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Occupational Choice of Indian and Thai Students

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One question that has often intrigued the social scientists of various hues is related to the problem of occupational prestige. Zytowasky (1969) viewed prestige not as residual in persons who have different occupations but rather as being conferred upon the occupation holder by others. Counts (1925), Hartman (1934), North and Hatt (1947), have studied the problem of occupational prestige. In most of these studies (conducted in the United States), Supreme Court Judges, Physicians, State Governors, Cabinet Members in the Federal Government, Diplomats in the foreign services, Mayors in the Federal Government, Diplomats in the foreign services, Mayors, College and University Professors and Scientists were rated at the top. On the other bottom extreme Was semi-skilled or unskilled jobs, like shoe-shiner.

There have been some cross-cultural studies as well. Inkles and Rossi (1956) compared occupations in six industrially developed countries of Britain, Newzeeland, Japan, Germany, Soviet, Union and United States. Tiryakian (1958) compared the perception of occupational prestige among people from suburban Manila and four seleted rural areas of the Islands. The rating of 30 occupations showed much agreement between the rankings of these people from Manila and other urban industrial countries of the West (vide Inkles and Rossi, 1956).

But that is not the end of the story. There are people who believe that attitudes towards work, professons and jobs vary from country to country and from culture to culture. That is, it may be that individuals' choice for a job is socially conditioned. Sinaiko (1975), for example, observed that in some parts of the

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earth there are "strong biases against task or occupations associated with dirty hands" (p. 162). This may also be because occupational interest has often been linked to childhood experiences (Roe, 1956, 1957) which in turn is a prodnct of value systems in a given seciety. These values and attitudes are often reflected in lower or higher average pay scales of people in different occupations. Sinaiko (1975) further observed, "the one reason for the scarcity of professional engineers among educated Vietnamese is that engineering is considered a low-status occupation" (p. 162). His observation was further generalized by Chapanis (1974) to cover "many Asian countries" (p. 173). His generalization prompted us to conduct this cross-cultural study of liking for various professions among Indian and Thai students.

In brief, there are two lines of thinking in matter of individuals' perception, and the implications, of occupational prestige. The one line of argument envisages that the occupational hierarchy is remarkably stable over time and highly generalizable across age, sex, racial and cultural groupings (Crites, 1969). The other line of argument is (for example, Sinaiko, 1975 and Chapanis, 1974) that which looks upon cultural and national differences in preferences for jobs based on social value systems of individual nations and cultures. So, the aim of this study is to determine as to which line of thinking is more valid.

METHOD

Subjects :—Forty Thai and forty Indian postgraduate students served as subjects. Both of these groups were studying in India at the University of Magadh, Bodh-Gaya. Subjects in both groups, generally, belonged to middle class families of two societies. Their age ranged between 20-29 years, mean age being 26. 3 years. In general, Thai students were older than their counterparts - the Indian students. They all belonged to Arts and Social Science faculties of the university.

Test materials :—The subjects were given a list of sixteen professions/jobs in duplicate. These jobs/professions were alphabatically arranged (See Table 1). One blank column was left against each of the list and the subjects were asked to rank those sixteen professions/jobs according to their (professions' jobs') importence

in their respective societies (an they believed) and also in another column they were asked to rank those professions/jobs in order of their personal likings.

The test-sheet also contained a few questionnaire containing personal questions to ascertain the Subjects' socio-economic status.

Procedure :—Each Subject was individually contacted in his room (of studetns' hostels) and were asked to fill the two columns and answer questions regarding their financial status. They were asked not to discuss the questionnaire with their friends

RESULTS AND DISCUSSION

It is apparent from Table 1 that in their preference for an occupation the subjects generally conform to the parameters of the various jobs in their respective societies. Rank correlations worked out for personal likings and the importance of a job in their societies came to be significantly high (Thais=.85, Indians=.87). As far as the gaps within 'likings' and 'importance in society is concerned the difference between two groups of the Subjects, the Indians and the Thais, were statistically significant (Importance, $t = 5.37$, $p = 0.05$; and likings, $t = 3.27$, $p = 0\ 05$).

Medical profession is ranked highest in the Indian society but only second or third in Thailand. Similarly, Engineering profession is after all not as low in Indian society (rank-5) as it is in Thai society (rank-8 or 9). This confirms Sinaiko's observation but negates Chapanis' generalization. It is interesting that teaching profession is generally rated high in Indian as well as in Thai societies. This fact has a significant cultural overtone, In Indian society teaching profession is generally a low paid job, but they are ranked high perhaps, because of the fact that Indian culture has a rich heritage of high respect for the *Gurus*. In Hindus sacred books teachers are ranked only next to God and higher than even both the parents.

So, Sinaiko's observation that less paying jobs are less respected may not always be true in Asian set up. that is, some jobs carrying low pay may be highly respected depending upon the cultural sanctity attached to it. It is interesting that Agriculture and Government executives are very similarly ranked by Indian sample but, as compared to India, agriculture is a very low ranked profession in Thailand.

Table-1 Showing societal respectability and personal likings for various occupations as indicated by Indian and Thai students.

Sl No	Occupations	THAIS		INDIANS	
		Personal likings	Respect in society	Personal likings	Respect in society
1	Advocates	10	7	10.5	8
2	Agriculture	14	13	8	7
3	Business	5	5	6	10
4	Clerk (Government Service)	8	11	9	12
5	Clerk(private Business Houses)	11	12	14	15
6	College Teachers	2	3	2	2
7	Doctors	3	2	1	1
8	Engineering	9	8	5	5
9	Executive (Government Service)	12.5	6	7	6
10	Executive (Private Business Houses)	6	9	10.5	13
11	Manual Labour	12.5	14	12	16
12	Nursing	15	15	16	11
13	Other Government Services	7	10	13	9
14	School Teachers	1	4	4	4
15	Skilled Labour	16	16	15	14
16	University Teachers	4	1	3	3

All these findings suggest that respectability of profession is not similar in different Asian Countries and no generalization can be made on this scores. Much will depend upon the cultural heritage and level of technological advancement of a particular society. That is, the second line of thinking which emphasizes the role of cultural factors in occupational prestige apears to be more valid as for as the findings of the present work is conncerned.

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With regards.
Chaparis

SIX

The Role of Human Factors Engineering in Underdeveloped Countries, with Special Reference to India

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It is not easy to classify unequivocally a country as developed or underdeveloped. According to Pepelasis, Mears, and Adelman (1961) some underdeveloped countries have the material requisites, human potentiality, and willingness to make economic progress, but they suffer from mismanagement of their resources. Pepelasis et al. argue further that, given proper opportunities and incentives, most of these countries have the potentialities of becoming "achieving societies." This point of view is a good starting point for human factors specialists in developing countries.

To achieve conditions requisite to industrialization and social change, individual and social learning has to be fostered through carefully planned programs of research and development. Alexander (1962) has identified the following seven conditions that must be remedied for economic growth: (1) low per capita income, (2) an unbalanced economy, (3) untapped natural resources, (4) a tradition-oriented culture, (5) a large but untrained labor force, (6) a small amount of capital equipment, and (7) chronic underemployment. To meet such a challenge, McClelland (1961) has suggested a series of psychological objectives:

- The gradual substitution of such conflicting values as "inner directedness" or "caste," with "other directedness" and "market morality."
- The substitution of father-figure dominance by habits of independent choice and action.

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Reprinted from Chapanis, A. (Ed) Ethnic Variables in Human Factors Engineering. John Hopkins U. Press.

- The introduction of ideological reforms to unify other directedness, market morality, and decreased father-dominance.
- The gradual introduction of educational programs with both short- and long-term benefits in the basic skill and knowledge requirements of a technological society.
- The reorganization of fantasy life to conform with a new cultural milieu.
- The more efficient use of existing need achievement resources.

To sum up, the "achieving society" must undertake broad, society-wide programs if it is to industrialize successfully. At the same time, one must be mindful of the differences between the psychological strategies needed for cultural change and the tools needed to create such changes. Programs of financial aid, education, improved roads and transportation systems, and increased communications among the members of a culture are only tools to be used in the fulfillment of strategic objectives. These tools must be coupled with a rational, planned program based on human engineering principles that should in turn be based on the local requirements, habit system, and psychological and anthropometric limitations of a given population.

PART 1: SOME DISTINCTIVE INDIAN CULTURAL AND ECONOMIC PROBLEMS

India is a country with mixed levels of technology. On the one hand, it constructs and maintains nuclear reactors and sophisticated electronic equipment for both military and civilian uses. On the other hand, possession of an automobile is a status symbol to 80 percent of its population. Likewise, since agricultural methods have only started to change, a tractor in rural India, like a car in the cities, is a matter of considerable status. Such extreme diversity has also to be viewed against a background of unique social, human, and behavioral peculiarities.

THE FAMILY AND THE CASTES

Rural India is a closely knit society with commonly shared work and family responsibilities operating through two important social institutions: the family system and the castes. Although there are indications lately that the family is showing some signs of disintegration, it, and not the individual, is still the basic social unit (Datta 1961). Village life is still tradition-bound, and jobs in villages are generally allocated and designed on the basis of family and caste. The son of a carpenter is most likely to become a carpenter, and he will generally inherit from his father not only his job, but his tools and postural patterns. This probably explains why attitudes about regular attendance at work to better oneself and family and a competitive philosophy of life are lacking in this country. In traditional India a job is generally regarded as a family responsibility to such an extent that its performance is shared by all the members of a family. For example, if the father is a blacksmith he will generally be assisted by his son in such auxiliary tasks as assembling and the transport of tools. Moreover, attempts to bring in anyone from outside the family are likely to be resented.

This kind of thinking was responsible for a widespread resistance movement in the Tata Iron and Steel Company (TISCO), Jamshedpur, some time ago. In the end, management acceded to worker demands that in filling all future vacancies the company would absorb at least one descendant of currently employed workers. This practice is still observed in TISCO and certain other companies.

To take another instance, Fraser (1966) states that the failure of a weavers' cooperative started at Barpali Village Service was due in part to the fact that the project technicians, interested only in selecting the best workers, had drawn weavers from two different caste groups that could not by tradition work together.

AGRICULTURE

Indian agriculture is a mixture of the old and the new. Although some farmers use modern tractors, most farmers still use tools that are essentially unchanged from those of a thousand years ago: homemade yokes for oxen, rope from local plants, and iron plowpoints and axeheads fashioned by the village blacksmith. Threshing is often done by oxen walking round and round over stalks of cereal until the grain is loosened sufficiently for winnowing. Alternatively, cereal stalks are threshed by human hands. For the latter purpose a rectangular wooden platform made out of tree trunks is used. The wooden platform is kept on a wooden bed and the grain is threshed by whipping the stalks of cereal on the flat wooden platform (see Fig. 1). This description conveys a significant message: For Indian agriculture we need to consider not only man-machine but man-machine-animal systems.

In rural India, time and labor are abundant resources, while capital to buy modern tools is extremely limited. These realities force Indian ergonomists to concentrate on small tools, with economy as a primary consideration.

HOUSING AND ARCHITECTURE

Thatched huts with mud walls, constructed usually by a family, its relatives, and neighbors, are still the most common kind of shelter in villages. The hutments are generally open to the elements and this, together with the limited kinds of clothing and other protective materials used by the inhabitants, poses some real problems for both building designers and ergonomists (Daftuar 1971*a*). Recently the federal government initiated an

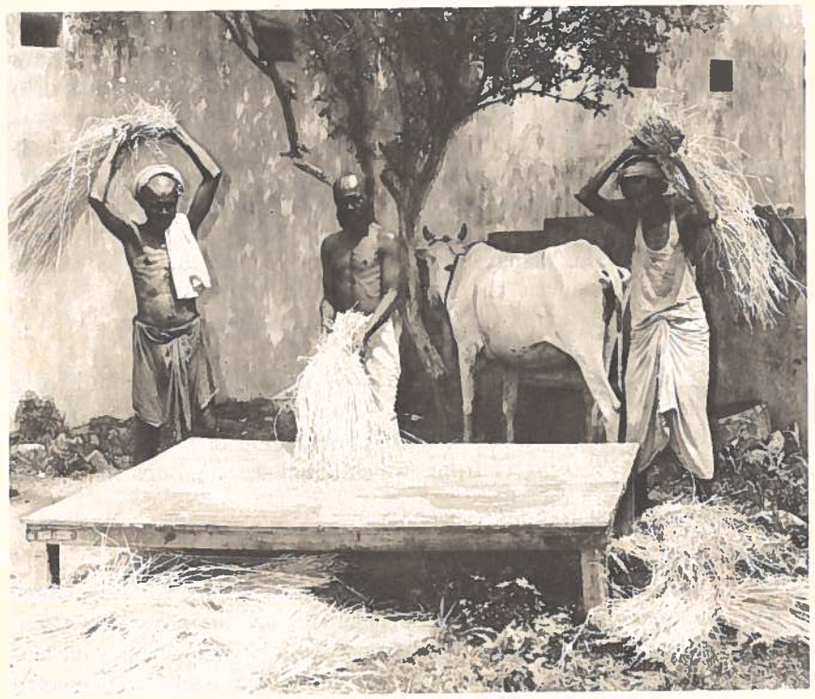


Fig. 1. Threshing by hand in rural India.

extensive program of low-cost housing in rural areas. It has yet to be seen how far this program will solve its human factors problems. One thing is clear: Innovators who bring their own traditions with them may fail to make use of locally available materials and skills and may be responsible for the introduction of housing unsuited to local conditions. India has a hot and humid climate. In cities there is a tendency, due largely to the British legacy, to use western structural and design techniques—heavy bricks with minimal ventilation. Such houses are not only very damp and uncomfortable, but their construction requires skills that are usually not found in local village populations.

CLOTHING

Indian workers, in villages as well as in cities, generally work half clad, exposing their bodies to severe wind and chill. The problem is intensified because a great deal of work in India involves handling materials that are heavy, cold, wet, and rough. Inadequate clothing is a serious problem in mountainous regions, especially for the armed forces. India has a very long border with the Peoples Republic of China. Parts of this border are in the

Himalayas. It is generally recognized that one major reason for the Indian debacle in 1962 was the poor clothing provided for the armed forces who often had to fight in below freezing temperatures.

HOUSEHOLD UTENSILS

The utensils and pottery used by Indian housewives in villages are made of clay. They are usually made by members of the village pottery caste with the help of wheels. Rotation of these wheels is started by a motion of the hands and momentum is imparted to the wheel by a stick held in the hands. The work of pushing the wheels may require a considerable amount of human energy. Fortunately, this method is gradually being replaced due to the increased use of metal utensils in villages as well as in cities.

WORKING POSTURES

Working postures differ among different cultural groups (Tichauer 1963). Indian workers more often squat than stand or sit (Daftuar & Bhan 1966). Figure 2 illustrates some typical working postures. For example, a carpenter working in a saw mill will most probably squat on the ground rather than assume any other working posture. Similarly, a housewife usually prefers to squat on the ground in the preparation of family meals, even if she possesses such modern kitchen appliances as a gas or electric oven. For this reason Ambee Industries (Ahmedabad, India) has designed a gas oven that can be easily manipulated on the ground or, at most, on a platform 12 or 13 cm above the ground. A full description of this stove is given in Part 3 of this paper.

Fig. 2. Typical Indian working postures assumed by a housewife preparing food (*left*) and a carpenter working on wood (*right*).

CONCEPT OF EFFICIENCY

The concept of *efficiency* in Indian thinking is different from what is understood in the West. To refer again to the Barpali Village Service Project, McClelland and Winter (1969) concluded that another reason for the failure of the project was that the norm of efficiency conflicted with caste traditionalism. Raising poultry is a low-caste occupation, and those who engaged in it did not want to improve their performance lest it prevent them from rising socially.

The extended family often forces an enterprising man to spend whatever he has saved on supporting others rather than on investment in business expansion. In traditional India the efficiency of a man is judged not by economic achievements alone but also by the effectiveness with which he maintains his extended family. As a result, job satisfaction in India is generally more directly related to a worker's satisfaction with his home environment than it is in the case of his counterparts in the West (Daftuar 1969).

ANTICIPATING INNOVATION

Another area where human factors engineers can help is in educating and training the masses for innovation. A well-designed learning program can foster better adjustment to rapid technological change. Once again, such programs must be appropriate for local conditions. In India, for example, visual aids should generally not show too advanced technology nor require sophisticated powers of interpretation. Nor should such aids violate Indian customs. A film successful in some areas may fail in India simply because a woman is shown in deep red or in some other very glossy colored dress. In India such dresses are usually worn by brides and by other women on special occasions, such as festivals. A simple peasant woman may be confused by what a festival dress has to do with the purpose of the film. For a country like India it is also essential that as much training be devoted to the maintenance of tools and machinery as to the introduction of technological innovations. Many foreign-made tractors are soon inoperative in Indian villages, because nobody has been properly taught to maintain them. The villagers are trained only to use the tractors.

AUTOMATION

While large-scale automation is increasing rapidly in almost every field in the West, the installation of high-speed computers has become a real problem for various Indian managements. Designing automated jobs in India is not an easy task. A case study (personal communication from U.S. Prasad 1972) of the Life Insurance Corporation of India (LIC) illustrates some special problems peculiar to the Indian scene.

In 1964 the All India Insurance Working Committee discussed the reorganization of LIC's working system and recommended the installation of high-speed computers. The first high-speed computer was installed in

LIC's Bombay Zonal Division in September 1965. That installation resulted in a large-scale strike and a resistance movement among LIC workers across the nation. The strikes were complete and nation-wide. A poll in August 1968 showed that 97 percent of LIC workers favored a general and indefinite strike. Subsequently, an *All India Committee Against Automation* and several other related committees were formed. Five million signatures were collected against automation, and these were submitted to the Indian Parliament. Almost all the political parties, including the then ruling party, and the trade unions of the country supported the movement. In Calcutta, the Ilaco building was virtually in a state of siege for three to four months during 1967–68. Dock workers were not even allowed to unload computer parts. The United Front government (a mixed party government) of West Bengal also refused to allow police to help keep the machine in the building.

The workers' main reason for their resistance was that, according to their estimate, 30,000 employees out of the then existing strength of 40,000 employees were likely to be laid off as surplus or redundant if the computer was put into operation. The government failed to give any assurance against this charge. The workers further argued that both their service security and their chances of promotion were in danger, since there would be no further appointments and hence no expansion of manpower in the corporation. Finally, they argued that high-speed computerization would hamper the servicing of policy-holder accounts because everything would be centralized in the four zonal divisions of Calcutta, New Delhi, Bombay, and Madras.

The crux of the entire case study for our purposes is that while LIC workers still oppose high-speed computerization, the government has gone ahead with the installation of small and medium computers in almost all divisional headquarters of the LIC. Nobody seems to be concerned about them. The lesson appears to be that if you want to design an automated job in India you must start with small or medium automation plans. Indian workers will apparently not object to that. But if the automation is large-scale, involving a very high-speed computer, you are heading for high-speed resistance.

PART 2: SOME STUDIES OF VISUAL DISPLAYS

Now let us turn to summaries of some hitherto unpublished studies of visual displays differing from similar ones published in the West because they involve customs or materials that are distinctively Indian.

THE MEANINGFULNESS OF INDIAN ROAD SIGNS

Indian road signs are, in general, old British road signs. Although the United Kingdom in the meantime switched to international road signs many years ago, Indian road signs have remained unchanged. Indeed,

Indian designers have paid no attention to the problem. The purpose of this study was to assess the meaningfulness of road signs currently used throughout India.

PROCEDURE

Tests were made on forty-five undergraduate psychology students with no driving experience. All the students had normal visual acuity and normal color vision as measured by standardized tests. Their ages ranged from sixteen to twenty-five years.

Out of a total set of 39 Indian road signs (Public Vehicle Department 1962), 25, those illustrated in Figure 3, were used. The remaining 14 were too obvious, or rare, and were dropped. The signs were each photographed in black and white in an actual road setting (see, for example, Fig. 4). The photographs were individually printed on 10.5 × 15.5 cm cards.

The students were tested individually. When a student came into the laboratory, he was first given standardized instructions. Then he was handed the photographs, one by one, and asked to interpret the meaning of the sign shown and to write his interpretation on a specially prepared answer sheet. Each photograph was presented to a subject for one minute and the subject was asked to scan the entire scene while concentrating on the traffic sign. The total experimental session for each subject lasted about 1½ hours and included a 15-minute rest period after the completion of the thirteenth photograph.

RESULTS

Since our sample consisted of students who did not drive, the percentages of correct interpretations of our road signs were naturally smaller than those obtained in comparable studies in the West. In fact, correct interpretations of the Indian road signs varied from zero to 75.5 percent with a mean of 39.9 percent (Table 1). Sign 24 (Fig. 3) was not understood by any subject, and no single traffic sign was correctly understood by all the subjects.

Some road signs were even found to convey meanings opposite to those actually intended. For example, the sign for *No Horn* (17 in Fig. 3) was often interpreted as *Blow your horn please*. The sign for *No overtaking* (16 in Fig. 3) was seldom interpreted as such. This was also the case with the sign for *Road crossing ahead* (24 in Fig. 3).

DISCUSSION

Symbolic displays may contain very little information and may be misinterpreted largely because of their poor design (Brown 1968). In a survey carried out in England, Mackie (1966) found that some symbolic displays were correctly interpreted by as few as 16 percent of drivers. Due to the nature of our sample, we expected still lower percentages. However, the fact that some signs were not correctly interpreted by a single subject calls

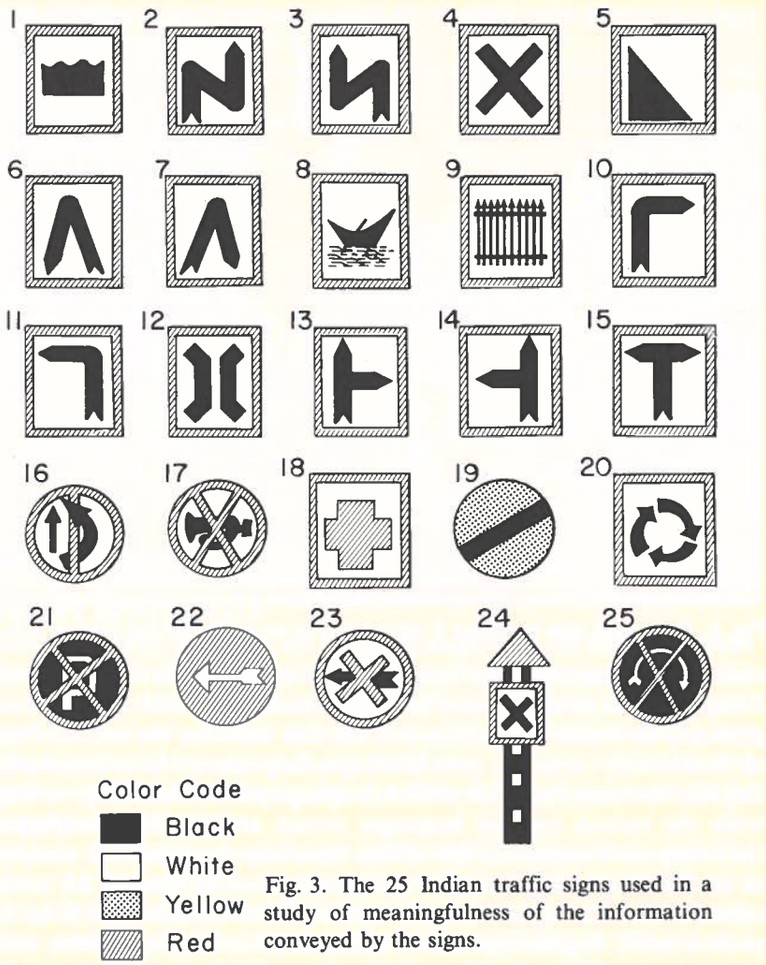


Fig. 3. The 25 Indian traffic signs used in a study of meaningfulness of the information conveyed by the signs.

for an urgent revision in the design of existing Indian road signs. For untrained persons they suffer from serious communication gaps. Since drivers are rarely tested for their knowledge of traffic signs at the time they are given driving licenses in India, the present results can probably be generalized to newly licensed drivers as well.

THE RELATIVE LEGIBILITY OF ALPHANUMERIC CHARACTERS OF ROMAN, ARABIC, DEVENAGARI, AND BENGALI SCRIPTS

India has several regional languages, hundreds of dialects, and many scripts. Under the Indian constitution, Hindi was envisioned as the Indian

Fig. 4. Each road sign in Figure 3 was shown in an actual setting such as this one.

national language because it is common in almost half of the nation. Following independence, the Indian leadership decided to switch over gradually to Hindi. However, when the time came for the switch, a storm of controversy arose in non-Hindi-speaking areas. As a consequence, English has remained the official language of the federal government, while the various regional languages remain as the official languages of their respective states. In the 1960s, there was a widespread movement in the Hindi-speaking areas for the introduction of Hindi at all levels of education and throughout the government. Hindi fanatics went so far as to paint over all English signboards and nameplates in black. Even though Arabic numerals developed originally from the Devenagari script, these fanatics even painted over automobile license plates because they bore Arabic numerals.

Various suggestions have been made for an amicable resolution of these controversies. One suggestion is to use Roman script for all the various Indian languages. Throughout all of these controversies, proposals, and counterproposals, no one has inquired into the scientific merits of these several languages for the practical communication of information. This study was designed to test first the relative legibility of Arabic, Devenagari, and Roman numerals, and second the relative legibility of two Indian scripts, Hindi, spoken by the largest portion of the Indian population and the official Indian national language, and Bengali, having the richest literature among all the Indian languages; and one foreign script, Roman, still used by the intelligentsia and bureaucracy almost all over India.

Table 1. Numbers and percentages of 45 students who interpreted correctly the road signs in Figure 3

Number of road sign	Number correct	Percentage correct	Number of road sign	Number correct	Percentage correct
1	12	26.7	14	22	48.9
2	8	17.8	15	4	8.9
3	6	13.3	16	1	2.2
4	17	37.8	17	17	37.8
5	13	28.9	18	27	60.0
6	12	26.7	19	22	48.9
7	13	28.9	20	11	24.4
8	19	42.2	21	14	31.1
9	34	75.5	22	10	22.2
10	26	57.8	23	9	20.0
11	24	53.4	24	0	0.0
12	28	62.2	25	9	20.0
13	19	42.2			

LEGIBILITY OF NUMERALS

Although Arabic numerals are a foreign script, they are almost a second mother-script for the Indian populace. Even barely literate persons can read and write Arabic numerals as well as their counterparts in Devenagari. Since there was no previous literature to guide us for formulating any specific hypothesis, we expected only that, since we used subjects having Bengali as their mother tongue, the alphabet of Bengali scripts would be most legible for our subjects.

Subjects. Twenty undergraduate and postgraduate students acted as subjects. All belonged to the Bengali-speaking community in Bihar, a Hindi-speaking area. We ensured that all of them knew and were equally familiar with the Roman, Devenagari, and Bengali scripts. They had a mean age of 22.6 years with a range of 18 to 30 years. There were equal numbers of men and women, and they were selected equally from the arts and sciences. All the subjects had normal vision. Corrected vision was not permitted.

Apparatus and test materials. The stimuli were presented with an ordinary tachistoscope. Experiments were conducted in a laboratory and under daylight conditions. Stimuli were printed on white cards in deep black printing ink (see Fig. 5). Three sizes—8-, 10-, and 12-point—were used for all three kinds of numeral. The digits 645, 768, 794, 684, and 975 were reproduced in all three sizes and scripts, yielding a total of 45 stimuli: 5 sets of digits $\times$ 3 scripts $\times$ 3 sizes. The digits 1, 2, and 3 were not tested because they are exactly alike in Arabic and Devenagari.

Experimental procedure. Each subject sat so that there was a constant distance of 76.2 cm between the stimuli and his cornea. This adjustment was maintained with the help of a chin rest. Stimuli were exposed for one-fifteenth of a second.

Tables of random numbers were used to assign a random order to all forty-five cards for the purpose of presentation. This random order was used for half the subjects and the reverse order for the other half.

To get the subjects fully accustomed to the experimental procedures they were given practice trials to the criterion of one correct response. Standardized instructions about the procedures and purpose of the experiment were given.

Subjects were asked to pronounce the digits they saw and their responses were recorded by an assistant as either correct or incorrect. To be called correct all three digits had to be correctly read. Thus, for any one block of five stimuli, the maximum score for a subject was 5.

After every fifteen trials, subjects were given a rest period of 5 minutes. An entire experimental session for one subject lasted about an hour.

Results. An analysis of variance of the data showed that there were highly significant differences among scripts, sizes of type, and the combinations of script and size, that is, the interaction of script with size. The largest single effect, however, was attributable to script (see Fig. 6). The Roman digits were the least legible of those tested. Although the average legibility score for the Arabic numerals was less than for the Devenagari numerals, the difference is small and not statistically significant. Legibility scores tend to increase as the size of type increases, but the exceptions to this generalization are sufficiently large to make a statistically significant interaction. I have no ready explanation for these irregularities in the data.

LEGIBILITY OF THE ROMAN, DEVENAGARI, AND BENGALI ALPHABETS

Subjects. The subjects who participated in this study were the same as those who had participated in the study of numerals.

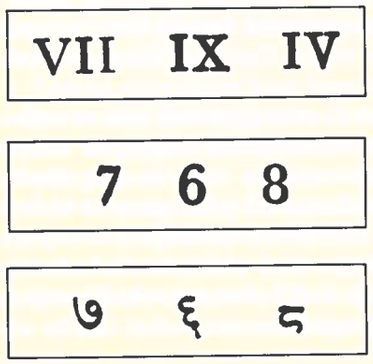


Fig. 5. Example of the Roman (*top*), Arabic (*center*), and Devenagari (*bottom*) numerals. (*Editor's Note*: No attempt has been made to make the sizes of the numerals in this illustration agree with any of the sizes of the numerals tested.)

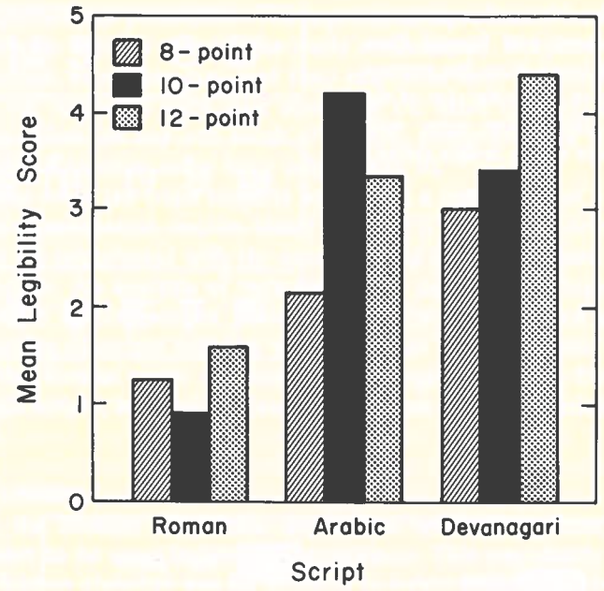


Fig. 6. Mean legibility scores for three types of numerals.

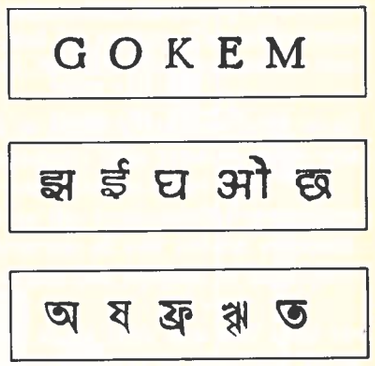
Apparatus and test materials. The same tachistoscope and the same experimental procedure and design were used in this study as in the numeral study.

The stimuli for this experiment were selected on the basis of results from a preliminary experiment to identify CVCVC paralogs of zero association value in Devenagari (Daftuar 1972). Similar five-letter, CVCVC paralogs were selected for the Bengali and Roman alphabets. Ten paralogs of each of the three scripts were used as stimuli. Four point sizes—8-, 10-, 12- and 14-point—were to have been used. However, the present analysis is based on the results obtained with 12- and 14-point printing faces only, because the 8- and 10-point faces for the Bengali scripts were not available in any local press.

We used CVCVC paralogs for two main reasons: (1) to minimize the possibility of bias in favor of any language; and (2) because Hodge (1963) has suggested that five-letter stimulus materials are capable of giving more realistic data than single letters.

The stimuli were printed on white cards in deep black ink. In the case of the Roman alphabet, only upper-case letters were used. Devenagari and Bengali scripts have only one case. Sample cards are shown in Figure 7. A stimulus set consisted of 60 cards, 10 paralogs × 3 scripts × 2 sizes.

Fig. 7. Examples of the Roman (*top*), Devenagari (*center*), and Bengali (*bottom*) scripts. (*Editor's Note*: No attempt has been made to make the size of the letters in this illustration agree with either of the sizes of the scripts tested.)



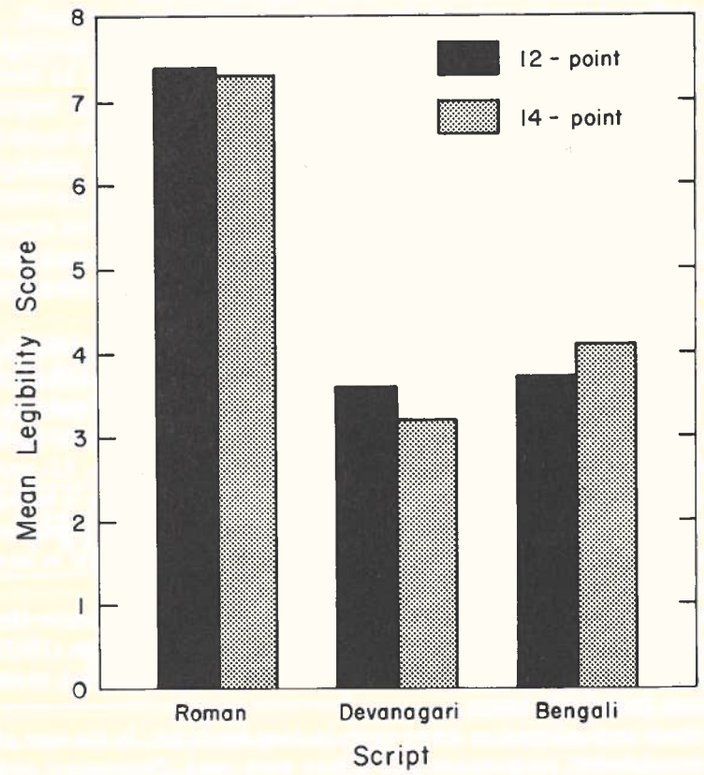


Fig. 8. Mean legibility scores for three types of alphabet.

Experimental procedure. The experimental procedure for this study was exactly the same as that for the study on numerals. Subjects were asked to pronounce what they saw, and their responses were recorded by an assistant. The responses were later scored in the same manner as for the numerals. Thus for any one block of stimuli, comprising ten stimuli in each case, the maximum score for a subject was 10.

After every ten trials subjects were given a rest period of 5 minutes. The entire experimental session lasted about 1½ hr. Two weeks elapsed between the experiment with the numerals and this experiment.

Results. An analysis of variance on the data shows a highly significant difference among scripts. Neither the difference between sizes nor the interaction of scripts with size was significant. The mean data (Fig. 8) show that the Roman script is distinctly more legible than the Devenagari and Bengali scripts, but that the latter two do not differ appreciably from each other.

DISCUSSION

In the absence of precise hypotheses we had expected the Bengali alphabet to be most legible for our subjects. This was clearly not the case. The Roman alphabet was far superior to either Indian alphabet. One likely explanation is that Roman letters are far less confusing in their structure. Out of a total of twenty-six upper-case Roman letters, sixteen are constructed by joining simple horizontal, vertical, or perpendicular lines. In the Devenagari or Bengali scripts, by contrast, there are hardly three or four such structures.

Empirical evidence to support this explanation comes from a comparison of results reported by Hodge (1962) and Howell and Kraft (1959), on the one hand, with those reported by Aziz (1970) on the other. Hodge found very low percentages of confusion among the Roman letters. Similarly, Howell and Craft report a maximum of about twenty percent confusion among Roman letters. By contrast Aziz (1970) reported confusion scores as high as 25.6 percent for the Bengali alphabet under normal laboratory conditions. Since there is a considerable amount of structural similarity between Devenagari and Bengali, it can be assumed that Devenagari would probably yield similar confusion data. Research is needed to test this assumption.

Although these findings are only suggestive, they point to what appear to be some fundamental differences among Indian and Western scripts. This is an exciting area of research that clearly needs to be extended. It may not only reveal important differences in legibility among the various alphabets and numerals of the world, but may also uncover some basic secrets about the workings of human information processing. In any case, much more work of this kind has to be done before we can make truly universal human engineering recommendations about alphanumeric symbols to be used in all cultures and all nations.

PART 3: A DIGEST OF SOME HUMAN FACTORS WORK IN INDIA

The literature on human factors work in India is meager. Readers interested in that literature are referred to reviews by Baumgartel (1966), Daftuar (1969, 1971*b*), and Sinha (1970, 1972). My intention is not to review comprehensively the scanty material available, but rather to mention briefly a few studies that bear directly on the topic of this book. These are studies that are either (a) cross-cultural, that is, that involve Indian subjects and those of some other nationalities, or (b) are concerned with problems that are distinctly Indian in nature. The studies mentioned here are also not generally available in the West.

A STUDY OF FORESTRY WORKERS

A truly cross-cultural field study was conducted under the cooperation of the Institute of Work Physiology, Stockholm, and the Forest Research Institute, Dehradun (Hansson, Lindholm, & Birath 1966) through funds made available by the government of Sweden under an Agreement on Financial Development Cooperation (1964/65). The primary purpose of the study, which lasted for seven weeks, was to compare different saws used by trained forestry workers. Although the study produced a great many results, only the following are relevant to our purposes:

1. Measurements were made of the body weight, height, and work capacity of forest workers from three regions of India and of Swedish and Norwegian forest workers. I have compared these data with similar measurements of Indian textile workers (Sen Gupta & Sen 1964) and coal miners (Chakravarty & Guharay 1965). The Indian workers had body weights ranging from about 46 to 51 kg, as compared with an average of about 72 kg for the Scandinavian workers. The Indian forest workers were also 11 to 13 cm shorter than their Scandinavian counterparts. One conclusion of the study was that logging tools with large physical dimensions are impractical in India.

2. In continuous work, the maximum O_2 consumption per kg of body weight was almost the same for the two samples. However, the maximal aerobic work capacity, expressed in liters of O_2 per min, of the Indian workers was 57 to 67 percent that of the Scandinavians.

3. The Indian system of felling by saw, lopping standing trees, turning logs, and loading timber imposes heavy local loads on the back muscles and hence unnecessary risks of injury.

4. The physiological load was high and the work output was low, with the one-man crosscut saw in felling. This is a one-man task, and sawing with a one-man crosscut saw requires a standing or kneeling position. Considering the work capacity of the Indian forest workers, the relatively harder wood, and the generally larger dimensions of the trees, all of which make it necessary for a man to work in a difficult position for a long time,

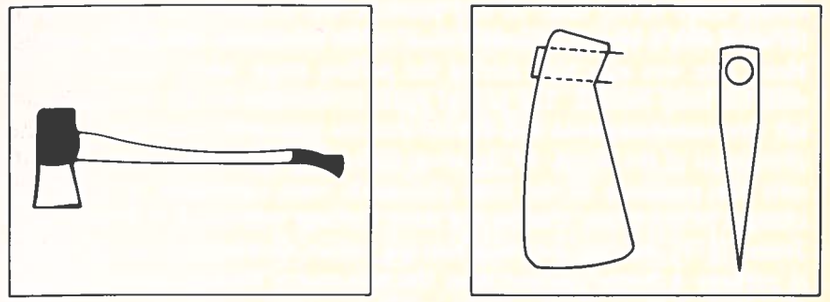


Fig. 9. Swedish (*left*) and Indian (*right*) axes (Hansson, Lindholm, & Birath 1966).

the one-man crosscut saw was not regarded as suitable for Indian conditions.

5. A Swedish axe, the "Saterpilen," and local Indian axes were tested in barking, lopping, and undercutting (Fig. 9). The Swedish type of axe was better than the Indian axe in undercutting and lopping, but for barking the Indian axe proved to be better. This might be because the Swedish axes had sharper and thinner edges, were made of better steel, and had a better balance and shaft. On the other hand, the Swedish axes had too small a back in proportion to the power developed and a bent shaft is unsuitable if the back as well as the edge of the axe is to be used. These drawbacks make the Swedish axe less useful in barking operations.

INDIAN WORKING POSTURES

As mentioned earlier, Indians prefer to work in a squatting posture. Dhesi and Firebaugh (1972*b*) measured the angular positions of various body members in the normal sitting position and in the making of *chapati*, Indian flat bread. Spots of adhesive were placed on various landmarks on the subject's body, the subject was photographed, and tracings were made from the photographs (see Fig. 10). Figure 10 defines the various angular measurements given in Table 2. So, for example, the mean angular deviation of the upper back from the vertical was 35.3°. This increased to 42.4° during the rolling of *chapati*. The data in Table 2 are difficult to relate to anthropometric data in Western human engineering guides, because the working posture illustrated in Figure 10 does not occur in the West.

SOME PHYSIOLOGICAL IMPLICATIONS OF THE SQUATTING POSTURE

In another study, measuring the effect of body position on heart rate, Dhesi and Firebaugh (1972*a*) concluded that significant changes in heart rate occurred in two out of three task conditions for subjects in the squatting position. The greatest increase in heart rate occurred during the

rolling stage of the task. In this position, the subject is required to lean forward with a resultant compression of the abdominal and pelvic organs. Heart rate was also high during the puffing stage, when the subject sits with his body twisted. The partial static contraction of the muscles of the left sternocleidomastoid and deltoid muscles apparently interferes with the circulation of the blood. Of the seven different parts of the body measured, only the positions of the knee and ankle were significant in producing changes in heart rate. Comparing these findings with those of Hanson and Jones (1970), one may conclude that the Indian working posture, squatting, is perhaps a better posture than the customary Western sitting posture. Hanson and Jones tested subjects seated in various postures on a stool and in the squatting position. Although the heart rate was less in the squatting position than in the seated position, their subjects found the squatting posture difficult to maintain.

DESIGN OF A MANUALLY OPERATED HARVESTER

Saran and Ojha (1967) reported the redesign of a harvester to utilize man more efficiently and to match the financial and sociological limitations of rural India (Fig. 11). The harvester is designed for economy, versatility, and simplicity. As the operator pushes the harvester, power is transmitted from the traction wheels to the camshaft through a chain and sprocket assembly. The camshaft drives the cam, which actuates the followers to give a reciprocating motion to the knife. A grass bar pushes the severed stalks to the side. This redesign utilizes human power more efficiently. The human energy requirements are well within the limits of the average Indian farmer, while the working speed and the height of the handle match his physical characteristics.

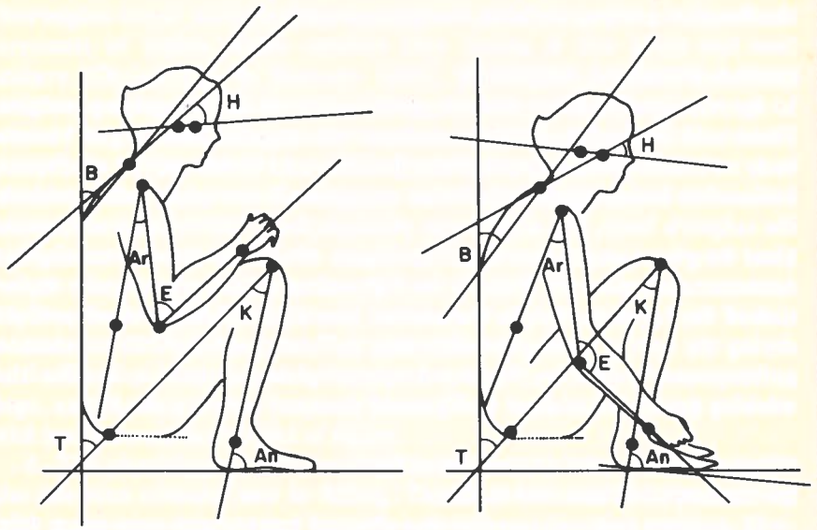


Fig. 10. Tracing of the normal sitting posture of a housewife, showing the various landmarks and angular measurements made (*left*). Outline tracing of the same housewife during the making of *chapati* (*right*) (Dhesi & Firebaugh 1972*b*).

Table 2. Mean angular positions of various parts of the body in the normal sitting position and during ball-making, rolling, and puffing in the making of *chapati* [a]

Positions of body during	Part of the body						
	Upper back (B)	Head tilt and thrust (H)	Armpit (Ar)	Elbow (E)	Thigh (T)	Knee (K)	Ankle (An)
Normal sitting	35.3	36.8	30.7	119.0	44.7	33.6	81.3
Ball-making	39.6[b]	37.5	48.4[c]	87.2[c]	41.6[c]	33.2	85.2[c]
Rolling	42.4[c]	33.7	61.0[c]	143.7[c]	42.9[b]	32.8	85.2[c]
Puffing	37.4[b]	57.2[c]	19.3[c]	94.2[c]	41.5[c]	34.2	85.8[c]

[a] Dhesi & Firebaugh 1972*b*.
[b] Significantly different from the normal sitting position at $p \leqslant 0.01$.
[c] Significantly different from the normal sitting position at $p \leqslant 0.001$.

A KITCHEN STOVE FOR INDIAN HOMES

As mentioned earlier, Ambee Industries (Ahmedabad) has designed a gas oven so that it can be easily manipulated by Indian housewives accustomed to preparing food on the ground in a squatting position. The total length of the gas oven is only 58 cm, the total height, including the flame area, is 13 cm (10.5 cm for the oven and 2.5 cm for the flame area), the width at both ends is 29.5 cm. It has two flame areas, each covering 21 × 21 cm, that is, 441 square cm.

A KITCHEN ADAPTED TO THE INDIAN STYLE OF LIFE

Sinha (N.C.P. Sinha, personal communication, April 2, 1972) has designed a kitchen for his house which fits very well the anthropometric dimensions and the social and economic limitations of a typical Indian middle-class family (see Fig. 12). The entire kitchen area is 4.1 m in length, 1.8 m wide, and 2.3 m high. These dimensions easily fit even the 95th percentile of the Indian female population (Daftuar 1964; Chatterjee & Daftuar 1966). Within this small area the kitchen has a water tub, a three-story rack, storage space for coal and cow-dung fuel, three *Chulhahs* (ovens), a water tap, a small place to wash utensils, and a 30.5 cm high elevation to keep utensils. The kitchen designed by Sinha appears to combine a utilitarian and functional approach. The rising population in India and the increasing migration to cities have posed serious problems of ac-

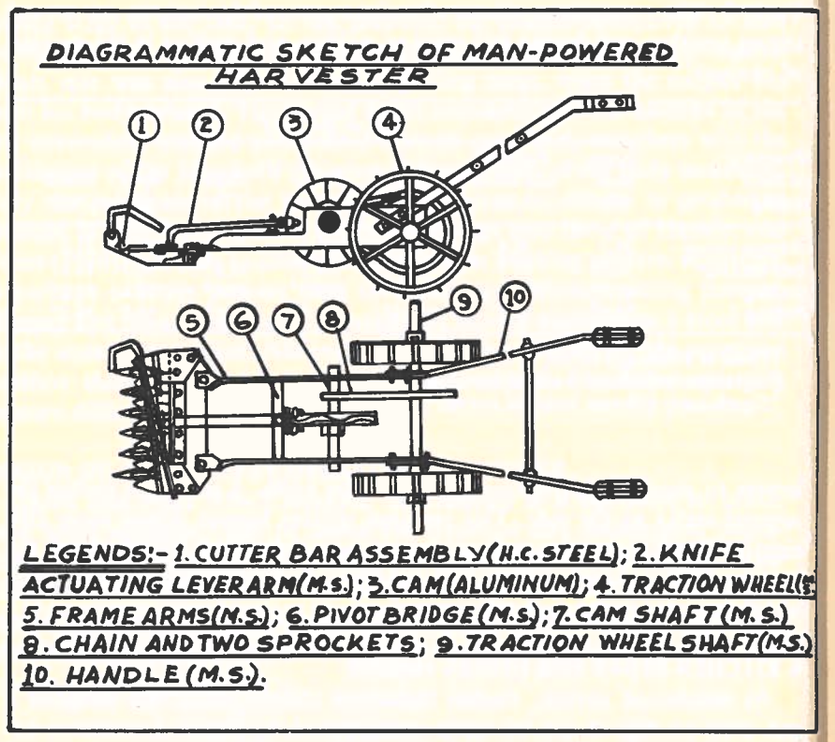


Fig. 11. Diagram of the harvester redesigned by Saran and Ojha.

commodation in this country. While India has abundant time and labor, capital to buy modern technology is seriously lacking. These are the basic conditions that apply to the construction and utilization of Indian buildings (Daftuar 1971*a*). Sinha's design meets at least a part of the problem.

SUMMARY

This paper consists of three principal sections: (1) A discussion of the role of human engineers in facilitating social change in developing countries, with special reference to India; (2) three experimental reports which deal specifically with the theme of the symposium; and (3) a brief survey of Indian work in the area of human factors engineering, with special reference to designs that suit the Indians. Developing countries offer a new field for human factors activities because the effective reapplication of existing human factors knowledge to different levels of technology in newer physical and human environments may require that existing principles be retested and perhaps modified. In so doing, human factors engineers may be better able to bring about desirable social changes throughout the world.

ACKNOWLEDGMENTS

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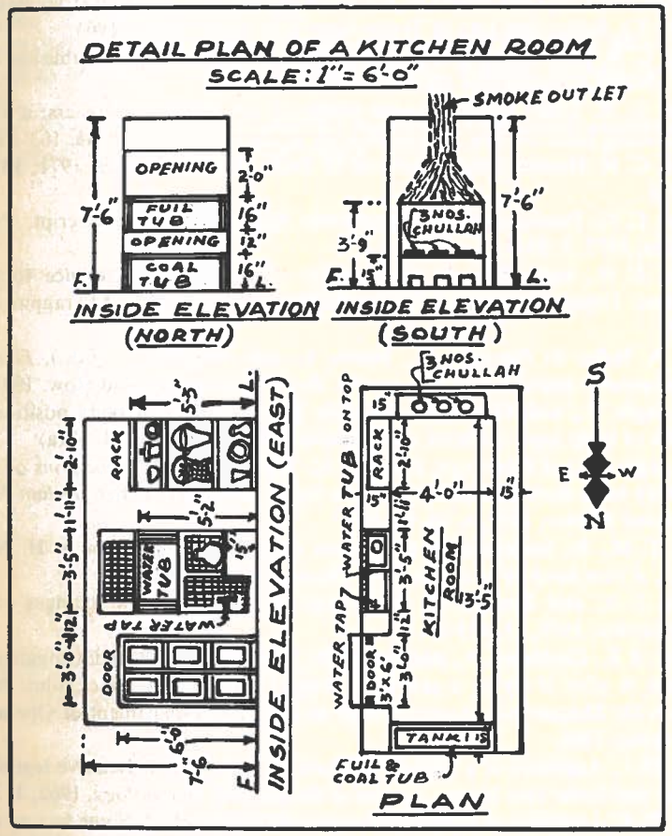

Fig. 12. Diagram of the kitchen designed by Sinha.

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Human Factors Research in India

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This paper covers the published research in the area of human factors in India since 1955 under the following subheadings: (1) physiology and anthropometry, (2) accidents, (3) stress, (4) abilities requirements and performance, (5) decision making, and (6) displays.

INTRODUCTION

In India human factors engineering is still generally called "human engineering," but in more technical circles it is often called "ergonomics." Research in the area of human factors engineering, like the general growth in industrial psychology research, has started gaining momentum in recent years. In 1963 Ganguli (1963, 598) could "come across" just two experimental studies by Indian psychologists in the field of engineering psychology (Adiseshiah, 1957a; Ganguli, 1960). However, it appears Ganguli took the term "human engineering" in a very narrow sense. It is obvious from a few studies referred to in the present paper that some studies other than those cited by Ganguli are now generally considered within the area of human factors.

During these intervening years the situation has changed to the extent that McCormick (1967) has commended our efforts. The Ergonomics Research Society of India has now been formed and the University of Delhi is planning to start a course in aviation psychology. A few noteworthy centers of human factors research are the Defence Science Laboratory, Psychological Directorate, Ministry of Defence, Air Headquarters; the Psychotechnical Cell, Ministry of Railways; the Psychotechnological Research Laboratory, Indian Institute of Technology, Kharagpur; the center established by the author at Gaya College; and the Central Labour Institute, Bombay.

PHYSIOLOGY AND ANTHROPOMETRY

Mukhopadhaya and Sirkar (1958) reported a study of the effect of different phases of cutaneous pain and pressure on respiratory systems with reference to normal muscular conditions leading to fatigue. Pneumographic records during periods of rest, muscular work until complete fatigue is reached, and pain and pressure showed marked relations to specific phases of work leading to fatigue.

Using motion and time study charts, Bhattacharya (1961) tried to determine observer reliability and the usefulness of redesigning workplace layouts. The operators of a Rotor print duplicating machine were observed both in the old and new workplace layouts. The data showed that the new, improved layout significantly reduced the frequency and distance of movements.

In a paper, at a Burg Wartenstein Symposium, Adiseshiah (1966) defined the process of adaptation as "a process of change with the observed tendency for normality to be restored." The adaptation process was viewed in its relation to human needs. It is essentially a change occurring in the way an individual has reacted to his changed environment. The paper discussed the problem of human adaptation with reference to six factors: (1) environmental changes, (2) nutritional factors, (3) physical capacity, (4) mental capacity, (5) social interactions, and (6) aging. It was concluded that "in general, . . . adaptation to the climatic change occurs in nearly everyone within a period of six months." Conditions prevailing in the mountain environment make a change in the food habits of personnel imperative. A change from sharper to softer types of food, from solid or heavy foods to concentrated liquids and tablets which will dissolve easily, and from conventional styles of cooking to the

use of processed and precooked food which can be warmed and quickly consumed, though disagreeable at first, have to become an essential part of diet routine. With regard to speed of action, accuracy of performance, and endurance, there does not appear to be any noticeable difference in the reactions of personnel immediately after their move to the mountain environment and those of personnel who have stayed there longer than six months. Mental efficiency in the mountainous climate is distinctly higher than in a tropical climate. However, mountain regions have the effect of stepping up the anxiety level of personnel. Level of social interaction tends to be high with personnel stationed in mountainous areas, but the level of social interaction tends to drop when the association between individuals continues for long periods. In matters of aging, no overall differences are evident with regard to physical or mental capacities. Older people are superior with respect to observation and judgment, whereas younger people excel in speed of action and endurance. A clear difference is noticed, however, with regard to social interactions: older people appear to be better adapted for social interactions.

However, Bhattacharya's paper lacks precision and many of the generalizations lack sufficient empirical data. Treatment of the data and the general analysis of results contain many vague and contradictory statements. Hence, in spite of its being a pioneer paper of its type in India, and in spite of the fact that it contains many useful and interesting findings, the conclusions should be taken with a certain amount of caution.

In the area of workplace layout from an anthropometrical point of view, a few significant, new, and unconventional studies, even by Western standards, have been reported by Chatterjee and Daftuar (1966), Daftuar (1966, 1969a), and Daftuar and Bhan (1966). The first two works started with the goal of verifying the French architect Le Corbusier's hypothesis of the "human scale." The scale is based on key human body dimensions and is claimed to be the most scientific and natural tool for achieving man-environment compatibility. It was hypothesized that the key body dimensions are intercorrelated among themselves in a ratio of 1:1.617 (Daftuar, 1969a). The late Corbusier observed the same relationship governing all natural objects (Corbusier, 1951). He proposed a new scale of measurement based on this relationship and hoped to achieve greater aesthetic and functional comfort in buildings than is achieved in those built on the basis of present measuring systems of inches and meters. The "modulor" is a harmonious measure of the human scale which is universally applicable wherever measurement matters. He defined his "modulor" as a

> "measuring tool based on the human body dimensions and on mathematics. A man with arms upraised provides at the determining points of occupation of space–foot, solarplexus, head, fingertips of the upraised arms–three intervals which give rise to a series of golden sections, called the Fibonacci Series. On the other hand, mathematics offers the simplest and most powerful variation of values: the single unit, the double unit and the three golden sections" (Corbusier, 1951).

Thus, Corbusier constructed a scale of figures which pinned down the human body at the decisive points of its occupation of space, and called them "anthropocentric."

The first study of the series (Chatterjee and Daftuar, 1966), confirmed Corbusier's hypothesis about the ratio relationship of 1:1.617 to a certain extent. The ratio was also found to be useful in the case of a working situation. For example, the best work efficiency was achieved when the stool and working tables were in this "phi," that is 1:1.617, relationship. As a next step, Daftuar (1966) studied the eye and hand-reach angles relative to different body dimensions in the job of typewriting and concluded that: (1) working heights should be adjusted to make an eye angle of about 30° for the lower edge of the upper level, and the area of eye movements should be about 70°; (2) the eye angles are independent of any variation in different body dimensions; and (3) in such jobs as manual control, hand-reach angles are more important than eye angles.

Iyer and Bhattacharyya (1966) studied body measurements in relation to cockpit design. On the basis of measurements of 22 body dimensions taken on 691 Indian airmen, they found

linear relationships among different body dimensions.

Saran and Ojha (1967) reported the redesign of a harvester to utilize man more efficiently. This manually operated machine was also designed to fit into the financial and sociological limitation of rural India by being designed for economy, versatility, and simplicity. As the operator pushes the harvester, power is transmitted from the traction wheels to the camshaft through a chain and sprocket assembly. The camshaft drives the cam, which actuates the follower to give a reciprocating motion to the knife. A grass bar pushes the severed stalk to the side. This redesign utilizes human power more efficiently, and the human energy requirements are well within the limits of the average Indian farmer while the working speed and handle heights suited his physical characteristics.

Daftuar (1969a, 1970a) attempted to draw general attention to a new, but potent, area of study within the general spectrum of engineering psychology. His paper discussed the psychophysical problems that may be of concern to all those who are involved in design and utilization of buildings and visualized exciting possibilities of developing, what may be called, architectural psychology. The general approach being that the entire situation was conceived as a system. Particular emphasis was placed on anthropometric and physiological problems of workspace, noise, vision, thermal comfort, colour combinations, etc. It was suggested that architects and others involved in the building designer's team should be given proper orientation to these problems as a part of their curriculum.

ACCIDENTS

From the point of view of mechanization and industrialization, India is a relatively underdeveloped country. Hence, the number of industrial accidents is also relatively small in comparison to such advanced nations as the United States. According to Shenoi (1970), as many as 700 persons die and about 3.5% of the total population of industrial workers are injured each year. The average rate of loss due to accidents in India is about 10 to 11 days per man per year.

Banerjee (1956) found a negative but significant correlation (–.54) between accident rate and reaction time, while intelligence was not significantly correlated. An effort was made to correlate word associations and word-association times with accident rates (Kundu, 1958). Associations appeared to be a distinguishing factor as did association times to certain words. Perceptual-motor speed ratio was correlated with accident proneness, confirming Drake's hypothesis (Ghosh and Tripathy, 1965). Tripathy (1967) found only alcoholism to be significantly correlated with accident rates, while age, experience in the plant, and a low level of education were correlated in a non-significant way. In studying the relationship between visual acuity and industrial accidents, Shree Kumar (1967) found that the relationship between accident repeating tendency (personal diathesis to accident) and visual skill (far vision) was so insignificant that visual tests were not a useful device for screening accident-prone workers.

A very exhaustive analysis was made of 11,000 accidents involving the bus drivers of a Bombay transport company in a 12-month period (Ganguli and Kasbekar, 1967). The analysis revealed that more accidents occurred between 11 a.m. and 2 p.m. on Mondays and Wednesdays and in the first week of the month. Accident rates also varied with routes, bus depots, and type and model of vehicle. Age and experience had an effect on accident rate. But after seven year's experience, age had no independent effect, whereas experience had some independent effect even after the age of 40. The nature of occupation before joining the present organization had some influence on accident rate. The results of the study do not lend support to the concept of accident-proneness. Number of days of absence in a two-year period and the number of accidents sustained during that period were correlated. The two matched groups of drivers, one free from accidents and the other with repeated accidents, differed significantly in a number of variables. The accident repeater group had more absences and more violations, but there was no

difference in performance score in driving test at the time of appointment. In the accident repeater group, it was commoner to find drivers who were unmarried, married late in life, had suffered from childhood illness, had other serious illness, had experienced accidents with other employers, and had been prosecuted for traffic violations. Also, there were differences in the living conditions and living space of the two groups–in general, the accident-free group lived in better conditions.

In a similar line, Sinha and Jha (1968) conducted a survey to determine relationships between various personal variables with traffic accident. Fifty bus drivers of Bihar Rajya Road Transport Corporation were randomly distributed into two equal groups, one having had accidents requiring hospitalization, the other a no-accident group. The two groups differed significantly with respect to age, driving experience, and chronic illness of some dependent member of the family. Differences in educational level, number of dependents, and family assets were found to be statistically insignificant. However, as far as the experience variable is concerned, it is doubtful if the two groups were really comparable. The comparison, as presented, is for differences between accident and nonaccident groups having different experience levels and not across different experience levels within the two groups of the sample. The authors also used Mann-Whitney U-test and χ^2 techniques interchangeably for the same types of data without any clear reason.

Bose and Dasgupta (1969) used an interview schedule to examine the role and character of different attitude areas, viz, (1) job satisfaction, (2) social satisfaction, (3) peer relations, (4) life-gestalt, and (5) optimism, with respect to their objective relations with accident-repetition behaviour of Calcutta drivers. The randomly selected sample of 100 drivers had a mean age of 36 years and 8 months, with working experience ranging from 5 to 15 years. It was concluded that the "total score of drivers' attitude is capable of predicting the component behaviour of his attitude gestalt that generates an impulse, negative in character, which may be held responsible for destructive habitual motor release terminating in accident during his professional activity."

The effect of age and fatigue on train drivers is being studied by a special group in the Indian Railways. The psychotechnical group, formed in 1964, began to devise intelligence and other types of tests to help in proper selection of staff. So far, it has been able to develop tests to assess the abilities required of points men, lever men, cabinmen, and steam locomotive drivers (*Times of India,* May 18, 1969).

STRESS

Arousal theory assumes that a man performs best when he is moderately aroused. In this context, a good deal of work has been done in the West (particularly in the U.S.A. and the U.K.) to test the effect of single and multiple stresses on performance. However, in India only a few studies have been reported.

Adiseshiah and Prakash Rao (1955) reported a study conducted on a group of Indian Air Force jet fighter pilots. The pilots were tested immediately before and after their flying exercises by measuring their response times to three arrangements of stimuli presented in rapid succession. The results indicated a slight prolongation in the postflight response times of pilots compared with preflight values. The difference was more marked after "hard" sorties, but very slight after "easy" and "slightly difficult" sorties. Of the various alternative explanations, "transient fatigue" (Grath, Wittkower, and Cleghorn, 1954) appeared to be the most plausible. However, no statistical test was applied to small differences in mean values ranging from 6 to 23 msec.

Results obtained in a number of studies conducted at the Defence Research Laboratory, New Delhi, were described in a paper by Adiseshiah (1958). All these studies point out the role of "speed stress" in flying efficiency by outlining the relative effect of such variables as vision, altitude duration, and perceptual delay. Three results of speed stress were noted: (1) the failure to perceive rapidly occurring changes in the environment; (2) serious breakdowns in the accuracy of decisions, which occur when the time available for making simple decisions fell below 10 sec.; and (3) disruption of the smoothness of skilled action which constitutes the effector phase of the skill. Such remedial measures as experience (adaptation with lapse of time), speeding up of responses by training, perceptual anticipation, and selection and proper training of pilots were suggested.

In combat situations fatigue is the result of abnormal strains, mental excitement, and hurried actions. After pointing out the broad differences between industrial work and combat operations, Adiseshiah (1963) concentrated his discussion around five basic problems: (1) stress caused by the nature of the physical environment, (2) stress due to operational conditions, (3) strain resulting from prolonged actions, (4) human factors in the use of weapons and equipments, and (5) social settings created by forces engaged in combat. It was concluded that irrespective of the nature of fatigue, the fact remains that the capacity for endurance and maintenance of the will to fight are the most potent psychological factors in an individual's struggles against bodily discomfort and mental weariness.

Daftuar (1970b) reported, for the first time in India, a laboratory study designed to measure the effect of 30 hours of sleep deprivation on a vigilance task consisting of auditory and visual signals. It was concluded that (1) sleep deprivation has greater impact in case of auditory signals; (2) when signals are intermixed, reaction time is significantly more effected by sleep deprivation; (3) in intermixed conditions, sleep deprivation has more influence on reaction time when auditory signals are mixed with visual signals than when visual signals are mixed with other visual signals. The phenomena observed in the study cannot be satisfactorily explained in the current state of the art.

Some studies have been reported on the problem of measuring the effect of noise on human performance. Ganguli and Rao (1954), in their study of Indian jute workers, concluded that the adverse effect of noise is a function of the noise not only in relation to the specific task but also in relation to the specific workers.

In a laboratory study conducted to determine the relationship of noise and the nature of task, Kumar and Mathur (1968) observed that a randomly selected sample of 50 subjects (25 males and 25 females) tended to perform mental tasks better under normal conditions. In the case of mechanical task, no significant difference was observed, though the performance of the group was a little better under noise condition. As such, the same level of noise was experienced as more disturbing while working on a mental task. In another laboratory study on a sample of 40 females and 40 males, Kumar and Mathur (1969) found that with the female subjects there was a facilitating effect of noise in a letter cancellation task, whereas in another mental task the deterioration in performance was not significant. With male subjects, on the other hand, there was a deterioration in both tasks under noise conditions.

ABILITIES REQUIREMENTS AND PERFORMANCE

Tyagi (1967), in his first study, used an opinion survey of a sample of flying instructors and officers to determine the skills involved in flying. Just three attributes–(1) muscular coordination, (2) quick grasp, and (3) mental alertness–were considered essential by 50% of the flyers and the instructors. Knowledge of procedures and cool-mindedness were seen as most essential for critical situations.

Another study by Tyagi (1966) was conducted with 44 pilot officers and 39 subjects of other ranks of the Indian Air Force who had applied for commission but were rejected for want of flying aptitudes measured by the Flying Aptitude Test Battery (developed by the Directorate of Psychological Research, Ministry of Defence, New Delhi). The officers varied from 21 to 34 years of age, with service experience varying from 1 to 13 years (mean 5 years) and, flying hours varying from 100 to more than 4,000 hours (mean 745 hours). The subjects were tested on an eye-hand coordination test (mirror drawing apparatus), spatial relation tests, immediate visual memory tests, an immediate auditory memory test, the O'Connor tweezer finger-dexterity test, a can-

cellation test, and a hand-steadiness test. The following sensory-motor attributes were found to be essential for flying: (1) quick movement of the hand and steady grip of fingertips, (2) immediate auditory memory, and (3) steadiness of fingers and eye and hand coordination.

DECISION-MAKING

March and Simon (1958) have emphasized the importance of a concept of rational man in organizations. In India, psychologists have yet to focus their attention to the vital problem as to why and how organizational decisions are taken. To date, just one study has been reported (Daftuar, 1967) on the problem of task structure and management decision-making. Three teams of five subjects each were given two types of management games to play. One type of game was highly involved and complex. A final decision could not be made by one individual. The second type of game consisted of simple problems related to industrial relations which could be solved and decided upon by one person of sufficient intelligence. The aim of the study was to determine the relation of task structure in problem-solving to centrality in decision-making. The author purposely did not say that the team with highest degree of centrality would perform the best. That may or may not be the case, depending partly upon the environment and partly—and more importantly—upon the structure of the team. However, it could be concluded with confidence and certainty that the important influence of centrality is in no way dependent upon the nature of the tasks to be performed—whether complex or simple—for a group having an element of competition among its members. Daftuar failed to support Shaw's assertion that when the task becomes "too complicated to be solved by any central person," the importance of centrality is low (Shaw, 1955). The role of personality factor in group decision-making was suspected.

However, it is premature to draw any generalized picture in the field of management decision-making. India is in need of its own research literature, and it is hoped that at least a few industrial psychologists will be attracted to work in this field.

DISPLAYS

"The Changing Face of the Altimeter" is the title of a review paper by Adiseshiah (1957a), which describes some of the altimeter designs developed during the years preceding 1957 in India as well as in some Western countries. One Indian study, quoted by Adiseshiah, was conducted during the autumn of 1955 to determine the relative visibility of a conventional altimeter design and a modified design adopted by Britain's Royal Air Force. In terms of time taken for each reading, it was observed that speed in reading improved by about 30% with the modified design. A decrease in reading error of approximately the same order was also evident with the modified design. Readers were informed that the British modification was recommended and subsequently accepted by the Indian Air Force. Adiseshiah concluded that the most serious type of reading error, viz, the misreading by a 1,000 ft., was not reduced in the modified design. Differences in error rate for the modified design, compared with the conventional design varied only from −0.2 to +3.5%. The modification merely served the purpose of providing clear visibility of all three pointers at any setting.

Another paper by Adiseshiah (1957b) reported results of experiments conducted at different Indian Air Force stations by the Defence Science Laboratory, New Delhi, to determine the average rate at which correct responses are capable of being given by pilots to signals for action presented under single-channel display conditions. Speed stress was introduced by varying the demand for decisions from 1 to 20 per minute. The sample consisted of three groups of subjects. (1) student pilots having less than 100 hours flying experience, (2) fighter pilots from jet fighter squadrons having flying experience ranging from 300 to 500 hours with 100 to 150 flying hours on jet aircrafts, and (3) flying instructors with 1,000 to 2,500 flying hours on various types of aircraft. Three main findings emerged from this study. (1) The accuracy of a decision broke down seriously when speed in decision-making exceeded the rate of six decisions per minute. (2) There was also a noticeable difference in the performance of the three samples. With student pilots, error rate tended to rise sharply and abruptly once the rate of decisions exceeded six per minute; with jet fighter pilots, the increase in error rate was considerably less abrupt, and certainly not so sharp, until the speed of decision-making exceeded 10 to 12 per minute. Flying instructors stood almost midway between student pilots and jet fighter pilots. (3) There were more errors of underestimation than of overestimation and this finding was more evident with student pilots.

From the third finding, it was concluded that it is not just prolonged flying experience but flying experience at high speed that trains the senses and brain along the lines of expedious accuracy.

Adiseshiah (1957c) reported a study conducted to evaluate a modified altimeter designed by the Royal Air Craft Establishment at Farnborough, England, in which the small pointer was arrow-shaped and the medium pointer had a circular central feature with an opening in the middle. Evaluation was done in terms of speed and accuracy. The findings were as follows: (1) A saving of approximately 30% was effected in reading the modified design compared to the conventional one. (2) A 30% reduction in the rate of error occurred. (3) The most frequent type of error was misreading altitude by a 1,000 feet more than the actual height. The change of design had no effect on the incidence of this type of error. The modified design a a three-pointer altimeter was recommended for the Indian Air Force and the recommendation was implemented. It was also suggested that this higher reading of 1,000 feet occurs due to the anticipatory tendency on the part of the pilots and it can probably be controlled by a modification in dial design in which the next numeral is not visible until the lower adjacent value has been entirely superseded. In other words, the single pointer-counter type of dial was suggested.

CONCLUSION

The total number of references covered in this review is 41, including three foreign papers. Considering the span of years under review, human factors research in India is still in its infancy, especially in relation to such countries as the U.S., the U.K. or even the U.S.S.R. Although an effort has been made to include almost all published material since 1955, this paper should not be considered as complete. The largest volume of research in the area of human factors is being carried out in defence laboratories and their publications are rarely available to the general reader. Aside from the general (7%) and foreign (10%) publications listed here, the classifications of papers is as follows: physiological and anthropometry (27%), accidents (24%), stress (17%), abilities requirements and performance (5%), decision-making (3%), and displays (7%).

The following are the Indian journals which frequently or occasionally publish materials relevant to human factors: *Defence Science Journal*, New Delhi; *Indian Journal of Applied Psychology*, Madras; *Journal of the Indian Academy of Applied Psychology*, Madras; *Journal of General and Applied Psychology*, Patna; *Indian Journal of Psychology*, Calcutta; *Journal of the Aero-Medical Society*, New Delhi; *Indian Psychology Review*, Raipur (previously from Varansi).

In spite of the low volume of publications, if we consider the fact that some very active private and government agencies have developed lately, we cannot help adding in McCormick's words, by way of conclusion, that "... human factors engineering in India now has a very few active friends, and perhaps a number of potential friends" (McCormick, 1967).

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ENGINEERING PSYCHOLOGY IN CROSS-CULTURAL SETTINGS

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Cross-cultural engineering psychology may be considered a new dimension of psychological science. For the first time in 1972, a symposium was organized in Holland at Oosterbeek 'to show how and to what extent human engineering (or ergonomics) principles and practices have been, or need to be, modified to take account of national and cultural differences' (Chapanis, personal communication). A book covering the papers presented in the symposium was edited by Chapanis (1975) and this book may rightly be considered as the beginning of a new stage in the evolution of ergonomics or human factors engineering. With this book, human factors engineering entered into, what may be called, a cosmopolitan era - 'the era in which human factors engineering loses its national parochialism and becomes a sophisticated discipline of the world' (Chapanis, 1975, p. 4).

CAN HUMAN ENGINEERING PRINCIPLES BE CONSIDERED UNIVERSAL?

To date human factors engineering (of which engineering psychology is the most dominant partner) has been largely an American and West-European discipline. Naturally almost all the findings and conclusions of this science are geared to a people who have Western customs, habits and ways of life. But such a state of affairs cannot be considered sufficient if one thinks of the enormous problems that one is most likely to encounter when Western technology is introduced into an underdeveloped country. Back in 1953, Mead edited a manual of some of these problems.

The main purpose of the present paper is to demonstrate the limited applicability of engineering psychology principles and this will be based on case studies, experimental findings and field observations.

PROBLEMS OF LANGUAGE

It is estimated that about 3000 different languages are spoken in the world. Problems related to language communication may be divided into two categories: (i) related to spoken communication, and (ii) related to written communication.

Spoken Communication Oral communication may affect such varied

functions as international air-traffic control systems or performance on an intelligence test. At least one of our experimental findings confirms such an influence of spoken language on intellectual performance. The test VNART (Verbal, Numerical, and Abstract reasoning test) is in Hindi. It was translated into English for administration to 40 Thai students. The test items were read out to them and they had to write answers on the answer sheets. I was myself administering the test, but after covering 20 students the responsibility for conducting the test was given to a Thai student. It was soon realized that after the Thai student had taken over the Thai subjects started performing better. The difference was highly significant ($t = 6.68$; $p < .01$). We suspected that this was due to a type of communication gap created by the vastly different styles of speaking English by an Indian and a Thai. We repeated the same procedure on 40 Indian students. I administered the test myself to one group ($N = 20$) and the Thai student administered the test to another group ($N = 20$). The difference in the mean scores was again highly significant ($t = 9.45$; $p < 0.01$). This confirmed that the differences in our style of pronounciation caused the difference in the performance of different groups of subjects. The mean I.Q. of Thai students was higher when the test was administrated to them by their native colleague and the mean I.Q. of the Indians was higher when they were given the test by me.

Ruffell Smith (1968) reported a study of this type of language problems in international aviation. In this study he noted the number and kinds of errors that occurred from the use of speech for air-to-air, air-to-ground and ground-to-air comnnunications. He suggested: 'it seems more likely that errors would be more frequent when both the speaker and the listener did not have English as their native tongue, Ruffell Smith (1975) further concluded that these problems were by no means solved and that variations in spoken English are responsible for a great deal of confusion, uncertainties and perhaps even accidents in air traffic.

The information we get from Human Engineering Guides (for example, VanCott and Kincade, 1972) about speech communication are generally about male American voices speaking American English. We have absolutely no engineering psychology (or engineering) information about the speech characteristics of the great majority of the spoken languages of the world which would enable us, for example, to design effective speech communication systems for these languages.

Written Communication Problems related to written communication have been categorized under three separate headings (Chapanis, 1974). They are:

(1) Differences in Alphabet: In the Oosterbeek symposium Hanes (1975) suggested that keyboards (of typewriters) for international use must at least accommodate the basic alphabets, such as Arabic, Greek, Hebrew, Katakome, and Roman. Even within a single alphabet, special symbols and characters are required to satisfy variations peculiar to some cultures and languages. For example, in the United States the signs $ and ¢ are common, in Britain £ and p, and in India Rs. and P. In addition, common characters within a basic alphabet may be assigned to different positions on a keyboard for historical reasons. The operator may have to operate typewriters designed in different

nations or cultures. Such a situation implies all the vexing problems associated with the transfer of training.

(2) Content Problems: The second major class of problems is associated with meanings and with the content words available in a particular language. One and the same word may mean different things at different places. Such problems become far more serious if more than one language is taken into account. Many languages have surprising paucity of technical terms. For example, several Indian languages are rich in contents dealing with literature, history, philosophy and the arts, but they are deficient in technical vocabulary. As a result translators who translate technical material into Hindi or in some other Indian languages have to use several stratagems to overcome the lack of proper words. Sinaiko (1975) reported similar problems in case of Vietnamese. In India, the Central Commission for Scientific and Technical Terminology has so far designed and published half a million Hindi equivalents of technical terms relating to natural and social sciences and humanities including professional subjects.

(3) Problems Related to Translation: Sinaiko and Brislin (1973) tried to estimate the accuracy with which technical instructions written in one language could be translated into another (Vietnamese). They assumed that the quality of a translation was directly proportional to how well (or poorly) it assisted a technican. The task used was a complicated series of adjustements of a portion of a helicopter engine. Their subjects were 72 Vietnamese airmen who had been trained as helicopter mechanics, and a group of 18 American technicians who had received a similar training. Three-man teams, either Vietnamese or American, were randomly selected and assigned to work with one or another of four sets of written communications. The data suggested that working in one's native language, instead of second tongue, and quality of translation are both contributing to efficiency.

VIGILANCE AND OTHER SIGNAL DETECTION PERFORMANCE

We all know that ethnic variables operate in our perceiving and attending behavior. Some supposedly universal phenomena too have been found to be influenced by ethnic variables. For example, geometrical figures such as the Müller-Lyer illusion have been found to be susceptible to cultural factors (Segall et al., 1966). Vigilance is a related phenomenon. To the best of my knowledge, there is not much research to decide whether or not vigilance performance is influenced by cultural factors. I know of only one such study in India by Jha (1976) which throws some light on this problem. He measured vigilance performance in terms of (i) correct detection, and (ii) rate of false alarm of subjects selected on the basis of differences with respect to seven different personality factors including extraversion and introversion. The subjects were tested under normal and sleep-deprivation conditions. Jha's results are striking on two counts, sleep-deprivation had a deteriorating effect on performance of all the subjects and the effect of sleep-deprivation on the Indian sample seemed to be more pronounced than on Western subjects. In addition, this study showed, contrary to Western findings, that extraverts and introverts differed in their performance due to sleep-deprivation significantly, the former performing poorly.

With respect to the first finding it may be mentioned that I found similar results on subjects performing (reaction-time) under normal and sleep-deprivation conditions (Daftuar, 1972). One possible explanation for this difference is that Indian students (mostly belonging to middle class in our sample) as compared to Western students suffer from vitamin deficiencies. Several of our (student) subjects found it extremely difficult to sustain even 24-hours of sleep-deprivation (Jha, 1976).

CONTROLS AND DISPLAYS

In most of the books dealing with ergonomics or human factors engineering, topics of control and display are dealt with separately. I combine them because I view them as essentially related processes in most engineering circumstances.

The relationship between a control movement and the effect which is expected by most members of a population is known as a 'population stereotype' (Fitts, 1951). Work in this area was reviewed by Loveless (1962) but he could not point to any study which tested control-display compatibility with reference to cultural variables and concluded that it is difficult even to formulate low-level generalizations with some confidence.

I know of only one relevant study by Verhaegen et al. (1975). They reported data regarding direction of movement stereotype collected on Algerian and Moroccan workers, Moroccan girls and boys and Negro groups. Fifty percent of non-Negro groups (muslim subjects) wrote as much French as Arabic (from right to left), the other 50 percent were only able to write their names and had learned to do this in Latin characters (left to right). The Negro groups had various degrees of exposure to Western culture.

Verhaegen et al. concluded that by and large Africans exhibited the same movement preferences as Europeans. Only one result showed some cross-cultural element in it. There was a difference between Negro-men and Negro-boys and adolescents, with the younger subjects exhibiting stronger movement preferences. There may have been a generation gap due to differences in education. The other results were consistent with Western recommendations.

There are several problems associated with display designs which may be related to cultural factors. For example, relative legibility of various alpha-numeric characters, and meaningfulness of symbols, and figures.

Legibility of numerals and letters is an old problem in ergonomics, even predating the field of ergonomics itself. The handbook of Cornog and Rose (1967) on alpha-numeric characters and other symbols has references dating back to 1898. However, as any other, this handbook too contains data related to English-speaking persons only. Virtually no data, except our own studies are available on the comparative legibility of different alphabets.

In my earlier experiments (Daftuar, 1975) I worked with Bengali speaking students who also knew both the Devanagari and the Roman alphabet. Letters and digits of different sizes (8-, 10-, 12-, and 14-points) were

tachistoscopically presented to our subjects. The results indicated that the Roman alphabet was significantly more legible than either Devanagari or Bengali. This is very interesting because English was not my subjects' mother tongue.

Similarly, we tested the legibility of 3-digit stimuli of Roman, Arabic, and Devanagari digits on the same sample. There were highly significant differences among scripts, sizes of type, and the interaction of script with size. The largest single effect, however, was attributable to script. Although the average legibility score for the Arabic numerals was less than for the Devanagari numerals, the differences were small and not statistically significant. Legibility scores showed a tendency to increase as the size of types increased.

I also tested the legibility of 5-digit Arabic and Devanagari numerals of varying sizes (Daftuar, 1976). Arabic numerals yielded significantly higher legibility scores for all point sizes. Within points, differences between means for Arabic numerals, were significant in all cases except (8- x 10- and 10- x 12-points). On the other hand, in case of Devanagari numerals means were significantly different from each other in only two cases (8- x 12-points and 8- x 14-points). Legibility scores distinctly rose with increase in size in both cases.

In spite of the fact that my subjects were Indians, Arabic numerals were more legible to them. I suspect that this might be due to structural variations because, at least five digits (4, 5, 6, 7 and 8) of Arabic characters are simpler in structure. A similar explanation may apply in the case of the alphabets. The Roman alphabet is simpler in structure than either Devanagari or Bengali.

We have also conducted experiments with 5-digit and 5-letter stimuli materials to test their legibility with subjects from different cultural origin - India and Thailand. With respect to letters, the Thais and Indians differed significantly. In all sizes (8-, 10-, 12-, 14-points), the Indian sample obtained higher mean legibility scores. All differences, except one (10-points) were statistically significant. It is most interesting that the Thai subjects obtained higher mean legibility scores on all sizes of digits except one (14-points).

At present I cannot explain, why Thai subjects were inferior to Indians in the case of letters but were superior in the case of digits.)

ADOPTION OF NEW TECHNOLOGY AND RESISTANCE TO CHANGE

The available research data suggest that human beings are capable of adapting to highly technological society and that they can learn to operate and maintain highly sophisticated equipment. Psychological capacity to absorb technical training is not limited by race or ethnic group. On the other hand, it is also true that people in various cultures have been found to resist technological and social change in different degrees and in different styles and patterns. For example, in 1964 the All India Insurance Working Committee discussed the reorganization of LIC's working system and recommended the installation of high-speed computers in its zonal offices. The first high-speed computer was installed in LIC's Bombay Zonal Division in September, 1965. That installation resulted in a large-scale strike

and a resistance movement among LIC workers across the nation. The strikes were complete and nationwide. A poll in August, 1968 showed that 97 percent of LIC workers favoured a general and indefinite strike. The workers' main reason for their resistance was that, according to their estimate, 30,000 employees out of the then existing strength of 40,000 employees were likely to be laid off if the computer was put into operation. While LIC workers still oppose high-speed computerization, the Government has gone ahead with installation of small and medium computers in almost all divisional headquarters of the LIC. Nobody seems to be concerned about them. A survey by Pestonjee et al. (1971) is also relevant to these observations.

In this context I would also like to refer to a social-cultural study of 155 Bantu Mine recruits from Sotho areas in South-Africa carried out by Glass (cf. Wyndham, 1975). Approximately 60 percent of this group remained conservative and tribally oriented. These men, in consequence, were not interested in learning new skills or in seeking promotion. The other 40 percent of the sample was 'forward looking' and preferred to work in secondary industries in South-Africa because of the greater opportunities for learning new skills, for getting promoted, and for earning higher pay. It is obvious that successful introduction of new ergonomic principles in the work environment depends upon the willingness to accept changes among the workers concerned.

Other evidence for the assumption that man everywhere is capable of adapting to new technological demands comes from an interview survey conducted by Sinaiko (1975). He had about 100 interviews with people who had an extensive experience of introducing technology in countries like the Philippines, Turkey, India, Nigeria, and Thailand. These informants could think of no inherent limits to the absorption of technical information and the acquisition of new skills. They believed that people of these countries can be trained for any sophisticated technology. Sinaiko cited several examples where multinational companies had been able to train people from those countries in maintenance and operation of sophisticated equipment.

Social and technological changes in developing countries depend on the resistance to change as well as on the capacity to absorb any technological advancement. We must be mindful of the difference between the psychological strategies and the actual tools needed to bring about such change. Programmes of financial aid, education, improved roads and transportation systems, and increased communication among the members of a culture are necessary for the fulfilment of strategic objectives. However, they must be coupled with rational, planned programmes based on engineering psychology principles that should in turn be based on the local requirements, habit systems, and psychological and anthropometric limitations of a given population.

ATTITUDES TOWARDS WORK AND PROFESSION

Attitudes towards work, profession and jobs vary from culture to culture. In some parts of the earth there are strong biases against tasks or occupations associated with 'dirty hands'. These attitudes are often reflected in lower average pay scales of people in such occupations. Sinaiko (1975) observed, 'One reason for the scarcity of

professional engineers among educated Vietnamese is that engineering is considered a low status occupation' (p. 163). His observation was further generalized by Chapanis to cover 'many Asian countries' (1974, p. 173). A cross-cultural study of liking for various professions among Indian and Thai students was carried out by Daftuar and Chandra (1976). Forty Thai and forty Indian post-graduate students (both groups studying in India) were asked to rank sixteen professions according to their (estimated) importance in the subjects' own society. The students were also asked to rank the professions according to their personal liking. The results have been summarized in Table 1.

Table 1

Ranks for societal respectability and personal liking of various occupations as indicated by Indian and Thai respondents (After Daftuar and Chandra, 1976)

Occupations	Thais (n = 40)		Indians (n = 40)	
	Personal liking	Respect in society	Personal liking	Respect in society
1. Advocate	10	7	10.5	8
2. Agriculture	14	13	8	7
3. Business	5	5	6	10
4. Clerk (Government Service)	8	11	9	12
5. Clerk (Private Business Houses)	11	12	14	15
6. College Teacher	2	3	2	2
7. Doctor	3	2	1	1
8. Engineering	9	8	5	5
9. Executive (Government Service)	12.5	6	7	6
10. Executive (Private Business Houses)	6	9	10.5	13
11. Manual Labour	12.5	14	12	16
12. Nursing	15	15	16	11
13. Other Government Services	7	10	13	9
14. School Teacher	1	4	4	4
15. Skilled Labour	16	16	15	14
16. University Teacher	4	1	3	3

It is apparent that in their preference for an occupation the subjects generally conform to their respective societies. Correlations between the two ratings showed a value of .87 for the Indian and .85 for the Thai sample. In terms of personal liking as well as 'importance in society' the Indian and the Thai sample differed significantly. Engineering is not as low in India (rank-5) as it is in Thai society (rank-8 and 9). This confirms Sinaiko's observations but tends to negate Chapanis' generalization. It is interesting that the teaching profession is generally rated high in both societies. This fact has a significant cultural overtone. In Indian society teaching is generally a low paid

job, but it is ranked high perhaps because of the fact that Indian culture has a rich heritage of high respect for the Gurus.

I would like to suggest that respectability of a profession and people's attitude towards it are not necessarily similar in different Asian countries and that few generalizations can be made on this score. Much depends upon the cultural heritage and the level of technological advancement in a particular country.

In traditional India, a job is generally regarded as a family responsibility to such an extent that its performance is shared by all the members of a family (Daftuar, 1975). Moreover, attempts to bring in anyone from outside the family or caste are likely to be resented. That means, the caste system in India may have throttling effects. Fraser (1966) states that the failure of a weavers' co-operative started at Barapali Village Service was due in part to the fact that the project technicians, interested only in selecting the best workers, had drawn weavers from different caste groups that could not by tradition work together.

CULTURALLY BASED CUSTOMS, PRACTICES AND ABILITIES

Various groups of people have gradually, through the generations, developed their own typical ways of thinking, of behaving and of living and these have become accepted as natural in their respective cultures. For example, even working postures differ among nations. In the West, industrial workers will use either a sitting or standing posture. In most Asian countries, however, people work in squatting posture, sitting on the ground.

In a study, measuring the effect of body position on heart rate, Dhesi and Firebaugh (1972) concluded that significant changes in heart rate occurred under some of the task conditions with the subject in the squatting position. When comparing these findings with those of Hanson and Jones (1970), one may conclude that the Indian working posture, squatting, is perhaps a better posture than the customary Western sitting posture. Hanson and Jones tested subjects seated in various postures on a stool and in the squatting position and found lower heart rate in the squatting position than in the seated position, but, their subjects found the squatting posture difficult to maintain.

Different regions have their own history with respect to technology and this has produced differences in practices as found in different parts of the world. Westerners who have travelled in India are full of stories about the near accidents they have had with Indian traffic because they automatically look and move the 'wrong way'. The same thing may happen to an American travelling in, say, Britain.

Another striking feature of many non-Westerners, including Indians, is that they appear to have little regard for preventive maintenance. Machines are used until they break down. So, in these countries, preventive maintenance needs much more emphasis in training for both operators and managers. This fact has serious implications for selection of equipment to be transferred from Western countries. It may be better to accept somewhat lower performance in a system if maintenance demands can thereby be greatly reduced.

There appear to be some genuine differences among certain ethnic groups in the way they can perceive, judge or learn things. And these have implications for engineering psychologists. For example, Dart (1972) made some anthropological studies of the Nepalese. He observed: 'The villagers use no other kind of map; they do not use drawing in constructing a building or a piece of furniture, in fact they hardly use drawing or spatial representations at all, and lack of spatial models is very natural' (p. 54). Dart's observation is, at least to some extent, correct and is perhaps to that extent applicable to Indian villages also. These villagers do not use any diagram or map, but when they are asked to explain their proposed building or furniture they take help of a sort of 'informal' diagrams, signs and gestures. They are perhaps capable, and may be trained to use drawings, but customarily they do not use such diagrams.

An interesting finding about the Bantu-speaking groups in South-Africa had been reported by Winter (1963). She reports that safety posters whose intent and meaning could be grasped immediately by Europeans, were completely unintelligible, or even completely misunderstood by Bantus.

Road Signs

Another example, relevant in the context of this paper, is a study of Indian road signs. We selected 45 under-graduate students having no driving experience to test the meaningfulness of Indian road signs. The percentages of correct interpretations of the signs was smaller than those obtained in comparable studies in Western countries with subjects having driving experience. In fact, correct interpretations of the Indian road signs varied from zero to 75.5 percent with a mean of 39.9 percent. One sign was not understood by any subject, and no single traffic sign was correctly understood by all the subjects. Some road signs were even found to convey meaning opposite to those actually intended (Daftuar, 1975). This situation may have disastrous implications but, in India, very few accidents are known to have occurred due to misinterpretation of traffic signs. This means, that training plays a crucial role in the interpretation of the symbols or figures. The low rate of correct identifications by the untrained subjects may partly be due to the fact that the Indian road signs were designed by foreigners who reflected their own frame of referen in these designs.

It may be apparent from the above discussion that there are certain differences in perceptual, judgmental and learning capacities of people of different cultures although there is a strong need for caution in the interpretation of cross-cultural data.

THE ROLE OF ENGINEERING PSYCHOLOGY IN SOCIAL CHANGE

Customs, habits, and styles of life are changing everywhere and changing fast. This is particularly true in Asian and African countries. They are in a state of ferment. It is an important question how engineering psychologists could be helpful in bringing about a social change in the desired direction, and also whether we should help in designing for the societies as they are today, or for the societies of the future that we want to build.

Sinaiko (1975) has given some suggestions for the human factors

scientists who find themselves working in a cross-cultural setting which may be equally valid for engineering psychologists. They are:
(1) Do not assume that design or training principles that have proved useful in one country are equally valid in another. This is the more important as cultural distance widens.
(2) We should become familar with the accumulated knowledge in cultural anthropology. There is a wealth of knowledge of non-scientific experience among businessmen and others who have worked in settings initially foreign to them. That may be fruitfully used.
(3) There is an urgent need for more experimentation in cross-cultural settings. But, here I will like to struck a note of warning: a local scientist of each country, who is concerned with cross-cultural research, must be involved in the interpretation of data.

Some underdeveloped countries have the material requisites, human potentiality, and willingness to make economic progress, but they suffer from mismanagement of their resources. Given proper opportunities and incentives, most of these countries have the potentialities of becoming 'achieving societies'. This point of view may be a good starting point for human factors specialists in developing countries (Daftuar, 1975).

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