.xxx</td>
<td>SOUTH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.xxx</td>
<td>6</td>
<td>8.xxx</td>
<td>4</td>
<td>9.xxx</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.xxx</td>
<td>5</td>
<td>11.xxx</td>
<td>9</td>
<td>12.xxx</td>
<td>1875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.xxx</td>
<td>3-10</td>
<td>14.xxx</td>
<td>18 FEB.</td>
<td>15.xxx</td>
<td>2 Hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.xxx</td>
<td>40 MIN</td>
<td>17.xxx</td>
<td>E</td>
<td>18.xxx</td>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.xxx</td>
<td>E</td>
<td>20.xxx</td>
<td>E</td>
<td>21.xxx</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.xxx</td>
<td>3</td>
<td>23.xxx</td>
<td>3</td>
<td>24.xxx</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.xxx</td>
<td>4</td>
<td>26.xxx</td>
<td>XX</td>
<td>27.xxx</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.xxx</td>
<td>XX</td>
<td>29.xxx</td>
<td>X</td>
<td>30.xxx</td>
<td>XX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.xxx</td>
<td>TOGA</td>
<td>32.xxx</td>
<td>SEED</td>
<td>33.xxx</td>
<td>INCH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.xxx</td>
<td>25</td>
<td>35.xxx</td>
<td>607</td>
<td>36.xxx</td>
<td>T</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.xxx</td>
<td>P</td>
<td>38.xxx</td>
<td>0</td>
<td>39.xxx</td>
<td>MY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.xxx</td>
<td>THE</td>
<td>41.xxx</td>
<td>SOURCE</td>
<td>42.xxx</td>
<td>POWER HOUSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No. of questions</td>
<td>Answer</td>
<td>S.No. of question</td>
<td>Answer</td>
<td>S.No. of question</td>
<td>Answer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>--------</td>
<td>------------------</td>
<td>--------</td>
<td>------------------</td>
<td>--------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.xxxx</td>
<td>MEMORY</td>
<td>44.xxxx</td>
<td>CONFLUENCE</td>
<td>45.xxxx</td>
<td>DEMOCRACY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46.xxxx</td>
<td>NATIONAL ANTHEM</td>
<td>47.xxxx</td>
<td>AMBASSADOR</td>
<td>48.xxxx</td>
<td>ARMISTICE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49.xxxx</td>
<td>EF</td>
<td>50.xxxx</td>
<td>S</td>
<td>51.xxxx</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52.xxxx</td>
<td>6</td>
<td>53.xxxx</td>
<td>6</td>
<td>54.xxxx</td>
<td>PLANT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55.xxxx</td>
<td>FAMILY</td>
<td>56.xxxx</td>
<td>PRESS</td>
<td>57.xxxx</td>
<td>PLough</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58.xxxx</td>
<td>SEE</td>
<td>59.xxxx</td>
<td>RAW</td>
<td>60.xxxx</td>
<td>PASS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61.xxxx</td>
<td>FALSE</td>
<td>62.xxxx</td>
<td>TRUE</td>
<td>63.xxxx</td>
<td>FALSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64.xxxx</td>
<td>TRUE</td>
<td>65.xxxx</td>
<td>TRUE</td>
<td>66.xxxx</td>
<td>DAY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>67.xxxx</td>
<td>JANUARY</td>
<td>68.xxxx</td>
<td>TRAIN</td>
<td>69.xxxx</td>
<td>OPPOSITE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70.xxxx</td>
<td>SAME</td>
<td>71.xxxx</td>
<td>OPPOSITE</td>
<td>72.xxxx</td>
<td>OPPOSITE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>73.xxxx</td>
<td>OPPOSITE</td>
<td>74.xxxx</td>
<td>OPPOSITE</td>
<td>75.xxxx</td>
<td>SAME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76.xxxx</td>
<td>2</td>
<td>77.xxxx</td>
<td>15  15</td>
<td>78.xxxx</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>79.xxxx</td>
<td>3</td>
<td>80.xxxx</td>
<td>38  76</td>
<td>81.xxxx</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>82.xxxx</td>
<td>A</td>
<td>83.xxxx</td>
<td>C</td>
<td>84.xxxx</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85.xxxx</td>
<td>C</td>
<td>86.xxxx</td>
<td>2</td>
<td>87.xxxx</td>
<td>HEAD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>88.xxxx</td>
<td>WATER</td>
<td>89.xxxx</td>
<td>BOOKS</td>
<td>90.xxxx</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>91.xxxx</td>
<td>RAZIYA</td>
<td>92.xxxx</td>
<td>RAZIYA</td>
<td>93.xxxx</td>
<td>ZAHIO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>94.xxxx</td>
<td>TWO</td>
<td>95.xxxx</td>
<td>ONE</td>
<td>96.xxxx</td>
<td>KRISHNA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>97.xxxx</td>
<td>3</td>
<td>98.xxxx</td>
<td>SMALL</td>
<td>99.xxxx</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100.xxxx</td>
<td>6/2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GROUP INTELLIGENCE TEST (Verbal)

Time — 45 minutes.

MANUAL OF INSTRUCTIONS.

1. Credit will be given if answers are completed before the given time.
2. Read each page of the test.
3. Do not waste your time over the questions which you find difficult. Pass on to the next.
4. Write the answers only on the answer-sheet and in the spaces intended for them. Write nothing on the question paper.
5. Write neatly. Do not rub or overwrite answers. If your answer is wrong, cut it out and write the correct one above it.
6. No calculation or scribbling is permitted.
7. Complete the entries on the top of the answer-sheet.
8. Follow closely the method of answering the Buffer Test.

BUFFER TEST.

1. My house is to the east of yours and yours to the south of Karim. To which side of Karim does my house lie?

2. Mohan is elder to Sohan by 3 years and Jagan is younger to Mohan by 2 years. Jagan was born in 1921. What is the age of Sohan now?

3. Write the appropriate word in the answer sheet to complete the pattern:
   Navy : Ship : : Airforce :

4. Give the number of the best reason.
   Holidays are a relief to the workers because—
   (a) They are observed all over the province
   (b) They come every year
   (c) They break the monotony of work

5. Write the next two digits:
   25, 30, 37, 46,—

6. Write the word which does not belong to the group:
   Nail, Kite, Thumb, Hand, Foot.

7. Give the number of the figure, which completes the pattern on the left.
   \[
   \begin{array}{c}
   + : \div : : - : x : \\
   \end{array}
   \]

   BUFFER ANSWER-SHEET.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>South-East</td>
<td>5</td>
<td>57 70</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>6</td>
<td>Kite</td>
</tr>
<tr>
<td>3</td>
<td>Aeroplane</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>(c)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Ram is to my right, Sena is to Ram’s right. Who is in the middle?
   Write the letter which occurs more than once in each of the words:

2. Pansophic.

3. Honour.

4. Patriot.
   Write the word which occurs more than once.

5. My face is clean but my hands are dirty.

6. The farther we go the higher is the summit.

7. Write the number which lies in the circle and one of the squares.

8. Write the number which lies in both the squares, circle and triangle.

9. Write the number which lies in both the squares, the circle and semi-circle?

10. Write the number which lies in the triangle, one of the squares and the circle.

11. Write the number which lies in the circle, one of the squares and semi-circle.

12. If August comes before September make two crosses if not one

13. Suppose you are going south, then turn to your right and then to your left. What direction are you going now?

14. If afternoon comes before evening make one cross, if not two.

15. If Sunday comes after Saturday and before Monday make one cross if not two.

   Write the appropriate word in the answer sheet to complete the following sentences:

16. The longer the night the shorter the——

17. ———- is the first month of the Christian calender.

18. A ——— train has an engine and carriages.

19. If infancy comes earlier than old age make two crosses if not one
Which is first in the ascending order?

22. Inch, furlong, mile, yard, foot.

Write the number which occurs more than once—

23. 534, 896, 927, 532, 534, 672, 679.
24. 12 23, 80, 41, 52, 41, 6.

Write the next two letters in the following patterns:

25. a b c d.
26. l o p f R.

Write 'E' in the answer sheet if the lines between a b and c d are of the same length in the following figures. Otherwise put down 'F'.

Name the right word from among the alternatives:

31. Flower is a part of (plant, school, river, home).

Write the appropriate word (in the answer sheet) to complete the sentence:

32. Books are printed in the ——
33. We have noses to smell and eyes to—
34. We work hard at our books to—our examinations.
35. When the rain has fallen the field is tilled with a—
36. These fruits are not ripe they are——
37. If summer comes before autumn make two crosses if not one.

Which of the four figures on the right best completes the pattern on the left?

38. Which of the four figures on the right best completes the pattern on the left?

39. Which of the four figures on the right best completes the pattern on the left?

40. Which of the four figures on the right best completes the pattern on the left?

41. Which of the four figures on the right best completes the pattern on the left?

42. Which of the four figures on the right best completes the pattern on the left?

Below are given some questions. Three answers are given to each question. You are to look at the answers carefully, then put down the number of the best answer.

43. Pencils are carried more often than fountain pens because:

   (a) they are brightly coloured  
   (b) they are cheaper  
   (c) they are not so heavy.

44. If the earth were nearer the Sun

   (a) the stars would disappear  
   (b) our months would be longer  
   (c) the earth would be warmer.

45. Freezing water bursts pipes because:

   (a) cold makes the pipe weak  
   (b) water expands on freezing  
   (c) ice stops the flow of water.

46. Clocks are common enough in offices because:

   (a) we like to hear them strike  
   (b) they have hands  
   (c) they tell us time.

47. Paper is used for writing because:

   (a) it is cheap  
   (b) it can be preserved.
it can be burnt at will.

48. Zakir was married in December 1916, exactly at the age of 36, his wife was five years older to him and would celebrate her next birthday in December next. When was she born?

Look up each row of the numbers below and write the two digits that should come next:

49. 8 7 6 5 4 3
50. 27 27 23 23 19 19
51. 19 16 14 11 9 6
52. 29 28 26 23 19 14
53. 8 6 8 18 18 36

Zahid had an aunt Razia, an uncle Khalid and a sister Zuhra,

Answer the following questions:

54. Who is Khalid's wife?
55. Who is Zuhra's aunt?
56. Who is Khalid's nephew?
57. How many male relations has Zuhra?
58. How many female relations has Razia?

Give the number of the word which does not belong to the same class as the others:

59. sympathy, piety, truthfulness, ignorance, tall.
60. wheel, spoke, handle, tie, mudguard.
61. give, lend, lose, keep.

Name the class to which the following belong:

62. Father, child, wife, sister, husband.

Insert the fourth term in the following:

63. Granary : wheat : : library : ::
64. January : February : : 1 is to : :.
65. 5 : 25 : : 8 : : : : :
66. Fire : heat : : ice : : :
67. Shoe : foot : : hat : : :

Arrange the following words, mentally into a sentence and say whether the statement is true or false:

68. Months coldest are summer
69. Taking is fruits good health for

70. Stand is dangerous it crossing railway to near

71. The warmer you nearer to is to equator the are it the not.

72. Plague terrible cholera scourges are

Write same or opposite which gives the correct relation ship.

73. Cold — hot

74. Before — After

75. Collect — Distribute

76. Assembly — gathering

77. Debase — Degrade

78. Specific — General

79. Aggravate — Irritate.

80. Two trains left Allahabad station at 7 p.m. and were running in opposite directions. One was mail, the other passenger, their respective speeds being 50 and 30 miles. The guards of both will have rest after 150 miles. How many hours after the relief of the guard of the mail train would the guard of the passenger have his? Half an hour is taken by stoppages in the case of both trains.

81. Lachhman is smaller than Zubaida and Zubaida is smaller than Krishna, who is the tallest of the three?

82. An engine has four small wheels and four big wheels and has run a distance of 50 miles which of the two types of wheels (big or small) went round the largest number of times.

83. A fort has provision to last her army of 400 men for 3 months. There are only 200 men in the garrison during the first fortnight and when they leave the same number of soldiers arrive. How long will the provision last?

84. I heard the school clock strike yesterday ten minutes before the gun fired. I did not count the strokes, but I am sure it struck an odd number. I did not come to the school in the morning and the school clock stopped at five minutes to five in the afternoon. When do you think the gun was fired?

85. Two hounds started a chase at the same hour. One overtook its quarry in 20 minutes and the other in 25 minutes, the first having stopped for 1 1/2 hours of the time because of an accident on the way. How much time did the second take in actual running?

86. If you buy two dozens of oranges at 14 annas each dozen and one seer of almond (badam) at 38 annas a seer, how much change should you get from 5 rupee note?

87. Kartik the 9th month of the Hindu calendar, corresponds to October of the Christian calendar. Kartik ended on the 26th, of October this year. The lunar month of Hindu calendar consists of 30 days. When did Chait begin according to the Christian calendar? (Hindu months: Kartik, Maghar Poh Mag, Phagun, Chait).

88. There is a circus in the quadrangle; in the centre of the Quadrang-
gle there is a pole. At about 100 yards north-east of the pole is the cage of a lion. The arena for performance is in the north-west of the pole. To the south of the pole are seats for the audience in a semi-circle. Ram is seated right to the south of the pole. Behari and Daljit are seated north-west and north-east of the quadrangle respectively.

88. On which side of Ram is Behari seated?

89. Which direction is Behari facing when watching the performance?

90. On which side of Daljit is the cage of the lion?

91. If the lion's cage is moved towards south-west, on which direction of the arena is it?

Give one word for the following:

92. The place a river rises from

93. The place where two rivers meet

94. The place where electricity is generated

95. The capacity to remember what is taught

96. The person who represents a government in another state.

97. The form of government in which representatives of the people have a voice in the matter of the state.

98. The song which voices the national sentiment of the people.

99. The agreement which temporarily suspends fighting in a war.

Write the number of appropriate relations:

100. 1 2 3 4 5
Lakshman's (mother, grandmother, aunt) is his (father, sister's, mother's)
6 7 8 9
son, daughter, sister),
THE TATA IRON & STEEL CO., LTD., MUMBAI.

Group Tests of Intelligence - Performance Tests.

INSTRUCTIONS.

1. In this group of tests, you are required to perform certain operations according to the instructions given. Carefully study the illustrations before attempting the test proper.

2. Work steadily through without any hurry. If, however, you finish before the total time allotted for the whole group, you will get credit for it.

Now study the following illustrations.

3. Test No. 1 - Maze Test.

In this test you will find a number of mazes. The entrance to the maze is marked by an arrow. You are to enter the maze at that place and come out of it by passing through the open channels at the exit shown by another arrow. Show the path you follow by a continuous pencil line. See illustration below:

4. Test No. 2.

In this test you will be given drawings of patterns made up of a number of cubes. You are required to count the number of cubes in each pattern. For example the pattern shown below is made of two cubes, so, the answer is 2.

Do not write anything on the question paper. A separate answer sheet is provided for the purpose.

Write the answer to each question against the proper serial number in the answer sheet.
5. Test No. 3.

In this test you will be given a series of rectangles filled with different patterns. At the end a few rectangles are left blank. You are required to complete the pattern by putting in the appropriate symbols in the blank pattern. See the illustration.

\[
\begin{array}{cccccc}
\times & \circ & \times & - & \circ & \times \\
\end{array}
\]

\[
\begin{array}{cccccc}
\times & \circ & \times & - & \circ & \times \\
& & & | & & \\
\end{array}
\]

Question

\[
\begin{array}{cccccc}
\times & \circ & \times & - & \circ & \times \\
\end{array}
\]

Answer.

6. Test No. 4.

This is a test of substituting a symbol for a digit. You will find the key at the top of the test. Below the key you will get rows of digits with blank spaces below for entering the corresponding symbol.

\[
\begin{array}{|c|c|c|c|c|c|c|c|c|c|}
\hline
1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\
\hline
- & U & O & V & \times & \equiv \\
\hline
\end{array}
\]

\[
\begin{array}{|c|c|c|c|c|}
\hline
3 & 1 & 4 & 3 & 2 \\
\hline
\end{array}
\]

Question

\[
\begin{array}{|c|c|c|c|c|}
\hline
3 & 1 & 4 & 3 & 2 \\
\hline
J & \equiv & \equiv & \equiv & \equiv \\
\hline
\end{array}
\]

Question complete with answer.

7. Test No. 5

This is a test of comparing numbers. You will find two rows of pairs of numbers. Each pair has a serial number given to it. Compare the numbers in the pair and find out whether they are the same or different.

You are provided with a separate answer sheet in which the serial numbers of the pairs have been reproduced with a blank space against each number.

If the numbers in a pair are the same put a tick in the blank space. If, on the other hand, the numbers are different put a 'X'.

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{SERIAL No.} & \text{QUESTION} \\
\hline
1. & 15 76 \quad \cdots \cdots \quad 15 76 \\
2. & 22135 \quad \cdots \cdots \quad 22153 \\
\hline
\end{array}
\]

\[
\begin{array}{|c|c|c|}
\hline
\text{SERIAL No.} & 1 & 2 & 3 \\
\hline
& \checkmark & \times & \\
\hline
\end{array}
\]

ANSWER SHEET.
6. Test No. 6

In this test you will find a square cut into pieces in different ways. In each case the square is drawn on the right and the pieces into which it has been cut, on the left. By drawing lines within the square you are required to show how the pieces can be fitted together to form the square.

![Pieces and Square]

**Answer.**

9. Test No. 7

In this test you will find a number of patterns. From each pattern a piece from the right hand bottom corner has been cut off. By the side of the cut pattern you will find five pieces which will fit exactly in the portion cut off from the pattern, but there is only one which will complete the pattern. You are required to find out that particular piece.

**Answer Sheet.**
<table>
<thead>
<tr>
<th></th>
<th>650</th>
<th></th>
<th></th>
<th>650</th>
<th></th>
<th>22</th>
<th>24,9990,1354</th>
<th></th>
<th>24,9990,1534</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2579</td>
<td></td>
<td></td>
<td>2579</td>
<td></td>
<td>23</td>
<td>22,610,59310</td>
<td></td>
<td>22,616,59310</td>
</tr>
<tr>
<td>3</td>
<td>55190</td>
<td></td>
<td></td>
<td>55102</td>
<td></td>
<td>24</td>
<td>29,110,38227</td>
<td></td>
<td>29,110,38227</td>
</tr>
<tr>
<td>4</td>
<td>650049</td>
<td></td>
<td></td>
<td>650849</td>
<td></td>
<td>25</td>
<td>31,337,77752</td>
<td></td>
<td>31,337,77752</td>
</tr>
<tr>
<td>5</td>
<td>63015991</td>
<td></td>
<td></td>
<td>63019991</td>
<td></td>
<td>26</td>
<td>1,012,938,567</td>
<td></td>
<td>1,012,938,567</td>
</tr>
<tr>
<td>6</td>
<td>69931087</td>
<td></td>
<td></td>
<td>69931087</td>
<td></td>
<td>27</td>
<td>7,162,209,888</td>
<td></td>
<td>7,162,209,888</td>
</tr>
<tr>
<td>7</td>
<td>299056013</td>
<td></td>
<td></td>
<td>299056013</td>
<td></td>
<td>28</td>
<td>31,776,28449</td>
<td></td>
<td>31,776,28449</td>
</tr>
<tr>
<td>8</td>
<td>3910066482</td>
<td></td>
<td></td>
<td>3910066482</td>
<td></td>
<td>29</td>
<td>4,68,672,663</td>
<td></td>
<td>4,68,672,663</td>
</tr>
<tr>
<td>9</td>
<td>8510273301</td>
<td></td>
<td></td>
<td>8510273301</td>
<td></td>
<td>30</td>
<td>9,104,529,003</td>
<td></td>
<td>9,104,529,003</td>
</tr>
<tr>
<td>10</td>
<td>451152903</td>
<td></td>
<td></td>
<td>451152903</td>
<td></td>
<td>31</td>
<td>3,48,465,712</td>
<td></td>
<td>3,48,465,712</td>
</tr>
<tr>
<td>11</td>
<td>3259016275</td>
<td></td>
<td></td>
<td>3259016275</td>
<td></td>
<td>32</td>
<td>8,58,817,256</td>
<td></td>
<td>8,58,817,256</td>
</tr>
<tr>
<td>12</td>
<td>582039144</td>
<td></td>
<td></td>
<td>582039144</td>
<td></td>
<td>33</td>
<td>3,120,166,671</td>
<td></td>
<td>3,120,166,671</td>
</tr>
<tr>
<td>13</td>
<td>61558529</td>
<td></td>
<td></td>
<td>61558529</td>
<td></td>
<td>34</td>
<td>7,611,348,879</td>
<td></td>
<td>7,611,348,879</td>
</tr>
<tr>
<td>14</td>
<td>211915883</td>
<td></td>
<td></td>
<td>211915883</td>
<td></td>
<td>35</td>
<td>2,65,573,916</td>
<td></td>
<td>2,65,573,916</td>
</tr>
<tr>
<td>15</td>
<td>670413822</td>
<td></td>
<td></td>
<td>670413822</td>
<td></td>
<td>36</td>
<td>8,8,190,023</td>
<td></td>
<td>8,8,190,023</td>
</tr>
<tr>
<td>16</td>
<td>17198591</td>
<td></td>
<td></td>
<td>17198591</td>
<td></td>
<td>37</td>
<td>6,57,101,803</td>
<td></td>
<td>6,57,101,803</td>
</tr>
<tr>
<td>17</td>
<td>36482991</td>
<td></td>
<td></td>
<td>36482991</td>
<td></td>
<td>38</td>
<td>3,87,797,625</td>
<td></td>
<td>3,87,797,625</td>
</tr>
<tr>
<td>18</td>
<td>10243586</td>
<td></td>
<td></td>
<td>10243586</td>
<td></td>
<td>39</td>
<td>3,90,081,265</td>
<td></td>
<td>3,90,081,265</td>
</tr>
<tr>
<td>19</td>
<td>659012534</td>
<td></td>
<td></td>
<td>659012534</td>
<td></td>
<td>40</td>
<td>7,56,581,003</td>
<td></td>
<td>7,56,581,003</td>
</tr>
<tr>
<td>20</td>
<td>388172902</td>
<td></td>
<td></td>
<td>388172902</td>
<td></td>
<td>41</td>
<td>4,118,190,072</td>
<td></td>
<td>4,118,190,072</td>
</tr>
<tr>
<td>21</td>
<td>631027594</td>
<td></td>
<td></td>
<td>631027594</td>
<td></td>
<td>42</td>
<td>6,543,920,871</td>
<td></td>
<td>6,543,920,871</td>
</tr>
<tr>
<td>1.</td>
<td>2.</td>
<td>3.</td>
<td>4.</td>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image1.png" alt="Image 1" /></td>
<td><img src="image2.png" alt="Image 2" /></td>
<td><img src="image3.png" alt="Image 3" /></td>
<td><img src="image4.png" alt="Image 4" /></td>
<td><img src="image5.png" alt="Image 5" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image6.png" alt="Image 6" /></td>
<td><img src="image7.png" alt="Image 7" /></td>
<td><img src="image8.png" alt="Image 8" /></td>
<td><img src="image9.png" alt="Image 9" /></td>
<td><img src="image10.png" alt="Image 10" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image11.png" alt="Image 11" /></td>
<td><img src="image12.png" alt="Image 12" /></td>
<td><img src="image13.png" alt="Image 13" /></td>
<td><img src="image14.png" alt="Image 14" /></td>
<td><img src="image15.png" alt="Image 15" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image16.png" alt="Image 16" /></td>
<td><img src="image17.png" alt="Image 17" /></td>
<td><img src="image18.png" alt="Image 18" /></td>
<td><img src="image19.png" alt="Image 19" /></td>
<td><img src="image20.png" alt="Image 20" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image21.png" alt="Image 21" /></td>
<td><img src="image22.png" alt="Image 22" /></td>
<td><img src="image23.png" alt="Image 23" /></td>
<td><img src="image24.png" alt="Image 24" /></td>
<td><img src="image25.png" alt="Image 25" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image26.png" alt="Image 26" /></td>
<td><img src="image27.png" alt="Image 27" /></td>
<td><img src="image28.png" alt="Image 28" /></td>
<td><img src="image29.png" alt="Image 29" /></td>
<td><img src="image30.png" alt="Image 30" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image31.png" alt="Image 31" /></td>
<td><img src="image32.png" alt="Image 32" /></td>
<td><img src="image33.png" alt="Image 33" /></td>
<td><img src="image34.png" alt="Image 34" /></td>
<td><img src="image35.png" alt="Image 35" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image36.png" alt="Image 36" /></td>
<td><img src="image37.png" alt="Image 37" /></td>
<td><img src="image38.png" alt="Image 38" /></td>
<td><img src="image39.png" alt="Image 39" /></td>
<td><img src="image40.png" alt="Image 40" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**THE TATA IRON & STEEL CO., LTD., JAMshedpur.**

Group Test of Intelligence - Performance Test.

**ANSWER SHEET**

**WRITE IN BLOCK LETTERS.**

Name

Department

Designation

Date of birth Province

Educational Qualifications

Name of the last school attended

Father's Name

Father's occupation

Post you aspire in the order of choice

1. 2. 3.

Proficiency

---

Test No. 2 - Counting of cubes in a pattern.

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test No. 5 - Comparison of Numbers.

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>32</td>
<td>33</td>
<td>34</td>
<td>35</td>
<td>36</td>
<td>37</td>
<td>38</td>
<td>39</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>42</td>
<td>43</td>
<td>44</td>
<td>45</td>
<td>46</td>
<td>47</td>
<td>48</td>
<td>49</td>
<td>50</td>
<td>51</td>
</tr>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>52</td>
<td>53</td>
<td>54</td>
<td>55</td>
<td>56</td>
<td>57</td>
<td>58</td>
<td>59</td>
<td>60</td>
<td>61</td>
</tr>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>62</td>
<td>63</td>
<td>64</td>
<td>65</td>
<td>66</td>
<td>67</td>
<td>68</td>
<td>69</td>
<td>70</td>
<td>71</td>
</tr>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test No. 7 - Completing of patterns.

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Manual of Instructions

1—You are provided with a booklet which contains 8 pages. Before answering the questions you should fill the particulars given below.

2—The question paper contains a large number of questions arranged in 5 sections. Try to solve as many questions as you can.

3—Some questions are easy; others are difficult. The answers of these would some times be a word or a number. Sometimes you will be required to make certain drawing in the last section. There are some mathematical sums which are to be solved on the blank papers supplied. Write your name on the top of these papers. While solving the questions their number should be entered clearly in the margin and the calculations should be neatly done.

4—Illustrations of the solutions have been given in a number of cases. You should note these carefully before attempting the questions.

5—Every question (and each part of a question, if in parts) carries equal marks.

6—When you are asked to answer the questions, read all the questions on each page. Answer the easy ones first. Don't waste time over the questions which you find too difficult. Pass on to the next. Write nothing except the answer on the question-paper.

7—Write neatly. Do not rub off answers or over-write them. If the answer is wrong, cut it out and write the correct one beside it.

Fill in the following particulars

Name

Caste

Age in years & months

Place of permanent residence: District Province, or State

Hobby

Name of the Institution Class

Examinations passed with the year of passing and the Divisions secured in each.

1. Year Division

2.

3.

4.
Q. 1 The following are patterns with certain designs, a portion of which is missing in each. Give the number from amongst the fragmentary patterns given against each that will complete the design. Write the number of the answers against each in the Answer-column. The answers of the first three patterns are given to serve as illustrations.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Q. 2 (a) If $A B$ is equal to $C D$, write yes otherwise write no in the answer-column.

(b) If $P Q$ and $R S$ form part of the same straight line, write yes otherwise write no in the answer-column.

Answers:

(a) 4
(b) 5
Q 3. Look at the following figures and find the way in which the first three figures on the same line are alike. Then look at the other five figures on the same line and give the number of the one that is most like the first three.

Q. 1. Indicate by letters the piece or pieces (from amongst those given), which are required to fill in each space on each of the lines. Write the letter piece to be used in the small dotted circle given to indicate the number of pieces required for each space. In the first line the first two spaces are filled to illustrate.
Q. 2. Below are various geometrical forms. Divide each form in two by means of a single line in such a way that when the two pieces are joined they will form a square. In the columns for answers write the two numbers which are at the ends of the line used to divide the form in two parts.

Answers
(a) 5 and 11
(b) 5 and 8

Write the names of the following tools in the answer column.

Answers
1
2
3
4
5
6
Q 3. (a) In which direction will the pointer move (towards A or B) when the crank is turned in the direction indicated by the arrow in the adjoining figure? In the answer-column write either A or B, whichever is the correct answer.

(b) The small cart is to be moved in the direction indicated by the arrow. Should the crank be moved in the direction indicated by the arrow C or in that indicated by the arrow D? In the answer-column write either C or D, whichever is the correct answer.

(c) In which direction should the crank be turned (towards E or H) in order to lift the weight which is hanging? In the answer-column write either E or H, whichever is the correct answer.
Q 3 Below are reproduced pictures of mechanical arrangements formed by jointed livers. Each mechanical set-up includes several fixed axes represented by black squares. When the handle marked G is pulled downwards the extremity X is displaced in a certain direction.

For example in the illustration given at the top when the handle G is pulled downwards the extremity X moves upwards and towards the right as indicated by the arrow.

Indicate by an arrow on each of the figures how the extremity X moves when G is pulled downwards.

Section IV

Q. 1 While cycling down the Stanley Road Shyamnarayan finds that all of a sudden paddling ceases to function and the cycle gradually comes to a stop. On examining he finds that the chain is in proper place, both on the chain-wheel and the free-wheel and there is no defect in the brakes. What can be the possible defect in the cycle? Give the number of the correct answer from amongst the following.

(1) The tube of the front-wheel is punctured.
(2) One of the paddles is broken.
(3) The wire of the free-wheel is cut.
(4) The cycle requires oiling.

Answer.

Q. 2 A certain cylinder in a motor-car engine was not firing. The ignition leads are properly connected and they are in good order. What could be the cause of misfiring in that cylinder alone when the engine is in good condition? Give the number of the correct answer from amongst the following.

(1) Battery is not fitted.
(2) Magnets are not working.
(3) The water radiator is hot.
(4) Sparking plug in that cylinder is out of order.

Answer

Q 3 In a motor-car engine the petrol supply to the carburettor from gravity fed tank is found to be restricted after a few hours running. There is enough petrol in the tank and the passages from the tank to the carburettor are clear and there is no leakage anywhere on the pipe connections. What could be the cause of this restricted flow of the petrol? Give the number of the correct answer from amongst the following.

(1) The float in the carburettor is punctured.
(2) The passage for the air to the tank is blocked.
(3) Petrol pump is not working.
(4) The tank is left open.

Answer
Q. 4. A cinema house has caught fire. The fire brigade arrives.
(a) What would they look for first? Give the number of the correct answer from amongst the following.

(1) Ladder, (2) Hydrant, (3) Rope

(b) What apparatus is used to make the water reach the upper storey? Give the number of the correct answer from amongst the following.

(1) Syphon, (2) Vacuum Pump (3) Hose

Section V

The following sums are to be solved on the blank papers supplied. The steps of the working are to be clearly shown. Rough calculations may be done in the marginal space which is to be left out.

Q. 1. The specific gravity of a piece of brass was found by use of a Nicholson's Hydrometer and the following observations were recorded.

(1) Weight required to sink the Hydrometer to the standard mark = 4.48 gms.
(2) Weight required to sink the Hydrometer to the standard mark with the brass piece on the upper pan = 2.28 gms.
(3) Weight required to sink the Hydrometer to the standard mark with the brass piece in the lower pan = 2.48 gms. Calculate the specific gravity of brass.

Q. 2. A hollow conical vessel has an internal diameter of 6" on the top and is 9" deep inside. Calculate the weight of water which it contains. (water weighs 0.026 Lbs per cubic inch.)

Q. 3. A wheel A having 20 teeth drives another wheel B having 54 teeth. If A runs at 110 revolutions per minute find the speed of revolution of B.

Q. 4. A 10 horse-power electric motor is getting up speed from rest from a resisting couple whose moment is 320 poundal feet. Find (a) the maximum angular velocity of the rotating part, and (b) the time taken to attain it if the acceleration is constant and equal to 40 radians per sec. per sec.

Q. 5. Two bodies A and B weigh 10 Lbs. and 40 Lbs. respectively. Each is acted upon by a force equal to the weight of 5 Lbs. Compare the times the force must act to produce in each of the bodies.

(a) the same momentum.
(b) the same Kinetic Energy.

Q. 6. The jib of a derrick crane measured 19 ft. The tie is 17½ ft. and the post is 9 ft long. A load of 2½ tons weight is attached to a chain which passes over a single pulley at the top of the jib and then along the tie. Find the push in the jib and the pull in the tie. (Neglect friction and the weight of the part of the crane.)
The Tata Iron & Steel Co., Ltd.

JAMSHEDPUR

GROUP TEST OF INTELLIGENCE

(DR. BANSIDHAR)

MANUAL OF INSTRUCTIONS.

1. You are provided with a booklet which contains a number of questions.
2. Carefully read every question before attempting to answer it and try to solve as many questions as you can.
3. If you find a question difficult, do not waste time over it; leave it at the first attempt and come back to it if you have time left.
4. Do not write any thing on the question paper. Neither written calculations nor scribbling, nor any drawing of figures is permissible anywhere on it. Written calculations alone are permissible only for questions No. 15 to No. 20. The remaining questions are to be solved mentally.
5. For the answers, a separate answer sheet is provided. Each question is numbered and the same numbers are reproduced in the answer sheet. Sufficient blank space is provided for the answer. Put the answer in its correct place.
6. Write neatly. Do not rub off answers or over write them. If you think that your answer is wrong, cut it out and write the correct one by the side of it.
7. In some cases you will find that typical illustrations with answers are provided. Study them carefully and follow closely those methods of answering.
In this question you are given a number of patterns. From each pattern a piece from the right hand bottom corner has been cut off. By the side of the cut pattern you will find five pieces which will fit exactly in the portion cut off from the pattern. But, there is only one which will complete the pattern. You are to find out the particular piece and write in the answer sheet, the letter indicating that piece against corresponding pattern number. For the pattern No. 1, evidently the answer will be "D".

<table>
<thead>
<tr>
<th>No.</th>
<th>Patterns</th>
<th>Pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><img src="image1.png" alt="Pattern 1" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>2.</td>
<td><img src="image7.png" alt="Pattern 2" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>3.</td>
<td><img src="image8.png" alt="Pattern 3" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>4.</td>
<td><img src="image9.png" alt="Pattern 4" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>5.</td>
<td><img src="image10.png" alt="Pattern 5" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>6.</td>
<td><img src="image11.png" alt="Pattern 6" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>7.</td>
<td><img src="image12.png" alt="Pattern 7" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>8.</td>
<td><img src="image13.png" alt="Pattern 8" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>9.</td>
<td><img src="image14.png" alt="Pattern 9" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
<tr>
<td>10.</td>
<td><img src="image15.png" alt="Pattern 10" /></td>
<td><img src="image2.png" alt="Piece A" /></td>
</tr>
</tbody>
</table>

2. If A B is equal to C D, write "Yes" if not write "No" in the answer - column provided in the answer sheet.

6. If P Q and R S form parts of the same straight line, write "Yes" if not write "No" in the answer - column provided in the answer sheet.
0.3. Look at the figures given above and find the property which is common to all the three figures on the left. Then look at the other five figures on the same line on the right and find out the figure which possesses the same common property of the three figures on the left. Evidently the figure marked 'E' is the only one which satisfies that condition. So the answer is 'E'. Do the same with the other groups of figures given below. Put down the answer in the answer column provided in the answer sheet. Do not write anything on the question paper.

0.4. In this question you are given four patterns. In each of these there are gaps. The number of dotted circles in each gap indicates the number of piece or pieces required to fill the gap. Each dotted circle is numbered. In the answer sheet give the letter indicating the piece required against corresponding circle number. In the case of pattern 'A' for the circle No. 1 and No. 2, the answer will be 'a' and 'b'. Put down the answer in the answer column provided on the answer sheet. Do not write anything on the question paper.

Patterns:

Pieces:

- a
- b
- c
- d
- e
- f
- g
- h
- i
- j
- k
- l
- m
- n
- o
- p
- q
- r
- s
- t
Several geometrical forms are given below. Each of them is to be divided into two parts by means of a single line in such a way that when the two parts are joined they will form a square. Look at the above two forms (a) and (b). In the case (a) the line joining 5 and 11 and in the case (b) the line joining 5 and 8 will do what is wanted.

Do the same for the forms given below. For answer, write on the answer sheet: the two numbers at the ends of the line used to divide the form against corresponding form number. Do not draw any line through the forms on the question paper.

The figures which are given below indicate some tools. Write the name of each against its corresponding number on the answer sheet. Do not write any thing on the question paper.
8.7. In this question four models are shown below. In each case you will find one part or more to be missing. But find out only the most essential missing part and write its name against the corresponding model number in the answer column provided in the answer sheet. Do not write any thing on the question paper.

1. 

2. 

3. 

4. 

8.8. In this mechanical device, the direction in which the crank turns is shown by the arrow. Find out the direction in which the pointer "P" will move. For answer write either "A" or "B" whichever you think correct. Put down the answer in the answer column provided for it on the answer sheet.

1. 

2. 

3. 

4. 

8.9. Find out the direction in which the crank is to be turned so that the small cart "P" will move in the direction shown by the arrow. For answer write either "C" or "D" whichever you think to be correct.

1. 

2. 

3. 

4. 

8.10. Find out the direction in which the crank is to be turned in order to lift the weight "P". For answer write either "E" or "H" whichever you think to be correct.

1. 

2. 

3. 

4.
Below are reproduced pictures of mechanical arrangements by jointed levers. Each mechanical set-up includes several fixed axes represented by black squares. When the handle marked G is pulled downwards the extremity X is displaced in a certain direction.

For example, in the illustration given at the top when the handle G is pulled downwards the extremity X moves upwards and towards the right as indicated by the arrow, i.e., clock-wise.

Indicate by an arrow the direction of movement of X for each figure when G is pulled downwards. Put the arrow for each figure against its corresponding number on the answer sheet.

While cycling down the Stanley Road Shyamnara-tan finds that all of a sudden pedalling ceases to function and the cycle gradually comes to a stop. On examining he finds that the chain is in proper place, both on the chain-wheel and the free-wheel, and there is no defect in the brakes. What can be the possible defect in the cycle? Give the letter indicating the correct answer from amongst the following, on the answer sheet.

The tube of the front-wheel is punctured.
The float in the carburettor is punctured.

One of the spokes is broken.
The wire of the free-wheel is cut.
The cycle requires oiling.

A certain cylinder in a motor-car engine was not firing. The ignition leads are properly connected and they are in good order. What could be the cause of misfiring in that cylinder alone when the engine is in good condition? Give the letter indicating the correct answer from amongst the following, on the answer sheet.

Battery is not fitted.
Magnets are not working.
The water in the radiator is hot.

Sparking plug in that cylinder is out of order.

In a motor car engine the petrol supply to the carburettor from gravity fed tank is found to be restricted after a few hours running. There is enough petrol in the tank and the passages from the tank to the carburettor are clear and there is no leakage anywhere on the pipe connections. What could be the cause of this restricted flow of the petrol? Give the letter indicating the correct answer from amongst the following, on the answer sheet.

The float in the carburettor is punctured.
The passage for the air to the tank is blocked.

Petrol pump is not working.
The tank is left open.
What Would They Look For First? Write On The Answer Sheet Only One Of The
Letters @, © And 6 Whichever Indicates Correct Answer.

@ Ladder © Hydrant © Rope

Q. 14. What Apparatus Is Used To Make The Water Reach The Upper Storey? Write On The
Answer Sheet Only One Of The Letters @, © And 6 Whichever Indicates Cor-
RECT Answer.

@ Syphon © Vacuum Pump © Hose

The Following Sums Are To Be Solved On The Blank Papers Supplied. The Steps Of
The Working Are To Be Clearly Shown. Rough Calculations May Be Done In The Marginal
Space Which Is To Be Left Out.

Q. 15. The Specific Gravity Of A Piece Of Brass Was Found By Use Of A Nicholson's Hydrome-
TER And The Following Observations Were Recorded.
1. Weight Required To Sink The Hydrometer To The Standard Mark = 4.48 Gms.
2. Weight Required To Sink The Hydrometer To The Standard Mark With The Brass
Piece On The Upper Pan = 2.28 Gms.
3. Weight Required To Sink The Hydrometer To The Standard Mark With The Brass
Piece In The Lower Part = 2.48 Gms. Calculate The Specific Gravity Of Brass.

Q. 16. A Hollow Conical Vessel Has An Internal Diameter Of 6' On The Top And Is 9 Deep
Inside. Calculate The Weight Of Water Which It Contains (Water Weighs 0.036
Lbs. Per Cubic Inch).

Q. 17. A Wheel A' Having 20 Teeth Drives Another Wheel 'B' Having 54 Teeth.
If 'A' Runs At 110 Revolutions Per Minute Find The Speed Of Revolution Of 'B'.

Q. 18. A 10 Horse-Power Electric Motor Is Getting Up Speed From Rest Against Resisti-
ING Couple Whose Moment Is 320 Poundal Feet. Find @ The Maximum Angular VeLO-
City Of The Rotating Part, And © The Time Taken To Attain It If The Acceleration
Is Constant And Equal To 40 Radians Per Sec. Per Sec.

A Force Equal To The Weight Of 5 Lbs. Compare The Times The Force Must Act To
PRODUCE IN EACH OF THE BODIES,

@ The Same Momentum.
© The Same Kinetic Energy.

Long. A Load Of 2½ Tons Weight Is Attached To A Chain Which Passes Over A
Single Pulley At The Top Of The Jib And Then Along The Tie. Find The Push In
The Jib And The Pull In The Tie (Neglect Friction And The Weight Of The Part
Of The Crane.)
CORRECT ANSWERS

QUESTION I

PATTERN NO
1 2 3 4 5
D E D D B

PATTERN NO
G 7 8 9 10
D A B C C

QUESTION II

YES YES

QUESTION III

COLUMN NO
1 2 3 4 5
D D C E E

QUESTION IV

CIRCLE NO
1 2 3 4 5 6
S I M N K T

CIRCLE NO
7 8 9 10 11 12
F L R H E C

CIRCLE NO
13 14 15 16 17 18
G A P D O B

QUESTION V

FORM NO
1 19, 4
2 17, 12
3 9, 22

QUESTION VI

1 TRY SQUARE
2 OUTSIDE CALIPERS
3 FLAT FILE

QUESTION VII

1 FILAMENT
2 STEERING WHEEL
3 PROPELLER
4 FORK

QUESTION VIII

FIG. NO
1 2 3
A D E

QUESTION IX

1 2 3 4 5 6

QUESTION X

C
QUESTION XI

D

QUESTION XII

B
Q. 15.

Weight to sink the hydrometer to the mark = 4.48 grammes

in the Brass

Weight to sink the hydrometer to the mark = 2.28 grammes

\[ \therefore \text{Weight of Brass in air} = 2.20 \text{ grammes} \]

Weight to sink the hydrometer with Brass in Lower Pan = 2.54 grammes

\[ \therefore \text{Weight of the brass in water} = (4.48 - 2.54) = 1.94 \text{ grammes} \]

So loss of weight in water = (2.2 - 1.94) grammes = .26 grammes

\[ \therefore \text{Sp. Gravity} = \frac{\text{Weight in air}}{\text{Loss of Weight in water}} = \frac{2.2}{.26} = 8.46 \]

Q. 16. Volume of a Cone = \( \frac{1}{3} \pi r^2 h \)

\[ \therefore \text{Volume of the given Cone} = \frac{1}{3} \pi 3^2 \times 9 \ \text{cu.in.} \]

\[ = \pi \times 3 \times 9 \ \text{cu. in.} \]

\[ = \pi \times 27 \ \text{cu. inch} \]

Weight of water per cu. inch = .036 lb.

\[ \therefore \text{Weight of water the cone will contain} = \pi \times 27 \times .036 \ \text{lbs.} \]

\[ = 3.050 \ \text{lbs.} \]

Q. 17. 20 Teeth \( A \) B 54 Teeth

\[ \frac{TA}{TB} = \frac{NB}{NA} \]

or \( \frac{20}{54} = \frac{NB}{110} \cdot \therefore NB = \frac{20 \times 110}{54} \]

\[ = 40 \frac{10}{27} \]
Q. 18

Torque = 320 lbf. ft. = 10 lbf. ft. \\
32 lbs.

H.P. = \frac{2 \text{ II. N.T.}}{3,000} =

\therefore \frac{10}{2 \text{ II. N.10}} = \frac{3,000}{3,000}

\therefore N = \frac{10 \times 3,000}{10 \times 2 \times 3.14} = \frac{3,000}{6.28} = 5254 \text{ R.P.M.}

\therefore \text{Maxm. angular velocity} = \frac{2 \text{ II. N.}}{60} = \frac{2 \times 22 \times 5254}{7 \times 60} \text{ radians}

= 550.4 \text{ radians per sec.}

Now the acceleration = 40 \text{ radians/sec.}^2

\therefore 40 \times t = 550.4

or \frac{t}{40} = 13.76 \text{ seconds}

Q. 19

A = 10 \text{ lbs.}

B = 40 \text{ lbs.}

Force = 5 \times 32 = 160 \text{ lbf.}

\therefore \text{acceleration of A is} \ 10 \times f_A = 160 \text{ or } f_A = 16 \text{ sec.}^2

\text{and acceleration of B is} \ 40 \times f_B = 160 \text{ or } f_B = 4 \text{ sec.}^2

let VA and VB be velocities of A & B respectively and TA & TB time taken to acquire these.

VA = f_A \frac{T_A}{A} \text{ & } VB = f_B \frac{T_B}{B}

To have same kinetic energy the relation will be

\therefore \frac{10 \times 16 \times T_A}{T_B} = 40 \times 4 \times T_B

\therefore \frac{T_A}{T_B} = \frac{10 \times 16}{40 \times 4} = 1
Q. 19 (Contd.)

KE of \( A = \frac{1}{2} M_A V_A^2 \)

" of \( B = \frac{1}{2} M_B V_B^2 \)

Let \( T_A \) and \( T_B \) be the time taken by the two bodies to have same kinetic energy

\[
\Rightarrow \quad \frac{1}{2} \times 10 \times (16 T_A)^2 = \frac{1}{2} \times 40 \times (4 T_B)^2
\]

or

\[
\frac{T_A^2}{T_B^2} = \frac{40 \times 16}{10 \times 16 \times 16} = \frac{40}{150} = \frac{1}{4}
\]

\[
\Rightarrow \quad \frac{T_A}{T_B} = \frac{1}{2}
\]

Q. 20

![Force diagram](attachment:force_diagram.png)

Two As are similar

\[
\Rightarrow \quad \frac{bc}{ab} = \frac{19}{9} \quad \text{or} \quad bc = \frac{19 \times ab}{9} = \frac{19 \times 2.5}{9} = 5.27 \text{ tons}
\]

Again \( \frac{ac}{ab} = \frac{17.5}{9} \) \( \text{or} \) \( ac = \frac{17.5 \times ab}{9} = \frac{17.5 \times 2.5}{9} = 4.86 \text{ tons} \)
### APPENDIX E.1.

**DISTRIBUTION OF SCORES**

V: Verbal  
B: Beta  
AP: Aptitude.

<table>
<thead>
<tr>
<th>Score Interval</th>
<th>Test V</th>
<th>Test B</th>
<th>Score Interval</th>
<th>Test AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 - 99</td>
<td>0</td>
<td>22</td>
<td>70</td>
<td>76</td>
</tr>
<tr>
<td>80</td>
<td>89</td>
<td>23</td>
<td>63</td>
<td>69</td>
</tr>
<tr>
<td>70</td>
<td>79</td>
<td>29</td>
<td>58</td>
<td>62</td>
</tr>
<tr>
<td>60</td>
<td>69</td>
<td>33</td>
<td>49</td>
<td>55</td>
</tr>
<tr>
<td>50</td>
<td>59</td>
<td>33</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>40</td>
<td>49</td>
<td>23</td>
<td>35</td>
<td>41</td>
</tr>
<tr>
<td>30</td>
<td>39</td>
<td>30</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>20</td>
<td>29</td>
<td>23</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>19</td>
<td>21</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>0</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>13</td>
</tr>
</tbody>
</table>

| MEAN           | 49.298 | 52.372 |
| ST. DEV.       | 23.07  | 26.967 |
| ST. ERROR OF MEAN | 1.545  | 1.774  |

**NOTE:** The means and standard deviations were checked by shifting the origin one step and recalculating the means and standard deviations.
FREQUENCY DISTRIBUTION OF THE SCORES OF 223 WORKERS IN THE TISCO, ON THE GROUP INTELLIGENCE TEST FOR 16+, COMPARED WITH BEST FITTING HISTOGRAM (RED) FOR SAME DATA.
FREQUENCY DISTRIBUTION OF THE SCORES OF 231 WORKERS IN THE TISCO. ON THE MODIFIED BETA TEST, COMPARED WITH BEST FITTING HISTOGRAM (RED) FOR SAME DATA.
FREQUENCY DISTRIBUTION OF THE SCORES OF 264 WORKERS IN
THE TISCO. ON THE APTITUDE TEST, COMPARED WITH BEST FITTING
HISTOGRAM (RED) FOR SAME DATA.
### APPENDIX E2

#### FACTORIAL ANALYSIS (CENTROID METHOD)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V.T.</td>
<td>(0.7023)</td>
<td>(0.7023)</td>
<td>(0.6927)</td>
<td>(0.6243)</td>
<td>(0.5144)</td>
<td>(0.5438)</td>
</tr>
<tr>
<td>B.T.</td>
<td>(0.7023)</td>
<td>(0.7023)</td>
<td>(0.6395)</td>
<td>(0.6062)</td>
<td>(0.4723)</td>
<td>(0.5165)</td>
</tr>
<tr>
<td>Apt.T.</td>
<td>(0.6927)</td>
<td>(0.6395)</td>
<td>(0.8428)</td>
<td>(0.7951)</td>
<td>(0.3428)</td>
<td>(0.7920)</td>
</tr>
<tr>
<td>Sp.R.</td>
<td>(0.6243)</td>
<td>(0.6062)</td>
<td>(0.7951)</td>
<td>(0.7951)</td>
<td>(0.5545)</td>
<td>(0.5246)</td>
</tr>
<tr>
<td>Drg.</td>
<td>(0.5144)</td>
<td>(0.4723)</td>
<td>(0.8428)</td>
<td>(0.5545)</td>
<td>(0.3428)</td>
<td>(0.5499)</td>
</tr>
<tr>
<td>Mech.</td>
<td>(0.5438)</td>
<td>(0.5165)</td>
<td>(0.7920)</td>
<td>(0.5246)</td>
<td>(0.5499)</td>
<td>(0.7920)</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
3.7798 & \quad 3.6391 & \quad 4.6049 & \quad 3.8998 & \quad 5.7787 & \quad 3.7183 \\
\end{align*}
\]

\[
\frac{23.4191}{23.4191} = 4.8393
\]

**(Reciprocal)** \(R = 0.20664\)

Factor Matrix - I.  - Multiplying the total of each column by R

<table>
<thead>
<tr>
<th>PF Loadings</th>
<th>.7611</th>
<th>.7520</th>
<th>.9516</th>
<th>.8059</th>
<th>.7304</th>
<th>.7685</th>
</tr>
</thead>
<tbody>
<tr>
<td>.7811</td>
<td>.6301</td>
<td>.5974</td>
<td>.7433</td>
<td>.6295</td>
<td>.6096</td>
<td>.6003</td>
</tr>
<tr>
<td>.7520</td>
<td>.5974</td>
<td>.5655</td>
<td>.7156</td>
<td>.6060</td>
<td>.5889</td>
<td>.5779</td>
</tr>
<tr>
<td>.9516</td>
<td>.7433</td>
<td>.7156</td>
<td>.9055</td>
<td>.7669</td>
<td>.7426</td>
<td>.7313</td>
</tr>
<tr>
<td>.8059</td>
<td>.6295</td>
<td>.6060</td>
<td>.7669</td>
<td>.6495</td>
<td>.6289</td>
<td>.6193</td>
</tr>
<tr>
<td>.7304</td>
<td>.6096</td>
<td>.5979</td>
<td>.7426</td>
<td>.6299</td>
<td>.6090</td>
<td>.5997</td>
</tr>
<tr>
<td>.7685</td>
<td>.6003</td>
<td>.5779</td>
<td>.7315</td>
<td>.6193</td>
<td>.5997</td>
<td>.5906</td>
</tr>
</tbody>
</table>
### Residual Matrix

<table>
<thead>
<tr>
<th></th>
<th>0.0922</th>
<th>0.1149</th>
<th>-0.0506</th>
<th>-0.0052</th>
<th>-0.0952</th>
<th>-0.0565</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1149</td>
<td>0.1568</td>
<td>-0.0761</td>
<td>0.0002</td>
<td>-0.1146</td>
<td>-0.0614</td>
<td></td>
</tr>
<tr>
<td>-0.0506</td>
<td>-0.0761</td>
<td>0.0627</td>
<td>0.0282</td>
<td>1.0002</td>
<td>0.0607</td>
<td></td>
</tr>
<tr>
<td>-0.0052</td>
<td>0.0002</td>
<td>0.0282</td>
<td>-0.1450</td>
<td>-0.0744</td>
<td>-0.0947</td>
<td></td>
</tr>
<tr>
<td>-0.0952</td>
<td>-0.1146</td>
<td>1.0002</td>
<td>-0.0744</td>
<td>-0.2333</td>
<td>-0.0498</td>
<td></td>
</tr>
<tr>
<td>-0.0565</td>
<td>-0.0614</td>
<td>0.0607</td>
<td>-0.0947</td>
<td>-0.0498</td>
<td>0.2014</td>
<td></td>
</tr>
</tbody>
</table>

### Changing the Signs of Tests 1, 2 & 4

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>.1149</td>
<td>.1149</td>
<td>.0806</td>
<td>(-)</td>
<td>.0052</td>
<td>.0952</td>
<td>.0565</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-----</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>.1149</td>
<td>(.1149)</td>
<td>.0761</td>
<td>.0002</td>
<td>.1146</td>
<td>.0814</td>
<td></td>
</tr>
<tr>
<td>.0506</td>
<td>.0761</td>
<td>(.1002)</td>
<td>(-)</td>
<td>.0282</td>
<td>.1002</td>
<td>.0807</td>
</tr>
<tr>
<td>(-)</td>
<td>.0052</td>
<td>.0002</td>
<td>(-)</td>
<td>.0282</td>
<td>(.0947)</td>
<td>.0744</td>
</tr>
<tr>
<td>.0952</td>
<td>.1146</td>
<td>.1002</td>
<td>.0744</td>
<td>(.1146)</td>
<td>(-)</td>
<td>.0493</td>
</tr>
<tr>
<td>.0565</td>
<td>.0814</td>
<td>.0607</td>
<td>.0947</td>
<td>(-)</td>
<td>.0493</td>
<td>.0047</td>
</tr>
</tbody>
</table>

= 2.2666
\[ \sqrt{2.2666} = 1.50552 \]

\[ R = .6643 \]

<table>
<thead>
<tr>
<th>Factor Matrix - II.</th>
<th>2nd Loadings</th>
<th>.2536</th>
<th>.3202</th>
<th>.2389</th>
<th>.1552</th>
<th>.2984</th>
<th>.2114</th>
</tr>
</thead>
<tbody>
<tr>
<td>.2936</td>
<td>.0304</td>
<td>.0908</td>
<td>.0878</td>
<td>.0434</td>
<td>.0848</td>
<td>.0500</td>
<td></td>
</tr>
<tr>
<td>.3202</td>
<td>.0908</td>
<td>.1025</td>
<td>.0765</td>
<td>.0491</td>
<td>.0955</td>
<td>.0577</td>
<td></td>
</tr>
<tr>
<td>.2589</td>
<td>.0378</td>
<td>.0765</td>
<td>.0566</td>
<td>.0386</td>
<td>.0713</td>
<td>.0505</td>
<td></td>
</tr>
<tr>
<td>.1532</td>
<td>.0434</td>
<td>.0491</td>
<td>.0366</td>
<td>.0235</td>
<td>.0437</td>
<td>.0594</td>
<td></td>
</tr>
<tr>
<td>.2934</td>
<td>.0846</td>
<td>.0955</td>
<td>.0713</td>
<td>.0457</td>
<td>.0890</td>
<td>.0651</td>
<td></td>
</tr>
<tr>
<td>.2114</td>
<td>.0800</td>
<td>.0677</td>
<td>.0505</td>
<td>.0626</td>
<td>.0651</td>
<td>.0447</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Residual Matrix.</th>
<th>(.0345)</th>
<th>.0241</th>
<th>(-)</th>
<th>.0712</th>
<th>(-)</th>
<th>.0486</th>
<th>.0106</th>
<th>(-)</th>
<th>.0055</th>
</tr>
</thead>
<tbody>
<tr>
<td>(.0241)</td>
<td>(.0124)</td>
<td>(-)</td>
<td>.0004</td>
<td>(-)</td>
<td>.0489</td>
<td>.0191</td>
<td>(-)</td>
<td>.0063</td>
<td></td>
</tr>
<tr>
<td>(-)</td>
<td>.0172</td>
<td>(-)</td>
<td>.0004</td>
<td>(.0433)</td>
<td>(-)</td>
<td>.0269</td>
<td>.0102</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(-)</td>
<td>.0496</td>
<td>(-)</td>
<td>.0499</td>
<td>(-)</td>
<td>.0648</td>
<td>(.0712)</td>
<td>.0287</td>
<td>.0623</td>
<td></td>
</tr>
<tr>
<td>(.0106)</td>
<td>.0191</td>
<td>.0289</td>
<td>.0287</td>
<td>(.0256)</td>
<td>(-)</td>
<td>.1129</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(-)</td>
<td>.0055</td>
<td>(-)</td>
<td>.0063</td>
<td>.0102</td>
<td>.0623</td>
<td>(-)</td>
<td>.1129</td>
<td>.0500</td>
<td></td>
</tr>
<tr>
<td>(-)</td>
<td>.0001</td>
<td>.0000</td>
<td>.0005</td>
<td>(-)</td>
<td>.0001</td>
<td>.0000</td>
<td>.0002</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0486</td>
<td>0.0241</td>
<td>-0.0172</td>
<td>-0.0486</td>
<td>0.0106</td>
<td>-0.0035</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0241</td>
<td>0.0489</td>
<td>-0.0004</td>
<td>-0.0489</td>
<td>0.0191</td>
<td>-0.0063</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.0172</td>
<td>-0.0004</td>
<td>0.0648</td>
<td>-0.0648</td>
<td>0.0289</td>
<td>0.0102</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.0486</td>
<td>-0.0489</td>
<td>-0.0648</td>
<td>(0.0648)</td>
<td>-0.0287</td>
<td>0.0623</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0106</td>
<td>0.0191</td>
<td>0.0289</td>
<td>-0.0287</td>
<td>(1.1129)</td>
<td>-1.1129</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-0.0035</td>
<td>-0.0063</td>
<td>0.0102</td>
<td>0.0823</td>
<td>(1.1129)</td>
<td>(1.1129)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Changing the Signs of Tests 4 & 6.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0486</td>
<td>0.0241</td>
<td>-0.0172</td>
<td>-0.0486</td>
<td>0.0106</td>
<td>-0.0035</td>
</tr>
<tr>
<td></td>
<td>0.0241</td>
<td>0.0489</td>
<td>-0.0004</td>
<td>-0.0489</td>
<td>0.0191</td>
<td>-0.0063</td>
</tr>
<tr>
<td>-0.0172</td>
<td>-0.0004</td>
<td>0.0648</td>
<td>-0.0648</td>
<td>0.0289</td>
<td>0.0102</td>
<td></td>
</tr>
<tr>
<td>-0.0486</td>
<td>-0.0489</td>
<td>-0.0648</td>
<td>(0.0648)</td>
<td>-0.0287</td>
<td>0.0623</td>
<td></td>
</tr>
<tr>
<td>0.0106</td>
<td>0.0191</td>
<td>0.0289</td>
<td>-0.0287</td>
<td>(1.1129)</td>
<td>-1.1129</td>
<td></td>
</tr>
<tr>
<td>-0.0035</td>
<td>-0.0063</td>
<td>0.0102</td>
<td>0.0823</td>
<td>(1.1129)</td>
<td>(1.1129)</td>
<td></td>
</tr>
</tbody>
</table>

\[
(\text{1.1129}) = \frac{1.1999}{\sqrt{1.1999}} = 1.0954 \\
R = 0.9129
\]
**FACTOR MATRIX - III. - MULTIPLYING THE TOTAL OF EACH COLUMN BY R.**

<table>
<thead>
<tr>
<th>3rd Leaving</th>
<th>.1079</th>
<th>.1341</th>
<th>.1193</th>
<th>.2380</th>
<th>.2334</th>
<th>.3626</th>
</tr>
</thead>
<tbody>
<tr>
<td>.1079</td>
<td>.0116</td>
<td>.0145</td>
<td>.0129</td>
<td>.0257</td>
<td>.0252</td>
<td>.0233</td>
</tr>
<tr>
<td>.1341</td>
<td>.0145</td>
<td>.0180</td>
<td>.0160</td>
<td>.0319</td>
<td>.0313</td>
<td>.0352</td>
</tr>
<tr>
<td>.1193</td>
<td>.0129</td>
<td>.0180</td>
<td>.0142</td>
<td>.0284</td>
<td>.0278</td>
<td>.0213</td>
</tr>
<tr>
<td>.2380</td>
<td>.0257</td>
<td>.0319</td>
<td>.0284</td>
<td>.0563</td>
<td>.0555</td>
<td>.0625</td>
</tr>
<tr>
<td>.2334</td>
<td>.0252</td>
<td>.0213</td>
<td>.0273</td>
<td>.0555</td>
<td>.0645</td>
<td>.0613</td>
</tr>
<tr>
<td>.3626</td>
<td>.0283</td>
<td>.0252</td>
<td>.0333</td>
<td>.0625</td>
<td>.0613</td>
<td>.0690</td>
</tr>
</tbody>
</table>

**RESIDUAL MATRIX.**

<table>
<thead>
<tr>
<th></th>
<th>.0370</th>
<th>.0096</th>
<th>-.0301</th>
<th>.0229</th>
<th>-.0146</th>
<th>-.0248</th>
</tr>
</thead>
<tbody>
<tr>
<td>.0096</td>
<td>(.0209)</td>
<td>(-)</td>
<td>.0184</td>
<td>.0170</td>
<td>(-)</td>
<td>.0123</td>
</tr>
<tr>
<td>(-)</td>
<td>.0301</td>
<td>(-)</td>
<td>.0164</td>
<td>(.0503)</td>
<td>.0564</td>
<td>.0011</td>
</tr>
<tr>
<td>.0229</td>
<td>.0170</td>
<td>.0564</td>
<td>(.0082)</td>
<td>(-)</td>
<td>.0842</td>
<td>(-)</td>
</tr>
<tr>
<td>(-)</td>
<td>.0146</td>
<td>(-)</td>
<td>.0122</td>
<td>.0011</td>
<td>(-)</td>
<td>.0842</td>
</tr>
<tr>
<td>(-)</td>
<td>.0248</td>
<td>(-)</td>
<td>.0289</td>
<td>(-)</td>
<td>.0415</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td>.0000</td>
<td>.0000</td>
<td>.0001</td>
<td>.0001</td>
<td>.0001</td>
<td>.0001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(.0301)</th>
<th>.0096</th>
<th>(-)</th>
<th>.0301</th>
<th>.0229</th>
<th>(-)</th>
<th>.0146</th>
<th>(-)</th>
<th>.0248</th>
</tr>
</thead>
<tbody>
<tr>
<td>.0096</td>
<td>(.0209)</td>
<td>(-)</td>
<td>.0184</td>
<td>.0170</td>
<td>(-)</td>
<td>.0123</td>
<td>(-)</td>
<td>.0289</td>
<td></td>
</tr>
<tr>
<td>(-)</td>
<td>.0301</td>
<td>(-)</td>
<td>.0164</td>
<td>(.0415)</td>
<td>.0564</td>
<td>.0011</td>
<td>(-)</td>
<td>.0415</td>
<td></td>
</tr>
<tr>
<td>.0229</td>
<td>.0170</td>
<td>.0364</td>
<td>(.0082)</td>
<td>(-)</td>
<td>.0942</td>
<td>(-)</td>
<td>.0002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(-)</td>
<td>.0146</td>
<td>(-)</td>
<td>.0122</td>
<td>.0011</td>
<td>(-)</td>
<td>.0942</td>
<td>(.0842)</td>
<td>.0516</td>
<td></td>
</tr>
<tr>
<td>(-)</td>
<td>.0248</td>
<td>(-)</td>
<td>.0289</td>
<td>(-)</td>
<td>.0415</td>
<td>(-)</td>
<td>.0002</td>
<td>.0516</td>
<td>(.0516)</td>
</tr>
</tbody>
</table>
### CHANGING THE SIGNS OF TESTS 3 & 6

<table>
<thead>
<tr>
<th></th>
<th>+</th>
<th>+</th>
<th>-</th>
<th>+</th>
<th>+</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(.0301)</th>
<th>.0086</th>
<th>(-), .0301</th>
<th>.0229</th>
<th>(-), .0146</th>
<th>(-), .0248</th>
</tr>
</thead>
<tbody>
<tr>
<td>.0096</td>
<td>(.0289)</td>
<td>(-), .0164</td>
<td>.0170</td>
<td>.0122</td>
<td>.0289</td>
<td></td>
</tr>
<tr>
<td>(-) .0301</td>
<td>(-) .0164</td>
<td>(.0415)</td>
<td>.0364</td>
<td>(-), .0011</td>
<td>.0415</td>
<td></td>
</tr>
<tr>
<td>.0229</td>
<td>.0170</td>
<td>.0364</td>
<td>(.0342)</td>
<td>.0842</td>
<td>.0002</td>
<td></td>
</tr>
<tr>
<td>.0146</td>
<td>.0122</td>
<td>(-), .0011</td>
<td>.0842</td>
<td>(.0342)</td>
<td>.0516</td>
<td></td>
</tr>
<tr>
<td>.0248</td>
<td>.0299</td>
<td>.0415</td>
<td>.0002</td>
<td>.0516</td>
<td>(.0516)</td>
<td></td>
</tr>
</tbody>
</table>

|       | .0719  | .0802  | .0718  | .2449  | .2457  | .1986  | = .9131 |

\[\sqrt{.9131} = .9556\]

\[R = 1.0465\]

### FACTOR MATRIX - IV.

Multiplying the total of each column by R.

<table>
<thead>
<tr>
<th>4th Loadings</th>
<th>0.0753</th>
<th>0.0839</th>
<th>0.0751</th>
<th>0.2563</th>
<th>0.2571</th>
<th>0.2078</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0753</td>
<td>0.0057</td>
<td>0.0063</td>
<td>0.0057</td>
<td>0.0193</td>
<td>0.0194</td>
<td>0.0156</td>
</tr>
<tr>
<td>0.0839</td>
<td>0.0057</td>
<td>0.0070</td>
<td>0.0063</td>
<td>0.0215</td>
<td>0.0216</td>
<td>0.0174</td>
</tr>
<tr>
<td>0.0751</td>
<td>0.0057</td>
<td>0.0063</td>
<td>0.0066</td>
<td>0.0122</td>
<td>0.0123</td>
<td>0.0156</td>
</tr>
<tr>
<td>0.2563</td>
<td>0.0193</td>
<td>0.0215</td>
<td>0.0192</td>
<td>0.0657</td>
<td>0.0659</td>
<td>0.0633</td>
</tr>
<tr>
<td>0.2571</td>
<td>0.0194</td>
<td>0.0216</td>
<td>0.0193</td>
<td>0.0689</td>
<td>0.0661</td>
<td>0.0534</td>
</tr>
<tr>
<td>0.2078</td>
<td>0.0156</td>
<td>0.0174</td>
<td>0.0156</td>
<td>0.0533</td>
<td>0.0554</td>
<td>0.0432</td>
</tr>
</tbody>
</table>
RESIDUAL MATRIX.

<table>
<thead>
<tr>
<th></th>
<th>F.I.</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.0344)</td>
<td>.0033</td>
<td>(-)</td>
<td>0.0358</td>
<td>.0036</td>
</tr>
<tr>
<td>0.0033</td>
<td>(-)</td>
<td>0.0219</td>
<td>(-)</td>
<td>0.0227</td>
</tr>
<tr>
<td>(-)</td>
<td>0.0358</td>
<td>(-)</td>
<td>0.0227</td>
<td>(-)</td>
</tr>
<tr>
<td>0.0036</td>
<td>(-)</td>
<td>0.0045</td>
<td>0.0172</td>
<td>(-)</td>
</tr>
<tr>
<td>(-)</td>
<td>0.0048</td>
<td>(-)</td>
<td>0.0094</td>
<td>(-)</td>
</tr>
<tr>
<td>0.0092</td>
<td>0.0115</td>
<td>0.0259</td>
<td>(-)</td>
<td>0.0531</td>
</tr>
<tr>
<td>-</td>
<td>-0.0001</td>
<td>0.0001</td>
<td>-0.0001</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F.I.</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.T.</td>
<td>0.7811</td>
<td>(-)</td>
<td>0.3336</td>
</tr>
<tr>
<td>B.T.</td>
<td>0.7520</td>
<td>(-)</td>
<td>0.3022</td>
</tr>
<tr>
<td>A.T.</td>
<td>0.9516</td>
<td>0.2399</td>
<td>0.1193</td>
</tr>
<tr>
<td>S.P.</td>
<td>0.8059</td>
<td>(-)</td>
<td>0.1532</td>
</tr>
<tr>
<td>D.E.</td>
<td>0.7804</td>
<td>0.2994</td>
<td>0.2334</td>
</tr>
<tr>
<td>A.B.</td>
<td>0.7835</td>
<td>0.2114</td>
<td>(-)</td>
</tr>
</tbody>
</table>

F2: signs of Tests V.T., B.T., & S.P.R. reversed.
### ROTATION OF AXES

<table>
<thead>
<tr>
<th></th>
<th>E.I.</th>
<th>E.II.</th>
<th>E.III.</th>
<th>E.IV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. V.T.</td>
<td>.7811</td>
<td>(.2356)</td>
<td>(-.1079)</td>
<td>(.0753)</td>
</tr>
<tr>
<td>2. B.T.</td>
<td>.7520</td>
<td>(-.3202)</td>
<td>(-.1541)</td>
<td>(.0339)</td>
</tr>
<tr>
<td>4. Sp.R.</td>
<td>.8059</td>
<td>(-.1532)</td>
<td>.2330</td>
<td>(-.2563)</td>
</tr>
<tr>
<td>5. Drg.</td>
<td>.7804</td>
<td>.2984</td>
<td>.2534</td>
<td>(-.2571)</td>
</tr>
</tbody>
</table>

### Table I

<table>
<thead>
<tr>
<th>I</th>
<th>E.I.</th>
<th>E.II.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>.8305</td>
<td>.2996</td>
</tr>
<tr>
<td>2.</td>
<td>.8272</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>.7928</td>
<td>.5780</td>
</tr>
<tr>
<td>4.</td>
<td>.8046</td>
<td>.1598</td>
</tr>
<tr>
<td>5.</td>
<td>.6118</td>
<td>.5690</td>
</tr>
<tr>
<td>6.</td>
<td>.6354</td>
<td>.4835</td>
</tr>
</tbody>
</table>

### Table II

<table>
<thead>
<tr>
<th>I</th>
<th>E.II.</th>
<th>E.III.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>.8305</td>
<td>(.1079)</td>
</tr>
<tr>
<td>2.</td>
<td>.8172</td>
<td>(.1541)</td>
</tr>
<tr>
<td>3.</td>
<td>.7982</td>
<td>.1193</td>
</tr>
<tr>
<td>4.</td>
<td>.9046</td>
<td>.2330</td>
</tr>
<tr>
<td>5.</td>
<td>.6118</td>
<td>.2354</td>
</tr>
<tr>
<td>6.</td>
<td>.6354</td>
<td>(.2626)</td>
</tr>
</tbody>
</table>

### Rotating F.I.° & F.II.° by 22° in the positive direction.

- Cos.: .9272
- Sin.: .3746
- F.Ix: x Cos. θ = - Y sin θ
- F.II y: x Sin. θ = + Y cos. θ

See Appendix (Graph)

### Rotating F.I.° & F.III.° by 22° in the positive direction.

- Cos.: .9272
- Sin.: .3746

See Appendix (Graph)
### Table

<table>
<thead>
<tr>
<th></th>
<th>F.I.</th>
<th>F.II.</th>
<th>F.III.</th>
<th>F.IV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.8904</td>
<td>.2111</td>
<td>.9079</td>
<td>.6254</td>
<td>.4096</td>
</tr>
<tr>
<td>.8979</td>
<td>.1828</td>
<td>.5821</td>
<td>.4456</td>
<td>.4096</td>
</tr>
<tr>
<td>.6569</td>
<td>.5221</td>
<td>.6569</td>
<td>.4456</td>
<td>.4096</td>
</tr>
<tr>
<td>.4798</td>
<td>.4456</td>
<td>.4798</td>
<td>.4456</td>
<td>.4096</td>
</tr>
<tr>
<td>.6357</td>
<td>.0</td>
<td>.6357</td>
<td>.4456</td>
<td>.4096</td>
</tr>
</tbody>
</table>

Rotating F.I. & F.II. by 45° in the positive direction.

Cos: .7071  
Sin: .7071

---

<table>
<thead>
<tr>
<th></th>
<th>F.III.</th>
<th>F.IV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.7223</td>
<td>.6753</td>
<td>.6936</td>
</tr>
<tr>
<td>.6888</td>
<td>.0699</td>
<td>.6527</td>
</tr>
<tr>
<td>.7313</td>
<td>.0721</td>
<td>.4949</td>
</tr>
<tr>
<td>.6544</td>
<td>.2871</td>
<td>.0</td>
</tr>
<tr>
<td>.4949</td>
<td>.2078</td>
<td>.3585</td>
</tr>
</tbody>
</table>

Rotating F.III. & F.IV. by 24° in the positive direction.

Cos: .9135  
Sin: .4067

---

<table>
<thead>
<tr>
<th></th>
<th>F.III.</th>
<th>F.IV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.6805</td>
<td>.2250</td>
<td>.6474</td>
</tr>
<tr>
<td>.6735</td>
<td>.2900</td>
<td>.6235</td>
</tr>
<tr>
<td>.6833</td>
<td>.3643</td>
<td>.7563</td>
</tr>
<tr>
<td>.6574</td>
<td>.5732</td>
<td>.6702</td>
</tr>
<tr>
<td>.7024</td>
<td>.0515</td>
<td>.5188</td>
</tr>
<tr>
<td>.3865</td>
<td>.3671</td>
<td>.5272</td>
</tr>
</tbody>
</table>

Rotating F.III. & F.IV. by 45° in the positive direction.

Cos: .7071  
Sin: .7071

---

<table>
<thead>
<tr>
<th></th>
<th>F.III.</th>
<th>F.IV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.3932</td>
<td>.6474</td>
<td>.6235</td>
</tr>
<tr>
<td>.3992</td>
<td>.7563</td>
<td>.7563</td>
</tr>
<tr>
<td>.2109</td>
<td>.6702</td>
<td>.6702</td>
</tr>
<tr>
<td>.6663</td>
<td>.5188</td>
<td>.5188</td>
</tr>
<tr>
<td>.4745</td>
<td>.5272</td>
<td>.5272</td>
</tr>
</tbody>
</table>

---

See E.