Title: ERGONOMICS AND ECONOMIC DEVELOPMENT

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Ergonomics is necessary at all stages of economic development. For some considerable time, it was involved in the very design of new tools and new artisanal machines without specialists appearing necessary. Indian ergonomics in the second half of the 20th century achieved world-wide fame through the attention it paid to the physical work of the most underprivileged, in particular with the Calcutta School of Work Psychology with R.N. Sen.

The spectacular development of the Indian economy led to India being classified as one of the NICs ("New Industrialized Countries") whose economic power is constantly increasing. It should be noted that, of all the different countries in the world, it is actually in the NICs that ergonomics has reached the level of the ergonomic activities of countries which were industrialized long before: India, Japan, Korea, China and the countries of South East Asia in Asia, and Brazil and Mexico in Latin America.

Problematics which differ from one country to another have appeared since ergonomics began to develop extensively in Asia. This diversity is not surprising in view of each of the civilizations on which the development of the various countries of Asia is based. Ergonomics that is strongly developed and well integrated in the Indian civilization is vital not only for India's human and economic success but also for the appearance of a modern world that is multicentred and hospitable for those who build it.

Technical developments over the last 25 years (automation, computerization) require a corresponding transformation of ergonomic knowledge and practices, as has been noticeable in all countries which suffered the same technological upheaval. In particular, the study of human thought, cognitive ergonomics, is vital in order to improve the relations between "natural" intelligence and artificial intelligence. This represents a research effort that is both significant and fascinating in order to have a better understanding of the natural intelligence in India which, like elsewhere, is an intelligence highlighted by culture. This investigation will lead to great progress in matters of answering questions raised by the transfer of foreign technologies and the creation of purely Indian technologies (Anthropotechnology).

However, the effort of adaptation to new industrial production methods should not be made at the expense of continuation of the remarkable efforts made by Indian ergonomists in regard to the poorest.

KEYWORDS: ERGONOMICS, COGNITION, ANTHROPOTECHNOLOGY, CULTURE, INDUSTRIAL DEVELOPMENT

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Paris, le 21 St March 1988

Dr Asis Goswani
Faculty of Sports Sciences
Netaji Subbash National Institute of Sports
Moti Bagh
Patiala 147 001 Punjab
India

Dear Dr Goswamy,

Thank you for your kind letter of February 25th. It is a pleasure for me to read about your successes and projects. Of course I would be delighted to give an advice to the Institute of Management at Kharagpur if it can help you to become assistant professor.

I dont work about human posture or EMG now. But I have used some of your interesting data in a paper that will be soon published by Industrial Ergonomics. The translation I send you is not in very good english. Another version will be published.

Truly yours.

A. Wisner

41, RUE GAY-LUSSAC — 75005 PARIS — ☎ 033-18-27, 033-83-94

Prof. Alain Wisner
Professor of Ergonomics and
Work Neuro-physiology
Department des Sciences de I'Homme
au Travail
Conservatoire National des Arts et Metiers
41 Rue Gay-Lussac-75005
PARIS.

February 25 1988.

Respected Professor,

Kindly forgive me for spoiling a part of your precious time. I am proud of the fact that my Ph.D. thesis was examined by a distinguished person like you. Many thanks for taking the trouble and sending the comments so early. After the viva voce examination by Prof. R.N. Sen, Calcutta University has admitted me in the degree on Nov. 23 1987.

During the viva voce, Prof. Sen had asked me many questions and suggested improvements which I should have added in the thesis. If only I had received such suggestions before submission, the quality of my thesis would have been better. Also I under stand there are many mistakes in my thesis which even I can identify now. I request you to kindly send me your comments on my thesis so that I can take care in my future research works.

I don't know how to inform you about one mistake I hade made very recently. I have applied for the post of Assistant Professor in the Department of Industrial Engineering and Management at Indian Institute of Technology, Kharagpur, West Bengal, India, and for which I have proposed your as one of the referee. I should have taken your consent before such proposal. Unfortunately, the last date for the submission of the application was so near that gave no scope of foreign correspondence. I am ashemed and request you to kindly forgive me. I am enclosing a copy of the advertisement and my biodata, also a few publications for your kind perusal.

I shall be obliged if you can send me a few of your recent publications related to human posture and EMG.

With warm personal regards to you,

Yours faithfully,

Goswami

(A. Goswami).

Mailing Address:

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Netaji Subhash National Institute of Sports
Moti Bagh
Patiala 147 001 Punjab
India.

CURRICULUM VITAE

Asis Goswami, Ph.D.

I. Personal Data:

Father's name	: Sri Kalipada Goswami
Birth Date	: March 24 1956.
Birth place	: Midnapore Town, West Bengal, India.
Citizenship	: Indian
Marital Status	: Married
Number of Children	: One Daughter
Home Address	: Present H/O.- Dr. Hardial Singh 10 Preet Nagar Lower Mall Patiala 147 001, India. Permanent C/O- Sri Kalipada Goswami 32 Khudiram Nagar Midnapore 721 101 West Bengal, India.
Office Address	: Department of Physiology Faculty of Sports Sciences Netaji Subhash National Institute of Sports Moti Bagh Patiala 147 001, India.

II. Education:

Year	Degree	Subject	Institution	Board/University
1987	Ph.D.	Physiology	University College of Medicine, Calcutta.	Calcutta University
1976	M.Sc.	Physiology	University College of Science, Technology & Agriculture, Calcutta.	Calcutta University
1974	B.Sc.	Physiology(H) Zoology Chemistry	Midnapore College, Midnapore, W.B.	Calcutta University
1971	H.S.	Beng., Eng., Ph., Ch., M., Biol.	Vidyasagar Vidyapith School, Midnapore.	W.B. Board of Secobdary Education, W.B.

Details of Ph.D. thesis:

Title: Bioengineering/Ergonomic evaluation of different types of mobility aids for lower extremity handicapped.

Guide: Dr. S. Ganguli, Hony. Bioengineer, Bioengineering Unit, University College of Medicine, Calcutta University.

III. Academic appointments:

Year	Position	Institution
March 1978 to July 1979	Lecturer in Physiology	Vidyasagar College, Calcutta, India.

IV. Research Positions held:

Year	Position	Institution
Jan. 1978 to Feb. 1979	Honorary Research Scientist	Department of Physiology, Calcutta University, Calcutta, India. Under the guidence of Prof. R.N. Sen.
Nov. 1979 to March 1983	Research Assistant	Bioengineering Unit, University College of Medicine, Calcutta University, Calcutta, India. Under the guidence of Dr. S. Ganguli.
May 1983 to Sept. 1986	Research Assistant	Occupational Physiology Division, National Institute of Occupational Health, (ICMR), Ahmedabad, India.

Present employment

Sept. 23 1986 onwards	Junior Scientific Officer	Dept. of Physiology, Faculty of Sports Sciences, Netaji Subhash National Institute of Sports, Patiala, India.

V. Professional Training:

Year	Period	Institution	Sponsorer
1977		Regional Labour Institute, Calcutta, on 'Industrial Safety and Hygiene'.	Calcutta University.
1984		Central Labour Institute, Bombay, India, on 'Development of Anthropometric Standards for Indian Workers', conducted by Prof. K.H.E. Kroemer of Virginia Polytechnique, USA.	National Institute of Occupational Health, (ICMR), Ahmedabad.

IV. Professional Training (contd):

Year	Period	Institution	Sponsorer
1987		Blue Star Ltd., Hewlett Packard Division, New Delhi, on "Measurement Automation through HP-IB".	Netaji Subhash National Institute of Sports, Patiala.

V. Professional Affiliation:

Year	Position	Organisation
1983	Member	Physiological Society of India, Calcutta.
1987	Founder Member	Indian Society of Ergonomics, Calcutta.
1988	Applied for Membership	South-East Asian Ergonomics Society, Bankock, Thailand.

VII. Research work done in areas:

Ergonomics/Human Factor Engineering
Work Physiology
Sports Physiology
Evaluation and development of mobility aids for lower extremity handicapped.
Evaluation of heat stress and heat acclimatization in man.
Electromyographic studies on man at rest and work.
New approach in operational research for motion economy, postural equillibrium and work safety in industry.
Methods for classification of human posture.

VIII. Current Project:

1. Identification of the involvement of different muscle groups in various sports activities.

IX. Student counseling:

1978-82 Two students per year on informal basis to help planning and executing M.Sc. dessertation at Calcutta University.

1983-85 Helped in planning and executing Ph.D. dessertation of Mr. C.K. Pradhan, ARO, NIOH, Ahmedabad, worked under the guidence of Dr. P.K. Nag, SRO, NIOH, on informal basis.

X. Honours and awards:

1974-76 Recipient of National Loan Scholarship awarded by the Government of West Bengal, India.

XI. Other activities:

Hobbies Listening and playing music; book reading.

Abstracts in National and International Symposia:

1. Sen, R.N., S. Basu and A. Goswami : An ergonomic design of Hand-Pulled Rickshaw. Proc. of Ind. Sc. Cong. Ass., Section of Physiology, 1979.

2. Goswami, A., A.K. Ghosh and S. Ganguli : Energy cost of tricycle driving. Proc. of Symposia on Biomedical Sciences, and Engineering, Jadavpur University, Calcutta, Dec., 1981.

3. Goswami, A., A.K. Ghosh and S. Ganguli : Estimation of physical working capacity of the severely handicapped by means of arm crank ergometry with modified seat design. Proc. of Ind. Sc. Cong. Ass., Section of Physiology, 1982.

4. Banerjee, A.K., A. Goswami, A.K. Ghosh and S. Ganguli : Performance evaluation of KHO-KHO players by simulated exercise tests. International Congress of Sports Sciences, NSNIS, Patiala, 1982.

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Papers published:

1. Tibarewala, D.N., A.K. Ghosh, A. Goswami, S. Ganguli and K.S. Bose Biomechanical and bioenergetic studies on human gait - a new approach. Medical and Life Science Engineering (India), vol.5, no.2, 81-92, 1979.

2. Ghosh, A.K., D.N. Tibarewala, S.R. Dasgupta, A. Goswami and S. Ganguli Metabolic cost of walking at different speeds with axillary crutches. Ergonomics (UK), vol.23, no.6, 571-577, 1980.

3. Goswami, A., A.K. Ghosh and S. ganguli : Assessment of a handicapped mobility aid by means of heart rate. Journal of the Institution of Engineers (India), vol.62, pt IDGE-3, June, 55-57, 1982.

4. Banerjee, A.K., A. Goswami and S. Ganguli : Performance Index - A systematic approach in athletic evaluation. Proceedings of 'All India Seminar on New Dimensions in Physical Education & Sports', Department of Physical Education, University of Kalyani, 70-73, 1983.

5. Goswami, A., A.K. Ghosh, S. Ganguli and A.K. Banerjee : Aerobic work capacity of the disabled Indians. Ergonomics(UK), vol.27, no.12, 1267-1269, 1984.

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7. Nag, P.K., C.K. Pradhan and A. Goswami : Ergonomics in railway track maintenance. Special Report, National Institute of Occupational Health, Ahmedabad, p22, 1985.

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ERGONOMICS, 1984, VOL. 27, NO. 12, 1267–1269

Aerobic capacity of severely disabled Indians

By A. GOSWAMI, A. K. GHOSH, S. GANGULI

Bioengineering Unit, Department of Orthopaedics, University College of Medicine, Goenka Hospital, Calcutta University, 145 Muktaram Babu Street, Calcutta 700 007, India

and A. K. BANERJEE

Department of Physical Education, University of Kalyani, Kalyani, West Bengal, India

To study the oxygen uptake capacity, the arm crank ergometer test was administered at three different loads, 25, 37·5 and 50 W, on seven severely disabled subjects, and their cardiorespiratory responses were compared to that of nine normal subjects (work loads, 25, 50 and 75 W). Values of $\dot{V}O_2$ of the disabled subjects corresponding to heart rates of 150 and 180 beats min^{-1} were significantly lower than those of the normal subjects, when expressed in l min^{-1}, but disappear when the results are expressed in ml $kg\ min^{-1}$. The observations indicate a reduced work capacity and a capacity for increasing the stroke volume of the disabled subjects.

1. Introduction

Measurement of aerobic capacity can be useful in assessing the effectiveness of rehabilitation in disabled people. This has often been reported for patients with ambulation disabilities (Wood 1976, Ganguli *et al.* 1973, 1974, James and Nordgren 1973), and even for more severely affected patients in Western countries (Peizer *et al.* 1964, Glaser *et al.* 1980, Cerny *et al.* 1980). Only two studies have been reported from India, despite the high incidence there of severe disabilities due to polio and trauma, on confining patients to wheelchairs or tricycles for mobility. Goswami *et al.* (1982) compared the efficiency of different types of tricycles by studying heart rates during propulsion and observed that a cranking system located in the middle-front position of the user was more convenient than cycles with a cranking system located on the left or right side of the user. Nag *et al.* (1982) showed a circulo-respiratory demand of more than 60% of the maximum capacity of disabled subjects when driving tricycles with cranking system on one side of the user.

This present study was performed to extend the work previously reported, and to measure indices of aerobic capacity in severely disabled Indians.

2. Subjects and methods

Seven severely disabled subjects confined to a wheelchair or tricycle were studied. Their paraplegia had been caused by polio (6) and trauma (1). Nine normal sedentary subjects were studied for comparison. Their physical characteristics are shown in the table.

Each subject performed a standard arm crank exercise test on a bicycle ergometer at three different work rates: 25, 50 and 75 W for the normal subjects and 25, 37·5 and

Physical characteristics of subjects.

Variable	Control ($n=9$)	Disabled ($n=7$)	Diff.	Significance level
Age (years)	25·7 ± 2·3	31·7 ± 9·9	6·0	NS
Height (cm)	166·0 ± 7·0	133·0 ± 14·0	33·0	S
Weight (kg)	54·4 ± 5·6	39·4 ± 3·6	15·0	S
Heart rate at 50 W (beats min^{-1})	137·0 ± 15·0	169·0 ± 9·0	32·0	S
$\dot{V}O_2$ at 150 beats min^{-1} (l min^{-1})	1·28 ± 0·17	0·89 ± 0·1	0·39	S
$\dot{V}O_2$ at 150 beats min^{-1} (ml kg^{-1} min^{-1})	23·6 ± 2·2	22·5 ± 1·0	1·1	NS
$\dot{V}O_2$ at 180 beats min^{-1} (l min^{-1})	1·77 ± 0·2	1·15 ± 0·1	0·27	S
$\dot{V}O_2$ at 180 beats min^{-1} (ml kg^{-1} min^{-1})	29·2 ± 2·8	26·8 ± 1·3	2·4	NS

50 W for the disabled subjects. Heart rates (using precordial ECG electrodes) and oxygen consumption (from expired air analysis) (Consolazio *et al.* 1963) were measured in the last minute of a 5 min period at each workrate. Ten minutes of rest was allowed between each run.

For each subject heart rate was plotted against O_2 consumption, and the regression line drawn. Values of $\dot{V}O_2$ were read off at heart rates of 150 beats min^{-1} and 180 beats min^{-1}, which is near to the predicted maximum heart rate.

3. Results

The table shows that the disabled subjects were older, shorter and lighter than the controls. The heart rate at 50 W and the $\dot{V}O_2$ corresponding to heart rates of 150 and 180 beats min^{-1} for each group are also given, and the two latter variables are also expressed as oxygen consumption per kilogramme body weight. The difference between the two groups of subjects is significant for the heart rate at 50 W, $\dot{V}O_2$ at 150 beats min^{-1} (l min^{-1}) and $\dot{V}O_2$ at 180 beats min^{-1} (l min^{-1}). The differences in oxygen consumption disappear when the results are expressed per kilogramme body weight.

4. Discussion

This study shows a substantial reduction in the aerobic capacity of disabled Indian subjects. In contrast to the result with normal controls, 50 W arm exercise is close to maximum working capacity of the disabled subjects, giving them a heart rate of 169 ± 9·0 beats min^{-1}. Nevertheless, the value of 1·151 min^{-1} maximal oxygen consumption in these disabled subjects is greater than the 0·781 min^{-1} reported by Nag *et al.* (1982) for a similar group. The reduced work capacity means that wheelchairs and tricycles for the disabled require to be efficiently designed to allow maximum mobility. Significantly higher heart rate at a work rate of 50 W of the disabled subjects also indicates a reduced capacity for increasing the stroke volume.

Acknowledgments

The work reported here has been carried out with financial support received from the Ministry of Social Welfare, Government of India. The authors acknowledge the help and assistance received for this work from their colleagues at the Bioengineering Unit and are grateful to Professor K. S. Bose, Head of the Department of Orthopaedics, University College of Medicine, University of Calcutta, for encouragement.

Afin d'étudier leur capacité aérobique, une épreuve sur ergomètre à bras a été administrée à 7 sujets fortement handicapés. Trois charges ont été appliquées: 25, 37,5 et 50 watts. Leurs réponses cardiovasculaires ont été comparées à celles de 9 sujets normaux (charges de travail, 25, 50 et 75 watts). Les valeurs de la $\dot{V}O_2$ des sujets handicapés et correspondants à des fréquences cardiaques de 150 et 180 battements min^{-1} étaient significativement plus basses que celles des sujets normaux lorsqu'elles sont exprimées en $l\,min^{-1}$, mais la différence disparaît lorsqu'on les exprime en $ml\,kg\,min^{-1}$. Ces résultats montrent, chez les sujets handicapés, une capacité de travail réduite, ainsi qu'une capacité d'accroître le débit sanguin.

Zur Ermittlung der Sauerstoff-Aufnahme-Kapazität wurden bei 7 schwerbehinderten Personen Armergometer-Versuche bei der Belastung mit 25, 37,5 und 50 Watt durchgeführt. Die kardiorespiratorischen Reaktionen dieser Personengruppe werden mit denen einer Personengruppe von 9 Nichtbehinderten verglichen. (Belastung 25, 50 and 75 Watt). Die Sauerstoffaufnahme der Behinderten, deren Herzschlagfrequenz bei der Tätigkeit zwischen 150 und $180\,min^{-1}$ betrug, war signifikant niedriger, als die der Vergleichsgruppe. Dieser Unterschied war allerdings nur vorhanden, wenn die Sauerstoffaufnahme in $l\,min^{-1}$ berechnet wurde, er verschwand, wenn die Sauerstoffaufnahme auf das Körpergewicht bezogen wurde ($ml\,kg\,min^{-1}$). Diese Beobachtungen zeigen, daß die Arbeitskapazität von behinderten Personen reduziert ist durch die verminderte Fähigkeit zur Erhöhung des Herzschlagvolumens.

重度身体障害者7名の酸素摂取量を調べるために，上腕クランクエルゴメータ試験を3段階の負荷レベル，25，37.5，および50Wで行い，その心臓呼吸器系の反応を正常者9名の反応（作業負荷，25，50，および75W）と比較した。心拍数が150および180拍/minの時の身障者の酸素摂取量 $\dot{V}_{O_2}$ は毎分の値で見ると，正常者の値より有意に低い値を示したが，mℓ kg/minで表現すると差は見られなかった。実験より身障者の低下した作業能力と一回拍出量を増加させるための能力とが観察された。

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To Prof. Alain Wisner
with regards.
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Anthropometric characteristics of disabled and normal Indian men

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Keywords: Anthropometric characteristics; Disabled men; Indian men; Normal men.

This paper describes a preliminary study of the anthropometric characteristics of disabled Indian men, undertaken in order to facilitate the design of mobility aids. Fourteen anthropometric measurements were made in 61 men with disabilities of the lower extremities caused by poliomyelitis or spinal cord injury, and in 140 normal men. The study reports reduced growth of the affected parts and also some acquired deformity in the upper limbs. Inter-correlations between the body dimensions were different in the disabled and normal groups.

1. Introduction

The design of mobility aids for people suffering from disabilities of the lower limbs requires data concerning their physical and physiological limitations. A number of studies have described the latter (Asmussen and Molbech 1954, Gordon 1958, Erdman *et al.* 1960, Asmussen 1968, Ganguli *et al.* 1973, James and Nordgren 1973, Ganguli *et al.* 1976, Ghosh *et al.* 1980, Glaser *et al.* 1980, Nag *et al.* 1982, Goswami *et al.* 1984) but data about the physical dimensions of disabled people are scanty. This is probably because of the wide variety of disabilities encountered and the frequent need for personalized design of aids. Most studies have been performed in Europe and North America (Floyd *et al.* 1966, US Department of Health, Education and Welfare 1968, Kenward 1971, Goldsmith 1976, Institute for Consumer Ergonomics 1981), but few data have been reported for disabled people in India (Goswami *et al.* 1986). This preliminary study has been undertaken to establish the anthropometric characteristics of Indian disabled men to facilitate the design of mobility aids.

2. Materials and methods

The subjects of the present study, who were all volunteers, consisted of 61 males suffering from lower limb disabilities and 140 normal males. Since the purpose was to provide anthropometric data for the design of mobility aids, all the disabled subjects were wheelchair or tricycle users affected by poliomyelitis or spinal cord injuries. Anthropometric dimensions were measured with the Martin anthropometer, spreading caliper, slide caliper or steel tape, using the method of Damon *et al.* (1971). For subjects unable to stand erect unaided, stature was measured with the subject supported against a wall and precautions were taken against the bending of the trunk and knees.

3. Results

Table 1 shows the mean and distributions (standard deviation, s.d.) of the anthropometric measurements in the disabled and normal subjects. Mean values of all

Table 1. Anthropometric measurements of disabled (DI, $n=61$) and normal (NI, $n=140$) subjects.

Measurements	Mean		s.d.		5th percentile		50th percentile		95th percentile	
	DI	NI	DI	NI	DI	NI	DI	NI	DI	NI
(1) Age (yrs)	24·4	23·7	3·8	2·8	—	—	—	—	—	—
(2) Weight (kg)	41·4	54·3	5·4	6·1	31·8	45·0	41·6	53·3	50·0	66·6
(3) Stature (cm)	139·2	165·2	17·5	4·8	110·0	154·0	141·0	164·8	163·3	175·0
(4) Acromial height (sitting) (cm)	47·3	56·6	6·8	2·6	33·0	50·4	48·1	56·8	56·4	62·4
(5) Elbow rest height (right) (cm)	18·1	21·2	2·3	2·2	13·6	17·6	18·3	20·9	21·2	26·4
(6) Popliteal height (right) (cm)	38·4	42·7	3·4	2·2	34·3	38·9	37·7	42·4	46·5	47·4
(7) Buttock–knee length (cm)	48·4	54·7	2·6	2·1	45·4	51·3	48·2	54·5	54·0	58·4
(8) Buttock popliteal length (cm)	39·9	45·1	2·8	5·2	35·6	41·4	39·9	44·8	44·7	48·7
(9) Arm grasp (Max.) (cm)	67·9	70·8	5·7	5·2	57·4	61·2	67·2	70·7	76·2	79·8
(10) Arm reach from wall (cm)	79·9	81·9	4·9	4·3	69·4	74·5	77·9	82·1	87·4	89·0
(11) Elbow-to-elbow breadth (cm)	38·2	37·6	2·7	3·7	33·4	30·7	38·2	37·9	43·4	44·0
(12) Hip breadth (cm)	28·3	30·8	2·2	2·1	24·4	25·4	28·4	30·4	33·4	34·7
(13) Hand breadth at thumb (cm)	9·3	9·5	1·4	0·3	7·0	8·4	9·3	9·5	11·7	10·3
(14) Hand thickness at metacarpal III (cm)	2·6	2·4	0·1	0·1	2·2	2·0	2·5	2·3	2·9	2·6

these dimensions, except for the elbow-to-elbow breadth and hand breadth at the thumb, were significantly lower in the disabled group than in the normal group. The disabled group displayed a greater variability. The ninety-fifth percentile values for body weight, stature, acromial height, buttock–knee and buttock popliteal length in the disabled group were lower than the respective fiftieth percentile values for the normal subjects. The fiftieth percentile values for elbow rest height and popliteal height in normal men were between the fiftieth percentile and the ninety-fifth percentile values of the disabled group. The ninety-fifth percentile values of maximum arm grasp and arm reach from the wall in the disabled men was a little higher than the fiftieth percentile measures in the normal men. Elbow-to-elbow breadth did not follow this overall trend. The fifth and fiftieth percentile values of this dimension were a little higher in the disabled group than in the normal group, but the ninety-fifth percentile

Table 2. Correlation matrix of the body dimensions of normal individuals.

	(1)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)*		0·54	0·18	−0·04	0·29	0·15	0·23	−0·02	0·07	0·09	0·48	0·21	−0·29	−0·15
(2)			0·46	0·11	0·35	0·26	0·58	0·32	0·16	0·1	0·52	0·42	0·17	0·17
(3)				0·28	0·41	0·55	0·52	0·7	0·3	0·24	0·03	0·24	0·23	0·26
(4)					0·38	0·32	0·08	0·22	0·18	0·09	−0·2	−0·24	0·06	0·16
(5)						0·1	0·06	−0·06	−0·13	−0·1	−0·04	−0·07	−0·09	−0·09
(6)							0·37	0·57	0·33	0·21	0·17	0·33	−0·11	0·12
(7)								0·65	0·42	0·44	0·51	0·43	0·05	0·09
(8)									0·42	0·4	0·12	0·23	0·16	0·25
(9)										0·86	0·27	0·22	0·03	0·11
(10)											0·27	0·21	−0·05	−0·11
(11)												0·57	−0·01	−0·05
(12)													0·17	−0·01
(13)														0·38

* The serial number of the dimensions corresponding to those in table 1.

Table 3. Correlation matrix of the body dimensions of disabled individuals.

	(1)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)		0·08	−0·04	−0·22	0·0	0·27	−0·01	−0·22	−0·13	−0·3	−0·06	−0·2	−0·32	−0·001
(2)			0·83	0·17	0·27	0·07	0·42	0·13	−0·23	0·02	0·1	0·24	−0·19	−0·42
(3)				0·25	0·37	0·04	0·39	0·06	−0·05	0·11	0·08	0·23	−0·16	−0·13
(4)					0·61	0·0	0·08	0·16	0·2	0·26	0·18	0·22	−0·03	−0·01
(5)						−0·26	0·39	0·06	−0·07	−0·07	0·002	0·22	−0·11	0·04
(6)							0·07	−0·08	0·08	0·17	0·28	0·02	−0·01	0·37
(7)								0·5	−0·09	−0·21	0·07	0·29	−0·06	−0·28
(8)									−0·08	0·15	−0·18	0·22	−0·12	−0·55
(9)										0·75	0·1	0·08	0·21	0·4
(10)											0·1	0·17	0·19	0·07
(11)												0·36	0·44	0·5
(12)													0·17	−0·08
(13)														0·3

* The serial number of the dimensions corresponding to that of Table 1.

Table 4. Anthropometric measurements among normal Indian (NI), US civilian (USC) and British car drivers (BCD).

Measurements	5th percentile			50th percentile			95th percentile		
	NI	BCD	USC	NI	BCD	USC	NI	BCD	USC
(1) Body weight (kg)	45·0	58·0	58·0	53·3	73·3	75·0	66·6	94·1	98·0
(2) Stature (cm)	154·0	162·6	162·0	164·8	173·7	173·0	175·0	185·1	185·0
(3) Acromial height (sitting) (cm)	50·4	57·3	—	56·8	62·1	—	62·4	66·8	—
(4) Elbow rest height (cm)	17·6	—	19·0	20·9	—	24·0	26·4	—	30·0
(5) Popliteal height (cm)	38·9	—	39·0	42·4	—	44·0	47·4	—	49·0
(6) Buttock–knee length (cm)	51·3	56·3	54·0	54·5	61·1	59·0	58·4	65·9	64·0
(7) Buttock popliteal length (cm)	35·7	—	44·0	39·9	—	50·0	44·7	—	55·0
(8) Arm reach from wall (cm)	74·5	—	—	82·1	—	—	89·0	—	—
(9) Elbow-to-elbow breadth (cm)	30·7	—	35·0	37·9	—	42·0	44·0	—	51·0
(10) Hip breadth (cm)	25·4	33·6	31·0	30·5	37·3	36·0	34·7	42·1	40·0

value was lower. For the hip breadth dimension the fifth, fiftieth and ninety-fifth percentile values were lower in the disabled group. The fifth and fiftieth percentile values of hand breadth at thumb were found to be lower among the disabled persons, whereas the ninety-fifth percentile value was higher in this group. All the percentiles of hand thickness at metacarpal III were higher among the disabled persons. Correlation matrices for the dimensions of the normal and disabled groups are given in tables 2 and 3, respectively. The pattern of inter-correlations among the measurements was found to be different in the normal and disabled groups. Among 91 inter-correlations 38 were statistically significant in the normal group, whereas only 17 were significant in the disabled group. The highest correlation was observed between maximum arm grasp and arm reach for the normal group, but was between weight and stature for the disabled group. Also, the correlation between hand breadth at thumb and hand thickness at metacarpal III was lower in the disabled group than in the normal group. Significant correlation was observed between stature and maximum arm grasp of the normal group, but that of the disabled group was low and negative.

The data of the normal group obtained from the present study were also compared to those of British car drivers (BCD) (Haslegrave 1979, 1980) and the US civilian population (USC) (McCormick 1976); all the data are presented in table 4. Most of the values for the fifth, fiftieth and ninety-fifth percentiles of the normal group were found to be lower than those of the comparable measurements of the BCD and USC populations. The ninety-fifth percentile weight, buttock–knee length and hip breadth of the normal individuals were even lower than the fiftieth percentile BCD and USC population values.

4. Discussion

The results of this survey suggest that the growth of the lower extremities of the disabled subjects had been reduced as a result of their medical conditions, but the dimensions of the elbow-to-elbow breadth and hand breadth at thumb indicated a near

A disabled person with acquired deformity at the left elbow.

normal development of the upper extremities. This interpretation was contradicted to a certain extent by a significantly lower value of arm reach and maximum arm grasp and also a lower correlation value between these two dimensions in the disabled group. This contradiction could only be explained by the presence of concurrent deformity in the upper limb. In fact, most of the disabled men studied had acquired some deformity in the elbow and wrist joints (figure 1). Differences in the pattern of inter-correlation of the dimensions between the normal and disabled group indicates a distortion of bodily proportions.

5. Conclusions

The present study shows that the design of aids for disabled persons should be based on their anthropometric characteristics, which are different from those of the normal population. More detailed studies on the anthropometric characteristics of disabled persons are needed.

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Cet article rapporte une étude pilote consacrée aux caractéristiques anthropométriques des handicapés physiques en Inde et dont l'objectif est de faciliter la conception d'aides de déplacement. On a relevé 14 mensurations anthropométriques chez, d'une part, 61 hommes présentant des infirmités des membres inférieurs provoquées par la polyomyélite ou par des lésions de la moelle épinière et, d'autre part, chez 140 hommes normaux. L'étude rapporte une croissance amoindrie des membres atteints et également quelques déformations acquises dans les membres supérieurs. Les inter-corrélations entre les dimensions corporelles diffèrent entre le groupe des handicapés et le groupe des normaux.

In dieser Veröffentlichung wird eine Vorstudie zur anthropometrischen Charakteristik von Behinderten in Indien vorgestellt. Diese Studie erfolgte mit der Zielsetzung der Verbesserung der Gestaltung von Bewegungshilfen. Bei 61 Personen mit Behinderungen der oberen Extremitäten aufgrund von Kinderlähmund und Wirbelsäulenbeschwerden sowie bei 140 Nichtbehinderten, wurden jeweils 14 anthropometrische Werte gemessen. Die Studie zeigt eine Reduzierung der Größe der betroffenen Körperteile sowie eine Deformation der oberen Gliedmaße. Bei den Behinderten und Nichtbehinderten waren die Interkorrelationen zwischen den Körpermaßen differierend.

本論文は移動補助装置の設計を容易にするために実施されたインド人男性身体障害者の身体計測特徴の予備研究を述べる。ポリオまたは脊髄損傷による下肢の傷害を持つ61名の男性と14名の健常な男性に対して14の身体計測を行った。該当部の成長の停滞と上肢の後天的変形も見られた。身体計測値の相関は障害者と健常者では異なっていた。

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To Prof. Alain Wisner
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Anthropometric analysis of tricycle designs

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A comparison of the designs of two types of tricycles available in India for the use of persons with severe both-lower-limb disability was made from the viewpoint of the anthropometric characteristics of the users. It was noted that neither design was compatible with the disabled persons' anthropometric dimensions in a number of ways. The seats did not provide for comfortable sitting. Although the hand crank was relatively well positioned in one, the distance of the crank from the back rest obliged the users to bend forward while driving their tricycles. The study concluded that suitable modifications in the dimensions of the tricycles are required to provide greater comfort, safety and ease of operation.

Keywords: Anthropometric characteristics, invalid carriages, disabled people

Introduction

People with severe handicaps of both lower limbs that preclude standing and walking may use hand-cranked tricycles for outdoor locomotion, especially in the developing countries, like India, where economic considerations restrict the use of motorised wheelchairs. Although tricycles are used by a large proportion of such handicapped people in India, their scientific evaluation leading to further cost efficient developments is scanty. The following is an attempt to explore the compatibility of tricycles with users from the viewpoint of anthropometry.

Materials and methods

Investigated materials

Variations in the design of the tricycles available for the use of the handicapped were observed in the different States of India. Of the two main varieties, one has the arm crank assembly in the middle front position of the user (Type A, Fig. 1), while the other type has one crank either on the right or the left of the user (Type B, Fig. 2). In the Type A tricycle, steering is achieved by turning the crank assembly itself, which is fixed to the shaft attached to the front wheel; in Type B this is done by a separate steering rod or wheel. The Type A tricycle only is commonly available in the State of West Bengal while Type B tricycles are commonly available in the States of Maharastra, Gujarat and Delhi. The present study considered both types for evaluation.

Subjects investigated

Selective anthropometric measurements were made on 61 male lower-extremity disabled subjects habitually using tricycles for locomotion. As the users of the tricycles are mostly paraplegics who had been affected with poliomyelitis or spinal injury, all the subjects in the disabled group were chosen from young adult persons with such disabilities only.

Investigation methods

Standard anthropometric measurements were taken with Martin's anthropometer, spreading calipers and steel tape. Measurements were taken following the definitions in Damon *et al* (1966). Stature was measured with the subjects standing

Fig. 1 Type A tricycle

0003–6870/86/01 0025–05 $03.00

Fig. 2 Type B tricycle

against a wall. The elbow-to-elbow breadth and hip breadth were taken with the subjects sitting in a relaxed comfortable posture. The various dimensions of the tricycles were measured with callipers and tape.

Discussions

Means and standard deviations of different dimensions of the two types of tricycles have been given in Table 1. Means and standard deviations of the ages and of the anthropometric measurements of the disabled persons have been tabulated in Table 2. In addition, the 5th, 50th and 95th percentile values of the anthropometric measurements also have been given.

Analysis of the tricycle seat

Seats and sitting have been extensively investigated in ergonomics. A number of studies have been made to define the anatomical and physiological principles of seat design (Floyd and Roberts, 1958; Damon *et al,* 1966; Grandjean *et al,* 1973). The following analysis of the tricycle seats was made according to the principles of seat design enunciated through such studies.

Seat height

It has been indicated that undue pressure underneath the thighs hampers circulation in the legs and causes discomfort. To avoid such problems it is better to select the seat height approximately 2·5 cm less than the popliteal height. As much as 95% of the population can be covered by selecting the 5th percentile value of popliteal height; but such a seat height can cause some difficulty for taller people. To compensate for this difficulty, researchers have favoured adjustable seat heights (McCormick, 1976).

In the present study the means of the seat heights in Types A and B tricycles were 27·6 and 35·3 cm respectively. The 5th and 95th percentile popliteal heights of the disabled group were 34·3 and 46·5 cm respectively. The seat height of the Type B tricycle was 2·4 cm less than the 50th percentile popliteal height of the disabled group. So a Type B tricycle could comfortably accommodate 50% of the disabled population, whereas Type A had a seat height much too low, even for the 5th percentile disabled persons.

Seat width

This dimension is determined from hip breadth. The recommendation states that the seat width should be sufficiently greater than hip breadth to allow for some lateral movements. The 95th percentile value should be considered to accommodate the greater proportion of the population. Taking into account the possibility of rest pauses in between the driving spells, and the use of the seat for resting, 95th percentile of hip breadth in a comfortable sitting posture was considered. Mean seat widths of the Types A and B tricycles were found as 42·4 and 41·1 cm

Table 1: Dimensions of tricycles used for evaluation (cm except for last column)

Type of tricycle	Seat width	Seat depth	Back rest height	Seat to foot rest height	Foot rest to ground	Crank centre to back rest	Vertical height of crank centre from seat	Length of the crank arm	Length of the crank handle	Weight of the tricycle (kg)
Type A										
Mean	42·4	33·3	34·9	27·6	32·9	60·5	21·0	13·2	10·5	65·0
± SD	4·3	4·2	8·0	4·4	8·2	4·4	2·1	2·5	0·9	10·8
Type B										
Mean	41·1	41·1	40·3	35·3	18·3	56·4	44·5	17·7	12·2	52·0
± SD	6·5	6·5	1·5	5·0	5·0	9·4	1·2	0·7	1·2	8·5

Table 2: Anthropometric measurements of disabled subjects relevant to tricycle design

Dimension		Mean	SD	Percentiles 5th	50th	95th
1.	Age (yr)	24·4	3·8	–	–	–
2.	Weight (kg)	41·4	5·4	–	–	–
3.	Stature	139·2	17·5	110·0	141·0	163·3
4.	Acromion height sitting	47·4	6·9	33·0	48·1	56·4
5.	Elbow rest height	18·1	2·3	13·6	18·3	21·3
6.	Popliteal height	38·4	3·4	34·3	37·7	46·5
7.	Buttock-knee length	48·4	2·7	45·4	48·2	54·0
8.	Buttock-popliteal length	39·9	2·8	35·7	39·9	44·7
9.	Maximum arm grasp	67·9	5·7	57·4	67·3	76·2
10.	Arm reach from wall	79·9	5·0	69·4	77·9	87·4
11.	Elbow-to-elbow breadth	38·3	2·7	33·4	38·2	43·4
12.	Elbow-to-elbow breadth (comfortable)	47·2	4·4	39·9	46·9	55·8
13.	Hip breadth	28·4	2·2	24·4	28·4	33·4
14.	Hip breadth (comfortable)	28·8	2·4	25·4	28·2	33·4
15.	Hand breadth at thumb	9·4	1·4	7·0	9·3	11·7
16.	Hand thickness at metacarpale III	2·4	0·1	2·2	2·5	2·9

All the measurements are expressed in centimetres, except age and weight

respectively. These widths were sufficiently larger than the 95th percentile reference hip breadths of the disabled users to allow adequate lateral movements and were therefore satisfactory.

Seat depth

It has been stated that adequate clearance should be kept between the back of the calf and the front of the seat to avoid discomfort due to pressure behind the knee by the edge of the seat. Therefore, buttock-popliteal length becomes the determining dimension of seat depth. It has been stated that the clearance should be between 9 and 19 cm behind the knee joint. To accommodate a larger proportion of the population it is better to consider the 5th percentile value of buttock-popliteal length.

Means of the seat depths of the Types A and B tricycles were found to be 33·3 and 41·1 cm respectively, whereas the 5th percentile of the buttock-popliteal length of the disabled group was 35·7 cm. The 95th percentile of this dimension was found to be 44·7 cm. If, according to the recommendations, a clearance of 9 cm between the front edge of the seat and the popliteal space is taken, the seat depth of Type A tricycle is compatible with less than 50% of the population and that of the Type B becomes incompatible for about 100% of the population.

Back rest

It has been suggested that the back rest should be rigid, gently rounded and spring loaded to support the trunk weight. It has been recommended that the support is most effective if the rest is positioned between 7 and 20 cm above the seat surface. It has been found that most people prefer a seat inclination of 25–26° and the back rest inclination of 105–108° with the horizontal plane, while resting.

Back rest heights of the tricycles were 34·9 and 40·3 cm for Types A and B cycles respectively. There were no spaces in between the seat surface and back rest on both models, not allowing any ventilation in the back, making prolonged sitting uncomfortable. In the case of the Type A tricycle, neither the seat nor the back rest were inclined to the horizontal and vertical planes respectively as required for comfortable sitting. In the Type B tricycle, although the seat was horizontal, an inclination of the back rest was present.

Arm rest

It has been suggested that arm rests should be at such a level as to make the arms hang freely and for the elbows to rest in a natural position. The determining dimension of the arm rest is elbow height. However, the arm rests do not have to interfere with the cranking action.

In both models no arm rests were provided.

Analysis of the position of the crank

It has been stated by earlier researchers that the efficiency of cranking is highest when the axis of the crank assembly is at about the heart level and when both arms could be used simultaneously (Nag *et al*, 1982; Schnauber & Muller, 1970). The heart level is generally considered as a height approximately 10–12 cm below the acromion process. It was observed that the mean acromion height of the disabled people was 47·4 cm. The position of the crank centre should therefore be between 35·0–37·0 cm above the seat surface. From Table 2 it is evident that in Type A tricycles the crank centre is situated at 21·0 cm above the seat surface, whereas in the Type B tricycles the crank centre is situated at 44·5 cm above the seat surface. Hence it is seen

that while the position of the crank of the Type A tricycle was much lower with respect to the heart level, that of Type B was much higher. Since arm position at much higher than heart level is more fatiguing than otherwise, Type A tricycles afford an arm position which was more advantageous than that in Type B cycles.

Analysis of the distance of the crank from the back rest

Regarding the pushing and pulling forces of the upper extremities, data are not available for the Indian population. Damon *et al* (1966) have suggested that, while sitting higher, pushing and pulling forces be exerted horizontally at a distance of 59 cm in front of the back rest, by the 5th percentile of average persons. It has also been stated that pushing force is maximum at 180° elbow angle, while the pulling force is maximum at 150° elbow angle (Damon *et al,* 1966). During cranking, the position of the crank should be such that angles between 180° and 150° at the elbow joint can be sustained, so as to obtain maximum pushing and pulling force respectively (Fig. 3). However, to get an elbow angle of 180°, the superior extremity should be completely extended. It was observed that the maximum arm grasp of the disabled people was 57·4 cm and the distance of the crank handle at a position furthest removed from the user was 73·7 and 74·1 cm for Types A and B tricycles respectively. Due to the positioning of the crank so far in front, the users of both tricycles are unable to use the back rest while driving and are obliged to bend forward while cranking. Not only is this fatiguing but long years of use of these aids, which obliges the user to adopt such an abnormal posture, may even lead to secondary deformities of the back.

Conclusions

From the above discussions it may be concluded that neither of these two commonly available models of tricycles is suitable for comfortable and efficient use by disabled people, though a few of the dimensions of the cycles were found compatible with the users' anthropometric measurements. The study proposes the following modifications to the present designs to suit the disabled people better:

1. The arm crank should be provided in the middle front position of the users, as in the Type A tricycle.
2. The distance of the crank centre from the back rest should be adjustable. The range of adjustment should be between the 5th to 95th percentile value of maximum arm grasp of the population minus the length of the crank arm so that each user may fix it firmly in a position which allows the full extension of his elbow when the crank arm is furthest away from his body, and the use of the back rest to assist in counteracting cranking thrust.
3. The seat width of the tricycle seat should be 5–10 cm greater than the 95th percentile value of hip breadth of the disabled in individuals.
4. The seat depth should be adjustable in the range of the 5th to 95th percentile value of buttock-popliteal length of the population. This adjustment can be done by making the depth equal to the 95th percentile value of the buttock-popliteal length minus 9 cm, or from our measurements about 38 cm. A strip of seat 9 cm wide at the front edge may be hinged in such a way that it could be folded up and kept bolted below the seat to accommodate people with measurement in the 5th percentile range.
5. Instead of making the seat height adjustable, it would be better to provide a foot rest whose height may be adjustable in the range between the 5th and 95th percentile values of the disabled group. It will be preferable to fix the foot rest about 5–10 cm in front of the vertical plane from the front edge of the seat.
6. A good support for the back should be provided. The support should be available for the whole of the upper back including the head as disabled people sometimes have problems of balancing the body and the head in the vertical plane. It may be better to allow an opening of 10–15 cm between the seat surface and lower edge of the back rest for ventilation and for accommodating the buttocks. Holes in the back rest surface may be drilled also to allow ventilation to the back.
7. Suitable arm rests should be provided. It would be preferable to make the arm rests so that they may be adjusted between the 5th and 95th percentile values of the elbow height of disabled people.
8. Height of the foot rest from the ground should be as low as practicable to allow easy mounting and getting down.
9. For safety purposes a hand brake should be provided. The position of the hand brake as fitted in Type A tricycles would be better.
10. The total weight of the tricycles should be reduced as far as practicable to reduce the strength required to drive the tricycle.

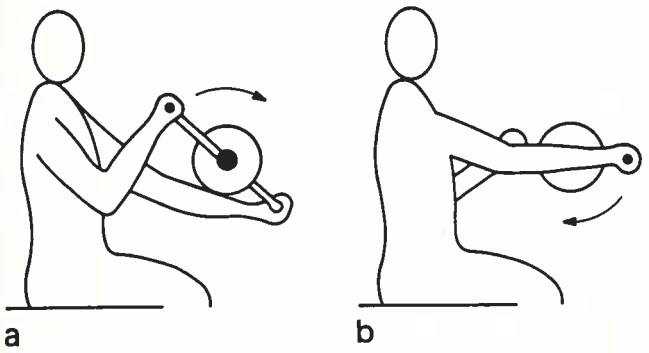

Fig. 3 Ideal position of the crank assembly and position of the two limbs at maximum flexion (a) and complete extension (b) shown diagrammatically

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To Prof. Alain Wisner
With regards
Goswami
25/2/86

Ergonomic analysis of wheelchair designs

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Summary

Four types of wheelchair available in India were evaluated from physiological, anthropometric and biomechanical points of view. None of the wheelchairs had a seat designed to provide comfort to the majority of disabled users. The diameter of the castor wheels in one type of wheelchair was found to be more suitable for overcoming the more common obstacles in buildings and net oxygen cost of this type was found to be much lower than the others. Propulsion of all the wheelchairs consumed more than 50% of the $VO_{2\ max}$ of the disabled persons. The space allowed between the hand rim and the wheel was not adequate in any of the designs for comfortable and efficient propulsion. From the present evaluation it was concluded that although one type of wheelchair was preferable amongst the four examined, it still needed several modifications.

Relevance

The physiological and anatomical limitations of wheelchair occupants place special demands on 'chair design. Ergonomic analysis provides design information of value in reducing the musculo-skeletal loads on the user.

Key words: Ergonomics, Wheelchairs, Musculo-skeletal, Physiology, Biomechanics

Introduction

Wheelchairs provide a wide field of mobility to disabled persons with confining disabilities. So far, the existence of four types of wheelchair (indoor, outdoor, combined indoor-outdoor and special chairs) has been reported. In India the use of wheelchairs is restricted to indoor purposes: outdoor and combined indoor-outdoor chairs are totally absent. Special chairs or wheeled ordinary chairs are rarely used. Numerous attempts have been made to evaluate and improve wheelchair designs in Western and European countries[1–9]. Most of the studies describe either physiological costs involved in driving the wheelchair or engineering improvements and mechanisation in the design, but do not consider the physical and anatomical limitations of the users. The present study describes the analysis of wheelchairs available in India, considering the physiological and physical limitations of the disabled persons.

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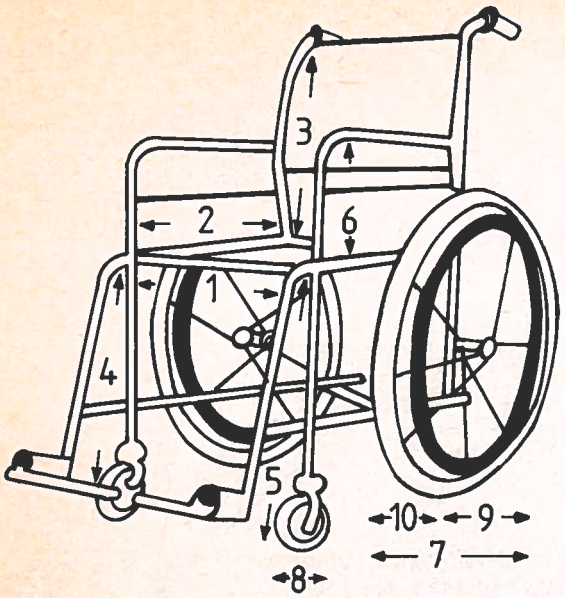
Materials and methods

Indian wheelchairs

Wheelchairs that are available in India vary little in their design but have measurable differences in their dimensions due to manufacturers' specifications. In total, four types of wheelchair were selected for evaluation from different states of India; among them three were of a non-folding type (A, B and C) and one was a folding type (D). Figure 1 describes their dimensions with a general diagram.

The volunteers

The volunteers cooperating in the present investigation comprised nine and six disabled persons for A and B type wheelchairs, respectively, and six disabled persons for the evaluation of both C and D type wheelchairs. Of the 21, 15 were paraplegics due to trauma and six were post-polio patients with both lower limbs severely affected. Since the use of different models of wheelchair is restricted to areas around the centres of their manufacturers, it was not possible to evaluate the models with the same group of volunteers since large geographical distances separate the centres. Mean and standard deviation (s.d.) of age, height and weight of the disabled volunteers are described in Table 1.



Key	Wheelchair type A	B	C	D
1. Seat width	42·0	41·0	44·0	44·0
2. Seat depth	42·0	37·5	49·0	41·5
3. Back rest ht.	40·0	28·0	38·5	40·5
4. Seat to foot rest ht.	38·0	50·0	39·0	32·5
5. Seat to ground ht.	51·5	56·0	53·0	47·0
6. Seat to arm rest ht.	30·5	15·0	15·0	13·0
7. Diameter of back wheel	62·0	64·0	58·0	58·0
8. Diameter of front wheel	18·0	9·5	10·0	10·0
9. Diameter of hand rim	56·0	54·0	44·0	44·0
10. Clearance between rim and wheel	3·0	2·5	8·0	7·5
11. Weight of wheelchair	23·0	25·0	26·0	25·0

Weight in kg, others in cm

Figure 1. A general diagram of a wheelchair and various dimensions of four types of wheelchairs.

Investigation methods

Evaluation of the wheelchairs was made in situations simulating actual usage, and the variables selected for measurement were peak heart rate, oxygen uptake, net oxygen cost and speed of propulsion. The oxygen consumptions of the activities studied were predicted from the heart rate–oxygen consumption relationship established in a previous study[10].

The volunteers were asked to propel the wheelchairs on a smooth concrete surface for a period of three minutes at their accustomed speeds. The period of observation was restricted to three minutes, as it was found that most were obliged to rest after continuously propelling wheelchairs for about this length of time. The speed was measured by the time taken to cover a distance of five metres marked on the floor. During the days of these experiments the recorded environmental temperatures showed no significant variations.

Selective anthropometric measurements of the disabled persons related to wheelchair design were taken according to standard methods[11] and are given in Table 2.

Table 1. Personal data of the volunteers

Wheelchair type	Age (yrs)	Height (cm)	Weight (kg)
Type A	23·8 ±4·2	152·9 ±11·2	49·7 ±2·4
Type B	28·8 ±4.2	159·4 ±5.0	50·0 ±10·9
Type C & D	27·8 ±1·7	158·6 ±8·3	45·1 ±6·5

Table 2. Anthropometric measurements related to wheelchair design (N=61)

Parameters	Mean	s.d.	Percentile values 5th	50th	95th
Popliteal height	38·4	3·4	34·3	37·7	46·5
Buttock popliteal length	39·9	2·8	35·7	39·9	44·7
Elbow rest height	18·1	2·3	13·6	18·3	21·3
Hip breadth	28·4	2·2	24·4	28·4	33·4
Hand thickness at 3rd metacarpal	2·6	0·1	2·2	2·5	2·9

(measurements in centimetres)

Results

Anthropometric analysis of seat

In addition to the mobility provided to the disabled persons, wheelchairs also serve the purpose of resting chairs for long term sitting. Improvement of the wheelchair seat is therefore of importance. The seats were analysed with regard to the recommendations for better seat designs evolved from various studies in this area[11–15].

Sitting height is determined by the popliteal height of the population. Seat to foot rest heights of three types of wheelchair (A, B and C) were greater than the 5th percentile value of the popliteal height of the disabled persons. Wheelchair B had a value exceeding the 95th percentile of the disabled group.

Seat width should be such as to accommodate the person and also to allow sufficient space for alteration of posture. Seat widths were nearly the same in all four types and were significantly greater than the 95th percentile value of the hip breadth of the disabled group.

Depth of the seat should allow sufficient space between the front edge of the seat and back of the knee joint and this is determined by buttock-popliteal length. Wheelchair B had a similar depth to the 5th percentile value but the rest of the wheelchairs had greater seat depths.

Back rests had a space of 5–10 cm between the seat surface and the lower edge of the back rest, and no inclination of seats or back rests was observed to be present in any of the types.

Table 3. Speed of wheelchair propulsion—comparison between previous reports and the present study

	Speed on hard surface Mean (m/min)	±s.d.
Wolfe[9] (Paraplegic using hard tyred wheelchairs)	82·7	19·0
Wolfe[9] (Paraplegic using pneumatic tyred wheelchair)	79·8	18·6
Cerny[1]	75·0	22·8
Hash[4]	37·0	9·6
Gordon[16]	32·0	—
Peizer[7]	81·8	8·33
Present study		
Wheelchair Type A	84·9	10·3
Wheelchair Type B	59·1	9·7
Wheelchair Type C	51·2	3·4
Wheelchair Type D	47·5	6·1

Table 4. Comparison of physiological costs of wheelchair propulsion

	Heart rate beats/ min	*VO_2 ml/kg/ min*	*Net O_2 cost ml/ kg/m*	*Relative VO_2 (% of $VO_{2\ max}$)*
Wolfe[9] (paraplegic using hard tyred wheelchair)	126 ±17	15·5 ±5·3	0·191 ±0·037	
Wolfe[9] (Paraplegic using pneumatic tyred wheelchair)	127 ±18	15·7 ±3·8	0·201 ±0·037	
Cerny[1]	109 ±16	13·28 ±4·07	0·18 ±0·04	
Hash[4]	107 ±13	10·04 ±1·47	0·272 ±0·092	
Present study				
Type A wheelchair	127 ±12	17·8 ±2·5	0·21 ±0·02	65·6
Type B wheelchair	129 ±8	18·3 ±1·7	0·313 ±0·03	68·5
Type C wheelchair	114 ±8	15·2 ±2·0	0·304 ±0·03	56·6
Type D wheelchair	124 ±11	17·3 ±2·6	0·36 ±0·01	64·6

Wheel size

It was observed that the diameter of the back wheel was largest in type B, followed by those of types A, C and D in decreasing order, whereas the diameter of the front wheels was largest in type A, followed by types C, D and B respectively.

Space between hand-rim and the wheel

It was observed that clearance between rim and wheel is minimum in type B followed by types A, D and C. Comparison of this value with the hand thickness of the disabled persons indicated that type B and A wheelchairs had insufficient clearance to allow the hand, in a large proportion of the disabled, to grip the rim comfortably whereas, in types D and C the clearance was too large, requiring abduction of the arms to an excessive degree.

Variation in speed of propulsion

Table 3 describes the speeds of wheelchair propulsion measured by different authors, compared with the present study. This review reveals various propulsion speeds. Gordon[16] reported an average velocity of 32 m/min by tuberculosis patients. Wolfe[9] reported higher average speeds of propulsion on concrete surfaces adopted by paraplegic subjects using a hard tyred wheelchair. Pneumatic tyred wheelchairs resulted in decreased velocity on both surfaces. Cerny[1] reported a similar velocity by habitual wheelchair users. In another study on hemiplegic patients, Hash[4] reported a slower velocity of wheelchair propulsion.

In the present study, four different speeds were observed to be adopted by the users of the four types of wheelchair, though in all instances the surfaces on which they were driven were of hard concrete and all the subjects were paraplegics and habitual wheelchair users. The highest speed of propulsion was observed during the use of type A wheelchairs.

Physiological cost of wheelchair propulsion

Table 4 summarizes the mean and standard deviations of the physiological variables during active propulsion of wheelchairs by the subjects and the values reported by other authors.

A comparison of peak heart rates during propulsion of the four types of wheelchair shows that heart rates were minimum while using the type C and maximum with the type B wheelchairs. The difference in the mean value of peak heart rates in the use of these two types of wheelchairs was significant (by unpaired t test, $P<0{\cdot}05$). No significant differences in peak heart rates were observed when comparisons were made between the values during the use of the other types. A similar trend was observed when oxygen uptakes per unit body weight were compared.

Since there was a variation in the self-selected speeds of propulsion of different types of wheelchairs, the effect of the variations was nullified by expressing the oxygen uptake per unit distance travelled. This parameter has been termed as the net oxygen cost in the literature[17]. Net oxygen costs of propelling the four types of wheelchair were compared and these had a pattern different from those observed in comparisons of peak heart rates. Propulsion of type A wheelchairs required minimum net oxygen costs, whereas the type D'chairs imposed maximum costs. No significant difference was observed when the values of this parameter

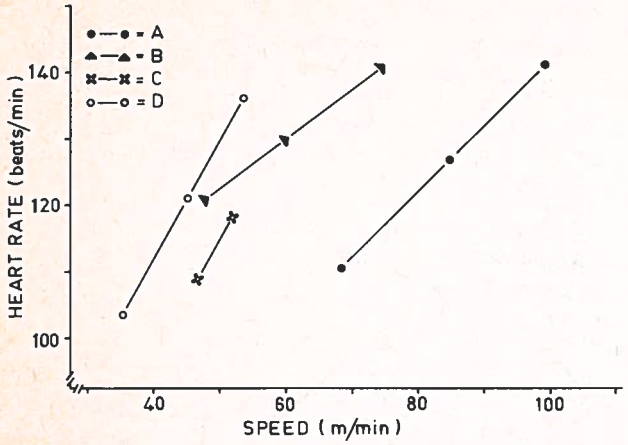


Figure 2. Relationship between speed and heart rate during driving different wheelchairs.

Table 5. Comparison of the status of wheelchairs from physiological, anthropometric and biomechanical point of view, using an arbitrary scoring system

Aspects	*Wheelchair type* A	B	C	D
Speed of driving	1	2	3	4
Physiological cost	1	3	2	4
Seat height	2	4	3	1
Seat width	2	1	3	4
Seat depth	3	1	4	2
Back rest	0	0	0	0
Arm rest	0	0	0	0
Wheel size	1	4	2	3
Space between rim and wheel	1	4	3	2
Weight	1	2	3	2
Total weighting	12	21	23	22

(1='best' chair for that feature, so low overall score is preferable)

during the use of type B and type C were compared. Comparisons of net oxygen costs entailed in the uses of all the other types of wheelchair elicited significant differences.

It has been mentioned in earlier studies that the variables speed of travel and heart rate bear a close relationship, and over a wide range of speeds the relationship was curvilinear[18]. The heart rates and speeds of propulsion were observed to be highly correlated with the use of all types of wheelchair, except type C. The best correlation was obtained with type D, followed by types B and A. Slope of the relationship line was greatest for type C followed by types D, B and A (Figure 2). Only the values of speed, heart rate, oxygen consumption and net oxygen cost of propelling type A wheelchair conformed closely to those obtained by Wolfe[9], but were considerably higher than those obtained by Cerny[1].

It has been established by earlier researchers that any muscular exertion could be prolonged for up to one hour, provided the oxygen consumption did not exceed 50% of the maximum oxygen uptake of the subjects[19]. It was observed that propulsion of all four wheelchairs required a higher percentage of oxygen over this recommended value.

Discussion

Analysis of the wheelchair seats indicates that only the seat height of type D wheelchairs was suitable for 95% of the disabled population, whereas type A could accommodate 50% and type B only 5% of the disabled group. The seat width of all four types could comfortably accommodate all of the disabled population. The seat depth of type B chairs could accommodate more than 50% of the disabled population. Thus, in 50% of cases for this type of wheelchair the back rest becomes useless or, if used, would alter the natural spinal curvature. All other types provide a worse situation. The back rests of types A, B and C were fixed and made of metal sheets. The back rest of type D wheelchairs was also fixed and made of foam plastic material. None of the back rests could provide adequate lumbar support and would force the disabled persons to sit in an undesirable posture. Hence, none of the wheelchairs fulfilled the criteria of an ideal rest chair or an ideal work chair.

In general, the front wheels of a wheelchair are small (castor wheels), whereas the back wheels are large with a rim for propulsion by hand. Regarding the diameter of the wheels, there have been no studies to specify optimum diameter. Large wheels may shift the centre of gravity of the wheelchairs upwards and reduce their stability. The small castor wheels at the front are not suitable for negotiating architectural barriers like kerbs, bumps, etc. In the present study, the diameters of the front wheels of the type A wheelchair were preferable for overcoming low architectural barriers on the floor.

The space between the hand rim and the wheel is a critical dimension which may determine the relative difficulty of wheelchair propulsion. The space should allow the thumb or fingers to be introduced comfortably through it and an adequate force to be applied to the rim. However, too large a space between these two would require a higher degree of abduction of the arms and may make the exertion of force difficult. It has been reported that abduction of the arm increases the resting muscular activity[20]. This could reduce the force to be applied and impose early fatigue in the muscles involved. None of the wheelchairs was found suitable in this respect.

Analysis of the physiological cost of wheelchair propulsion indicates that, though oxygen uptake for propulsion of type A wheelchairs was higher than those for

types C and D, the net oxygen cost in its use was lower than those for all the others. Speed of propulsion of the type A wheelchair was much higher than all the others. If the other wheelchairs were propelled with speeds at which type A wheelchairs are customarily propelled it could safely be assumed that oxygen uptakes and heart rates during propulsion of these other types might attain higher values than those observed with the use of type A chairs. Hence, from considerations of the physiological stresses of propulsion, the type A wheelchair seems to be much better than types B, C and D.

To make the comparison easier, the method of arbitrary scoring was applied. The wheelchairs were categorised according to the goodness of fit from the physiological, anthropometric and biomechanical point of view. The best among the four was numbered as 1 and the others were numbered in increasing order (Table 5). It can be observed that the type A wheelchair is comparatively better than types B, C and D. Types B and D seem more or less equivalent according to the attempted categorization. There are certain disadvantages to the type A wheelchair and it is expected that with suitable modifications in the design of its seat, wheel size, space between the rim and wheel, etc., greater optimization of the physiological cost, ease of operation and comfort of the user disabled persons may be achieved.

Recommendations

The following recommendations for modifications of the different types of commonly used wheelchairs for the lower limb disabled emerge from this study.

1. The seat width of the wheelchair seat should be 2–4 cm greater than the 95th percentile value of the disabled individuals.
2. Seat depth should be 2–5 cm less than the 5th percentile value of the buttock-popliteal length of the disabled group.
3. A good support for the back should be provided and be available for the whole of the upper back, including the head, because patients often have a problem of balancing their head in the vertical plane. It may be better to allow a space of 10–15 cm between the seat surface and lower edge of the back rest.
4. The gap between the wheel and the hand rim should be greater than the 95th percentile value of the hand thickness at the third metacarpal of normal persons.

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ERGONOMIE ET NEUROPHYSIOLOGIE DU TRAVAIL

Paris, le 14th April 1986

Professor C.N. Daftuar
Reader in Industrial Psychology
Department of Psychology
M.S. University
BARODA 390 002 (Inde)

Dear Pr Daftuar,

I have received your letter of March 29th with a mixed feeling of pleasure and sadness. My pleasure is related to your remarkable bibliography I know only partially and I have used in some of my papers (for example my report to IEA 1985 meeting in Bournemouth). My sadness is explained that I will be ... in Asia from June 14th to July 14th working at I.L.O. Bangkok with K. Kogi.

I am now strongly involved in ergonomics in developing countries and I have signed with Elsevier for a book under this title to be written for the end of 1986. I would appreciate very much to receive a copy of all your papers related to this subject. Inside this theme, I am specially interested by the human aspects of Technology transfer, subject that I call some time Anthropotechnology. I am sure that some of your works would be very enlightening to me in this area.

We have here a group of students who would be very interested by a conference given by you, but they are french speaking coming from South America and Africa, and I will not be there to translate. Another point is that many of them will be out of Paris for field research at this period of the year. Anyway, if you stay in Paris from June 20 to July 5, please let me know so that our students then available may have an opportunity to meet you.

I hope that later a better opportunity to meet you will appear.

Truly yours,

A. Wisner
Sc D., M.D., Dipl. Psychol.
Professor of Ergonomics and
Work Neuropsychology

41, RUE GAY-LUSSAC - 75005 PARIS - ☎ (1) 43 54 18 27 - (1) 43 54 18 34

Dr. chittranjan n. daftuar
M. A., D. I. I. T., D. Litt.
Reader in Industrial Psychology,
Department of Psychology,
M. S. UNIVERSITY, BARODA,
INDIA-390002

Office : 64409
Res :

To
Director,
Laboratoire de Physiologic du Travail
et d'Ergonomic du Conservatoire,
National des Arts et Metiers,
41 rue Gay-Lussac,
PARIS - 5.

Dated: 29/3/86.

Dear Sir,

May I introduce myself to you with a view to get an opportunity to visit your institution in May-June'86, I am a professional Psychologist teaching social, Industrial/Organizational and engineering psychologies in the Department of Psychology, M.S.University, Baroda, India. I have about 19 years of teaching and research experience in the areas of Psychology mentioned above. I am also involved in Management Development Programmes (Managerial training) and industrial consultancy assignments for the last 5 years. I hold a D.Litt degree (highest academic degree in India, a Post Ph.D. degree) in organizational Psychology/management (Topic of the D.Litt thesis was "Structure of Supervisory Control: with special reference to organizational effectiveness").

I am planning to attend some international meetings this year in U.S.A. Chicago, Turkey, and Israel. In between these meetings, I have a blank period of about 5 weeks. I want to use these periods in visiting places like your organization.

The first conference that I am attending is the 36th Annual Conference of the International Communication Association from May 22-26, 1986, at Chicago, Illinois. The second, the 8th International Congress of cross-cultural psychology is due from July 06 to July 10, 1986 at Istanbul, Turkey. Then, ofcourse, I will be going to ICP'S convention (July 8-11 Telaviv) and to IAAP congress (July 13-18, Jerusalem). I am also visiting some U.K. Universities in the first part of June'86.

The above schedule leaves me free between June 20, 1986 to July 05, 1986 (about 3 weeks). Do you think that I may be able to spend this time or a part of it, at your Institute under any Scheme (May be a visiting scientist, for example)? I can lecture/do collaborative work on theme(s) related to ergonomics (preferably cross-cultural aspect), Leadership and work values. For example, I may be utilized to lecture on (i) Industrial/Organizational Psychology in India, (ii) Ergonomics researches in India, (iii) Engineering Psychology researches in India, (iv) Indian culture and Managerial styles in Indian organisations, (v) work values in Indian systems, etc. The above list is only suggestive to give you an idea about my interest and expertise.

Do you feel interested? I am enclosing my bio-data for your perusal.

Thanking you, in anticipation,

Yours sincerely,

(C.N.Daftuar)
29/3

Encl: Bio-data.

Residence : 0-8, Tarabaug, Polytechnic Campus, Baroda, India-390002.

(BRIEF)

B I O D A T A

OF

1. Chitthranjan N. Daftuar,
   Reader (Industrial Psychology),
   Faculty of Education & Psychology,
   M.S.University, BARODA-390 002.

2. ADDRESS FOR CORRESPONDENCE :

   0/8, Tarabaug, Polytechnic Campus,
   BARODA-390 002.

3. Date of Birth : 5th October 1940.

4. SPECIALIZATION :

   Industrial - Organisational Psychology, Human Engineering and Organizational Behaviour.

5. ACADEMIC CAREER :

   A. D.Litt. 1985 Magadh University. Topic "Structure of Supervisory Control : A Study in Organizational Effectiveness" (D.Litt. is highest degree in India and is higher than Ph.D. degree).

   B. D,I.I.T. 1969 (Post-M.A. Diploma, from Indian Institute of Technology, Kharagpur, India) in 'Industrial Psychology and Industrial Relations' with major in Human Factors Engineering by dissertation (one year course).

   C. M.A. 1962, Psychology.

   D. B.A. 1960, with Honours in Psychology.

   E. A one week course in 'Problems of Test Construction in Developing Countries'. Free University, Amsterdam, Holland, 1976.

6. HONOUR, REWARDS, etc.:

   A. I was awarded National Associateship Status by the U.G.C. in 1978.

   B. I was invited to chair a session on 'Experimental Psychology' in Cross-cultural Settings' during the 3rd Congress of Association of Cross-cultural Psychologysts (Tilburg University, Holland) in July 1976.

   C. Get the Times Research Foundation award for an essay on leadership challenges under their National Essay Competition Scheme.

7. EXPERIENCE AND PUBLICATIONS, ETC.:

   A. Teaching : 19 years in various Universities. Primarily and extensively engaged in teaching of Industrial Psychology, Human Engineering/Ergonomics and Organizational Behaviour.

B. Research (Conducting & Guiding) : Extensive Research experience for about equal period (i.e. 19 years) in the area of specialization mentioned above. Also guided P.G.Diploma in O.B., M.A. and Ph.D. students for their research projects. Some independent projects handled.

C. Publications : Published extensively inIndian and international research journals. 26 research articles and one research book besides 6 book reviews published. 8 research articles and one book under publication.

D. Psychological Tests and Scales : I have prepared seven tests and scales and have adopted two American tests for Indian uses.

E. Administrative : Served as Head of Department of Psychology, Gaya College, Gaya, for more than two years.

F. Management Development Programmes (M.D.P.) :

Actively associated with MDP in various organizations

Some of the notables among them, where sessions were conducted, are the following :

i) Various MDP's of Baroda Management Association, Baroda.

ii) Bata India limited, Mokamah.

iii) Reilway Staff College, Baroda.

iv) Bank of Baroda, Baroda.

v) Jyoti Ltd., Baroda.

vi) Gujarat Oil Refinery, Baroda.

vii) Hindustan Brown Beveri Ltd., Baroda.

G. Editing : I have edited an interdisciplinary journal of Behavioural Sciences - BEHAVIOUROMETRIC - Since 1971, in the capacity of its Chief Editor.

8. MEMBERSHIP OF ACADEMIC/PROFESSIONAL BODIES :

I am full member of the following bodies :

1. Indian Psychological Association - Life member
2. Indian Psychological Society - Life member
3. Indian Science Congress - Life member
4. Council of Behavioural Research - Its organizing Secretary.
5. International Association or Cross-cultural Psychologists, - Member
6. International Association of Applied Psychologists-Member.
7. Baroda Management Association - Member, Management Committee.
8. Indian Society for Training & Development - Member, Executive Committee,Chapter Baroda.

Research - Guidance, Publication etc.

Guidance of Research : Ph.D., P.G.Diploma in O.B. and M.A.

1. Ph.D. Thesis :

Completed and degree awarded:

(i) Role of socio.psychological factors in academic achievements of three sub-cultural groups. Degree awarded in Sept'81.

(ii) A multivariate study of job characteristics and job attitudes among two work groups. Degree awarded in July 1985.

In Progress:

(i) Performance appraisal of bank employees : A study of its correlates and weightage system (In progress).

(ii) Academic achievement among tribles and noh-tribles with reference to socio-psychological variables.

(iii) Appraisal of executive potentials in a bank.

2. P.G. Diploma Dissertations :

(1) Study of an autonomous organization- 1983.

(2) A study of Personnel Needs of Technical & Non-technical executives-1983.

(3) Select organizational processes & employee behaviour: Culture study of a commercial enterprise in India-1984.

3. M.A. Dissertations :

(1) A study of control and participation within a trade union.

(2) A study of participation and control processes in relation to organizational effectiveness.

(3) A study of organizational needs and effectiveness.

(4) Power strategy and dynamics in organizations.

(5) A study of some work related values in organizations.

(6) An experimental study of leadership styles in management decision - making games.

(7) An experimental study of vigilance performance under various supervisory styles.

List of Research Projects:

A. Research Project Completed:

(1) A study of some personal, personality and motivational dynamics of enterprencurship (Financed by Magadh University).

(2) Management change in a hospital.

(3) Morale in a high technology organization.

(4) NDDB : a psycho-social profile.

(5) Development of weighted values for a performance appraisal system (EPRF 1: Bank of Baroda).

B. Research Project in Hand:

Supervisory control and organizational effectiveness: Comparative study in public and private sector (financed by the U.G.C.).

List of Publications:

A. Book:

(1) Job-attitudes in Management, New Delhi: Concept publication, 1982.

B. Papers : Published in Journals/Books (as chapters):

(i) Book Chapters:

1. The role of human factors engineering in underdeveloped Countries, with special reference to India, Published as a chapter in A. Chapanis (Ed.) Ethnic Variables in Human Factors Engineering. Baltimore : The John Hopkins University Press, 91-113, 1975.

2. Engineering psychology in cross-cultural settings. Published as a chapter in look of readings. Ype Poortinga (Ed.)"Basic problems in cross-cultural psychology", Amesterdam: Swets and Zetlinger, 1977, 361-371.

3. In defence of Authoritative Management (search for an Indian Theory of Corporate leadership). Chapter 8, Corporate sector. In Bs.KS.Chopra (Ed.) Select Readings in Leadership Challenges in India. Pune Times Research Foundation. PP. 155-173, 1985.

(ii) Research Papers (International Journals):

1. Application of Corbusier's 'Human Scale' to the layout of work space for type-writing job. J.Engineering Psychology, 1966, 5, 2, 52-62.

3. Sleep deprivation and Human performance. Psychologid, 1972, 15, 2, 122-126.

4. Legibility of five digit Arabic and Devangri numerals as a function of their sizes. Journal of General Psychology, 1977, 97, 139-144.

(iii) Research Papers (Indian Journals):

1. A study of eye and hand-reach angle as a function of different body dimensions in type-writing job. Journal of the Indian Academy of Applied Psychology, 1966, 3, 2, 40-40.

2. Certain correlates of study habit. J.Psychological Researches, 1967, 11, 3, 97-101.

3. A study of task structure and centrality in a management decision making game. Indian J. Applied Psychology, 1967, 5, 11, 11-19.

4. Optmizing system and machine design following human scale of proportion. Manas, 1969, 16, 1, 1-11.

5. Status of Industrial Psychology in India : A review of published literature. Indian Psychological Review, 1969, 5, 2, 166-182.

6. Some psychological problems for building designers: A human engineering point of view. Indian J. Psychology, 1971, 46, 2, 163-171.

7. Perceived characteristics of good and bad supervisors(1): by white collored bank employees. Indian J. Psychology, 1971, 46, 1, 45-53.

8. An empirical study of two psychological methods, J.Psychometric and Educational Measurement, 1971, 1, 1-2, 21-23.

9. Critique of MAS: Apilot study in co-educational and single sex institutions. Indian J. Psychology, 1972, 47, 3, 239-243.

10. Paralogs of Zero association value in Devangri script. Psycho-Lingus 1972, 2, 2, 83-87.

11. Trammel academe. Behaviorometric 1972, 2, 2, 63-64, (Special Issues).

12. The Modulor : A system of measuring body dimensions for designing household ~~equip~~ equipment. Behaviourometric. 1975, 5 (1-2), 15-26.

13. Cultural variables in Engineering psychology. Journal of Social and Economic studies. 1979, 7 (1), 43-74.

14. Occupational choice of Indian and Thai students. Manodarshan, 1979, 14, 16-19.

15. Personal variants and intellectual performance on a verbal intelligence test. Psycho-Lingua, 1980, 10 (2), 33-35.

16. Bio-data as a tool of industrial/Organizational psychologists, Indian J. Industrial Relations. 1981, 16 (4), 593-603.

17. Legibility of type faces. Journal of Psychological Researches, 1981, 25 (2), 108-110.

18. Control in an utilitarian organization. Indian J. public Administration, 1983, 24, 1, 11-18.

19. Hindi adaptation of 'Choice Dilemma Questionnare' Indian Journal of Applied Psychology, 1983, 20 (1) 40-42.

20. Do foreign management theories apply to Indian systems? Bullet-in of the Indian Pharmaceutical Association (Vadodara Branch), 1983, 1, 3, 1-3.

C. Tests and Scales Prepared :

All (7) published in 'Second Handbook of Psychological & Social Instruments, Pestonjee, D.M. (Ed.) I.I.M., Ahmedabad, Mimeographed, 1984.

1. Managerial Behaviour Questionnaire (MBQ).

2. A scale to measure Dysfunctional consequences of control system (Dy. C.S.S.).

3. Delegation of Authority Scale (D.A.S.).

4. Job satisfaction scale (J.S.S.).

5. Organizational Effectiveness Scale (E.F.F.) (Has, 9 subscales).

6. Power strategies Scale (P.S.S.).

7. Hospital Climate Questionnaire (H.C.Q.) (Has 9 sub-scale).

Test/Scale Adopted/Revised:

1. Choice Dilemman Questionnaire (Also published in Indian Journal of Applied Psychology, 1983).

2. Certainly of Judgement Scale (Also published in Means, 1982).

D. Book/Papers submitted for publications :

(i) Book:

1. Socio-Psychological Factors of Academic Achievements: A subcultural comparison.

(ii) Papers to International Journals:

1. Attitudes towards Technology of Thai and Indian students studying in India and in Thailand. Communicated to Journal of Social Psychology.

2. Power distance and other work values among handicapped and non-handicapped employees. Communicated to Journal of Applied Psychology.

(iii) Papers to Indian Journals :

1. Certainty of Judgement scale : An Indian adaptation in Hindi. Submitted to Manas, 1982.

2. Control distribution in public and private Indian Hospitals. Communicated.

3. Power Strategies : The game top people play in organizations, Communicated.

4. Change process in organizations: An open system approach to human resource development. Proceedings of National Seminar on HRD, Department of Psychology, M.S.University, Baroda, Feb. 18-20, 1985.

5. Environment and human performance. Proceedings of Seminar on Environmental Stress & Human Sufferings. Faculty of Social works, M.S.University, Baroda, March 4, 1985.

E. Papers submitted at International Seminars/Conferences, etc:

1. Role of Human Facotrs Engineering in under developed countries, with special reference to India. First Seminar on National and Cultural Variables in Human Factors/ Erogonomics, Oosterbeek, Holland, 19-23 June, 1972.

2. Engineering Psychology in Cross-cultural settings. Second conference of Cross-cultural Psychology, University of Tilburg, Holland, 1976.

3. Sterotypes of Indian and Thai students towards different nationalities. Paper accepted for presentation to the third convention of International Association of cross-cultural psychologists. Held at Munich, Germany, July 1978.

4. Ergonomics Researches in India : A review of published literature. 23rd congress of International Association of Applied Psychology. Edinburg. U.K. July 25-31, 1982.

5. A, P + N style of leadership: Experimental verifications of a concept of effective leadership style in Indian work situations. 21st International Congress of Applied Psychology, Telaviv, July 13-12, 1986.

6. Attitude towards technology among two groups of Thai and Indian students. 8th International Congress of Cross-cultural Psychology, Istanbul, July 6-10, 1986.

7. Ambiguous communication in an Indian organization. Annual conference of International communication Association. Chicago, May 22-27, 1986.

F. Paper presented to national seminars and conferences:

Several-At least one or two every year to the Indian Science Congress Association's Annual Conferences.

C. Book Reviews, etc.:

1. Scientist: A social psychological study. By Sri Chandra. Oxford Publishing House. Behaviorometric.

2. Psycho-Lingue: Ravi Shankar University. Behaviorometric.

3. Communications in Organization, Penguin. Indian Journal of Industrial Relations. Vol. 13, 1977.

4. Behaviour in Organizations. Tata-McGraw-Hill. Indian Journal Industrial Relations. Vol. 14.

5. Organizational Behaviour (By Fred Luthans). McGraw-Hill-Kogakusa, Ltd., Tokyo. 2nd Ed. Indian Journal of Industrial Relations. Vol. 15, 3, 1980, 476-478.

6. Industrial Democracy in Europe (By IDE Research Group). N.Y. Oxford University Press, 1982, In management Review and News letter, 1983.

NEW DELHI

1996

THE PURCHASE OF A FOREIGN PRODUCTION SYSTEM
THE ROLE OF ERGONOMICS AND ANTHROPOTECHNOLOGY
SYNOPSIS OF THE TUTORIAL GIVEN IN NEW DELHI ON THE OCCASION OF THE 2nd INDIAN ERGONOMICS SEMINAR
(NOVEMBER 1996)

A. WISNER *

* Emeritus Professor at Conservatoire National des Arts et Métiers, Laboratoire d'Ergonomie, 41 rue Gay-Lussac, 75005 Paris, France, Fax 331.43.25.36.14

THE TECHNOLOGY TRANSFER

CULTURAL MACHINES AND THE ART OF THE ENGINEER

DIVERSITY OF TECHNOLOGY INSTALLATION SITUATIONS

CRITERIA FOR A SUCCESSFUL TRANSFER

NEGOTIATION OF THE SPECIFICATIONS

THE PLACE OF ORGANIZATION OF THE COMPANY AND THE WORK

CONCLUSION : THE TECHNOLOGY TRANSFER IS A DIFFICULT OPERATION

CULTURAL MACHINES AND THE ART OF THE ENGINEER :

- LOGIC OF DESIGN

- LOGIC OF USE

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DIVERSITY OF TECHNOLOGY INSTALLATION SITUATIONS :

- GEOGRAPHY

- TECHNICAL COMPETENCE

- SOCIAL RESOURCES

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CRITERIA FOR A SUCCESSFUL TRANSFER :

- QUANTITY OF PRODUCTION

- PRODUCTION QUALITY

- KEEPING THE TECHNICAL SYSTEM ACQUIRED IN GOOD CONDITIONS

CONDITIONS FOR A LASTING SUCCESS :

- MAINTENANCE

- ACQUISITION OF THE NECESSARY RAW MATERIALS AND SPARE PARTS

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NEGOTIATION OF THE SPECIFICATIONS

1) A SPECIFIC DEFINITION OF THE REASONS WHY THE SYSTEM IS PURCHASED

2) AN IN-DEPTH STUDY OF THE RESOURCES OF THE INDIAN REGION

3) A STUDY OF THE TECHNICAL SYSTEM IN THE SELLER AND IN THE BUYER COUNTRIES

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ERGONOMICS AND ECONOMIC DEVELOPMENT

KEYNOTE ADDRESS GIVEN AT THE SECOND INTERNATIONAL SYMPOSIUM ON ERGONOMICS, OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENT, 25-28 NOVEMBER, 1996, IN NEW DELHI

A. WISNER*

* Emeritus Professor at Conservatoire National des Arts et Métiers, Laboratoire d'Ergonomie, 75005 Paris, France, fax 331.43.25.36.14

1.0. INTRODUCTION : FOR INDIAN ERGONOMICS AND ANTHROPOTECHNOLOGY

2.0. THE INDIAN SCHOOL OF WORK PHYSIOLOGY

3.0. THE INDIAN ORIGINS OF ANTHROPOTECHNOLOGY

4.0. ERGONOMIC WORK ANALYSIS

5.0. CONCLUSIONS

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- GOONATILAKE

- MACAULAY

- SINHA

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- INDIAN ETHNOPHYSIOLOGY : SEN, NAG, GANGULI, GOSWAMI, MITRA

- PHYSICAL ANTHROPOLOGY OF INDIANS

- AEROBIC POWER AND STRENGTH

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- 25 YEARS OF INDIAN ERGONOMICS

- DIVERSITY OF INDIAN WORK SITUATIONS

- BHOPAL

4.0. ERGONOMIC WORK ANALYSIS

4.2. INDIAN CONTRIBUTION TO PSYCHOLOGICAL ERGONOMICS

4.3. ANALOGIES AND DIFFERENCES BETWEEN THE STUDY OF SITUATED ACTION AND ERGONOMIC WORK ANALYSIS

4.3.1. CONTRIBUTIONS FROM COGNITIVE ANTHROPOLOGY

4.3.2. TECHNICAL, ECONOMIC AND SOCIAL CONSTRAINTS AND ANTHROPOLOGICAL TREATMENTS

4.3.4. THE OPERATOR, ITERATIVE CREATOR OF HIS TASK. THE GRASP OF FOREIGN TECHNOLOGY

5.0. CONCLUSIONS

- ERGONOMICS AND INDIAN ECONOMICAL SUCCESS

- INDIA : A MAJOR INDUSTRIAL CIVILIZATION OF THE XXIst CENTURY

KEYNOTE ADDRESS

ERGONOMICS

AND ECONOMIC DEVELOPMENT

MR TANDEL

WISNER

ERGONOMICS AND ECONOMIC DEVELOPMENT

KEYNOTE ADDRESS GIVEN AT THE SECOND INTERNATIONAL SYMPOSIUM ON ERGONOMICS, OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENT, 25-28 NOVEMBER, 1996, IN NEW DELHI

A. WISNER*

* Emeritus Professor at Conservatoire National des Arts et Métiers, Laboratoire d'Ergonomie, 75005 Paris, France, fax 331.43.25.36.14

LUMOCOLOR

PRÄSENTATIONSHÜLLE
PRESENTATION + FILING SLEEVE
POCHETTE DE RETROPROJECTION
ET ARCHIVAGE
FUNDA PARA PRESENTACION
BUSTA DI PRESENTAZIONE

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M PROF. DR. R.N. SEN, D.Sc. Ergonomics Laboratory. H.B. 260, Sector - 3, Salt Lake City. 700.091.

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Timbre du bureau de destination

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Venue of the 2nd. ISE-OH-SE

Scope Complex
Lodhi Road
New-Delhi-110 003

BY AIR MAIL
PAR AVION

Under Certificate of Posting

Prof.Dr.Alain Y. Wisner
Professur Emeritus
Laboratorie D'Ergonomic Du Conservatorie National
Des Arts of Metiers

41, rue Gay-Lussac,
75005 PARIS.

Under Certificate of Posting

ISE-OH-SE
ISE-OH-SE

Second International Symposium on Ergonomics, Occupational Health, Safety and Environment (ISE-OH-SE)

November 25-28, 1996, New Delhi

ISE-OH-SE Secretariat :

- H.P. Chattopadhyay
  Chairman
- R. N. Sen
  Hony. Secretary General
- S. Das
  Treasurer

Indian Society of Ergonomics
HB-260, Sector-3
Salt Lake City
Calcutta-700 091, INDIA
Fax : 091-33-241-3222
Phone : 091-33-337-8701
E-Mail : rnsen @cubmb. ernet. in

Local Organizing Committee

- W. Selvamurthy
  Chairman
- S.K. Mangal
  Co-Chairman
- D. Majumdar
  Secretary

Defence Institute of
Physiology and Allied
Sciences (DIPAS)
Lucknow Road, Timerpur
Delhi-110 054, INDIA
Fax : 091-11-251-2035
091-11-329-2684
Phone : 091-251-2035,
091-293-7275
E-Mail :
WSM @ dipas. ernet. in

Ref : ERG/RNS/ISE-OH-SE/AW/96 Date 20th July, 1996

Dear Prof.Dr. Wisner,

Many thanks for your kind letter dated 21st June, 1996 received by me after my return from Japan participating in two International Conferences. We were very much pleased to receive the copies of the abstract entitled "ERGONOMICS AND ECONOMIC DEVELOPMENT" for your Keynote address, along with the Registration Form. We would eagerly wait for your full text (10 pages A4 size) of the address.

The address of the Scope Complex is in Lodhi Road, near the Jawharlal Nehru Stadium (Director's Office of Sports Authority of India) as given in the map on page 16 of the brochure of 2nd. ISE-OH-SE. This is the very popular place where the conferences and meetings of importance for the industries are held.

Your kind lecture (about 60 minutes) in the Pre-Symposium Workshop would be kept on 21st November or 22nd whichever you prefer, for the industrial participants. Your Keynote address would be kept on 25th or 26th November, as desired by you.

We are all extremely happy that you would be present to encourage and guide us to make both the Pre-Symposium Workshop and the International Symposium a grand success. We are very fortunate that all through out, your kind support, help and guidance have lead us to achieve whatever we could for the progress and development of training and research on Ergonomics in India. We are extremely grateful to/for all these.

With kindest personal regards,

Yours sincerely,

Robin

(R. N. SEN)

To: Prof.Dr.Alain Y. Wisner
Professor Emeritus
Laboratorie D'Ergonomie Du Conservatoire National
Des Arts et Metiers

41, rue Gay-Lussac,
75005 PARIS.

FIRST ANNOUNCEMENT

SECOND INTERNATIONAL SYMPOSIUM ON ERGONOMICS, OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENT

(ISE-OH-SE)

NEW DELHI, INDIA
25-28 NOVEMBER, 1996

With

PRE-SYMPOSIUM WORKSHOP FROM 21-23 NOVEMBER, 1996.

Under the Auspices of the

INDIAN SOCIETY FOR ERGONOMICS (ISE)

Federated with the
INTERNATIONAL ERGONOMICS ASSOCIATION (IEA)

In Collaboration with

DEFENCE INSTITUTE OF PHYSIOLOGY AND ALLIED SCIENCES (DIPAS), DELHI

AND

Other National and International Organizations

Indian Society for Ergonomics (ISE) :

The Indian Society for Ergonomics (ISE) was established in 1987 and was registered as a scientific body in 1988. The Society consists of scientists, experts and interested persons of different disciplines. The aims of the Society are to promote Ergonomics (Human Factors) and allied studies in India for the benefit of the people at work and to improve thier welfare and quality of life. The Society is federated with the Inernational Ergonomics Association (IEA) since 1993.

Defence Institute of Physiology and Allied Sciences (DIPAS) :

The Defence Institute of Physiology and Allied Sciences (DIPAS) is one of the premier institutions of India, which has significantly contributed to the studies in the areas of Environmental Physiology, Ergonomics, Occupational Health and Defence Sciences.

Aims of the Symposium :

1. To apply knowledge of Ergonomics, Occupational Health, Safety and Environmental Sciences in India and other developing countries for greater productivity and cost-effectiveness in Industries, Agriculture, and other areas (Organized and Unorganized Sectors).

2. To improve occupational health and safety and to reduce illness and injuries caused by occupational and environmental hazards.

3. The Symposium will be a forum for exchange of ideas and shared experiences by specialists and research workers in Agriculture, Industries, Universities, Trade Unions and Public Sector Undertakings of India and other industrially developing countries.

Provisional Scientific Themes for the Symposium :

I	**Ergonomics of**	✱ Industry, Agriculture, Mines, Household, Office, Sports and Recreation
		✱ Work-space Design
		✱ Anthropometry, Product Design and Low-cost Improvements
		✱ Manual Materials Handling
		✱ Methods in Ergonomics
		✱ Robotics
		✱ Training and Awareness
II	**Occupational Health and Safety relating to**	✱ Industrial Hygiene
		✱ Industrial Psychology
		✱ Accidents and their Prevention including PPD
		✱ Rehabilitation and Health Care
		✱ Chronobiology and Shift Work
III	**Human and Animal Environmental System**	✱ Environmental Ergonomics
		✱ Musculo-skeletal Disorders
		✱ High Altitude Physiology
		✱ Underwater Physiology

Pre-Symposium Workshop :
Ergonomics and related problems of industrial participants would be tackled by the National and International Faculties.

Offical Language : English
Preliminary Registration by **30th July, 1994**
Abstract (300 words) by **31st January, 1995**
Acceptance of Abstract **30th September, 1995**
More details will be mailed on receipt of the Preliminary Registration Form.

Please Contact : **Prof. Dr. R. N. Sen (ISE-OH-SE)**
Ergonomics Laboratory, Cal. Univ.
HB-260, Sector 3, Salt Lake City,
Calcutta-700 091, India
Fax : 91-33-241-3222
Telex : 021-2752 UNIV IN

Preliminary Registration Form (use Block letters) :

Please complete and return before **30th July, 1994.**

Title.....Surname.....

Name.....

(First) (Middle)

Affiliation.....

and

Address.....

.....

.....

.....

☎.....

Fax.....

E. Mail:.....

I intend to participate in : (Please ✓)

Pre-symposium Workshop	❑
Demonstration in Exhibition	❑
Video Session	❑
Poster Interactive Session	❑
Oral Presentation	❑
Technical Visits	❑
Sight-seeing Tours	❑

I would be accompained by.....person(s)
as participant/observer(s)

Are you a member of ISE? Yes/No

Provisional title of the Paper.....

.....

.....

Author(s).....

.....

Please also send information to.....

.....

.....

(Xerox copies are also acceptable). Signature....

Prof. Dr. R. N. Sen

The Secretary General
Organizing Committee
ISE-OH-SE,
HB-260, Sector 3,
Salt Lake City
Calcutta-700 091
India

International Scientific Advisory Committee

J. Jeyaratnam (Singapore)
W. O. Phoon (Australia)
C. Smith (USA)
K. C. Parsons (UK)
A. Grieco (Italy)
D. Costa (Italy)
P. Engel (Germany)
G. Hagglund (USA)
S. Horino (Japan)
K. Kogi (Japan)
I. Kuorinka (Finland)
A. Wisner (France)
J. M. Patrick (UK)
K. Vanwonterghem (Belgium)
Y. Hayashi (Japan)
S. R. Neelam (USA)
P. Rookmaaker (Holland)
W. Laurig (Germany)
B. Moncelon (France)
J. Wood (UK)
E. J. Hamley (UK)
A. S. Paintal (India)
A. Khaleque (Bangladesh)
M. Helander (USA)
S. Banerjee (India)
B. Das (Canada)
K. N. Sharma (India)
S. E. G. Perera (Sri Lanka)
Y. Tochihara (Japan)
T. Okubo (Japan)
I. Holmer (Sweden)
H. Monod (France)
S. Folkard (UK)
C. Ong (Singapore)

National Organizing Committee

H. P. Chattopadhyay	:	Conference Chairman.
A. R. Guha Roy	:	Conference Vice-Chairman.
R. N. Sen	:	Hony. Secretary General.
S. Das	:	Hony. Treasurer.
W. Selvamurthy	:	Chairman, Local Organizing Committee.
D. Majumdar	:	Secretary, Local Organizing Committee.

Members :

S. Guha (New Delhi)
A. Goswami (Patiala)
S. Gangopadhyay (Bhilai)
T. Panchal (Bokaro)
A. Ghosh (New Delhi)
P. L. Bali (Patiala)
A. K. Ganguli (Trichi)
S. Ghosal (Ahmedabad)
C. K. Pradhan (Ahmedabad)
K. Munshi (Bombay)
K. K. Sengupta (Calcutta)
T. Ganguli (Calcutta)
L. P. Gite (Bhopal)
S. Sethuraman (Ahmedabad)
K. Gulshan (Bangalore)
D. Chakraborti (Ahmedabad)

List of members of different committees are not complete

Paris, 30 th October 1996

Professor R.N.Sen
Indian Society of Ergonomics
H.B. 260 Sector 3
Salt Lake City
Calcutta 700.091
Inde
Fax 00.91.33.241.32.22

Dear Professor Sen,

I am very sorry to have done a repeated mistake about your address. We have send my two last letters to your former University adress : the letter you mention in your own letter (20th September) containing the text of my keynote address and a second one dated 4th October and containing the text of the synopsis of the tutorial with the corresponding cassette. I will bring with me the cassette corresponding to my keynote address. We have also sent to you four samples of the book collecting my papers written in English 1990-1996. Though we have used a very competent (and costly) messenger (Chronopost), they were unable at the first presentation to deliver it at you former University address. Then I asked them to insist at this former address or to deliver it at Delhi to Dipas. I dont know where this packet is now.

Anyway, I will travel to Bangkok the 6th November and stay at hotel Asia (Fax 00.662.215.43.60) antil I will fly to Delhi the 20th November, and will go to Hotel Ambassador where I will stay the first two nights.

I dont know yet when I will deliver my tutorial. Would you kindly send me a fax eather in Paris (01.43.25.36.14) before the 6th/11 or in Bangkok (Hotel Asia) after the 7th/11.

I am really happy to see your soon.

Truly yours.

A. Wisner

ISE-OH-SE

Second International Symposium on Ergonomics, Occupational Health, Safety and Environment (ISE-OH-SE)

November 25-28, 1996, New Delhi

ISE-OH-SE Secretariat :

- H.P. Chattopadhyay
  Chairman
- R. N. Sen
  Hony. Secretary General
- S. Das
  Treasurer

Indian Society of Ergonomics
HB-260, Sector-3
Salt Lake City
Calcutta-700 091, INDIA
Fax : 091-33-241-3222
Phone : 091-33-337870
E-Mail :
rnsen @cubmb. ernet. in

Local Organizing Committee

- W. Selvamurthy
  Chairman
- S. K. Mangal
  Co-Chairman
- D. Majumdar
  Secretary

Defence Institute of
Physiology and Allied
Sciences (DIPAS)
Lucknow Road, Timerpur
Delhi-110 054, INDIA
Fax : 091-11-2932869
Phone : 091-11-2940567
E-Mail :
root@drdipa.ren.nic.in

Ref : ERG/RNS/ISE-OH-SE/96 Date 3rd October '96

To: Prof. Dr.A.Wisner, Emeritus Prof.,CINAM, 75005 Par s

Dear Prof.Dr.Wisner,

I hope, you have already received my letter dated sent under Certificate of Posting.

Thank you very much for your letter dated 20th September 1996 received by me on 30th September as the letter was addressed to my former place of work at 92 A P C Road, Calcutta - 700 009 instead of my permanent mailing address (and also ISE Address at) HB - 260, Sector - 3, Salt Lake City, Calcutta-700 091, enclosing full paper of your Keynote Address.. From 17th July 1996 my laboratory has been shifted to the Department of Physiology, University College of Medicine (UCM) at 244B, Acharaya Jagadish Chandra Bose Road(A.C Bose Road), Calcutta-700 020 of the Faculty of Medicine, University of Calcutta, for the continuity of the two projects under the Ministry of Environment and Forests and under the Department of Science and Technology, Government of India and also for the completion of the research work of my remaining PhD Students. I would prefer to receive my communications in my permanent mailing address to avoid delay since there are two more persons with the same as that of mine in the same University Campus at 92 APC Road.

You can rest assured that the Press Editor would not dare reduce the number of pages of your full paper in the final volume of the proceedings to be printed after the 2nd ISE-OH-SE. If you wish to make any modifications in the full paper after delivery of your Keynote Address, kindly do so for incorporation in the final proceedings.

May we have the Synopsis of your lecture to the Industrial Participants in the Pre-symposium Workshop (about 8 pages of A-4 Size lecture notes) copies of which would be distributed to each of the Industrial Participants, as a bound volume of the Workshop/Course Materials! I am enclosing herewith a form for the Foreign Faculties to be filled in as required by DIPAS.

With kindest personal regards,

Sincerely yours,

(R.N.SEN)

Enc. A.A.

CONSERVATOIRE
NATIONAL
DES ARTS
ET MÉTIERS

ERGONOMIE ET
NEUROSCIENCES
DU TRAVAIL

PARIS 02/09/96

A. WISNER
à
Professor R.N. SEN
091-33.241.32.22

Dear Professor Sen,
Dear Robindranath,

I am very sorry not to have sent you (yet) my full paper for my Keynote adress. It has been longer to write than I thought but extreamly interesting for me.

It is now ready but I have no necessary to type it in such a form that I may send it to our professional translation I hope that anyway, you will have it in three weeks or so.

You shall receive in 2 or 3 ~~weeks~~ weeks an offset book published by our laboratory collecting 15 papers that have been printed in English between 1991 and 1996. This book could be used by the participants of the workshop on Anthropotechnology but I am not sure to be able to send enough copies for all participants of this workshop. Can you help me for this decision?

My reservations are nearly complete. I hope to arrive in Delhi Tuesday the 24th in the evening but I will have probably wednesday 25th at midnight.

I really enjoy to visit again your country for my last trip to Asia

With my best regards

Truly yours

A. WISNER

LABORATOIRE
D'ERGONOMIE

41, RUE
GAY-LUSSAC
75005 PARIS

TÉLÉPHONE
(1) 43 54 18 27
TÉLÉCOPIE
(1) 43 25 36 14

Paris, 4th October 1996

CHRONOPOST

Mr le Professeur R.N. Sen
Head of Department of Physiology
University College of Science and
Technology
92 Acharyya Prafullachandra Road
Calcutta 700 009 (Inde)

Dear Professor Sen,
Dear Rabindranath,

You shall find under the same cover, a copy of the synopsis of the tutorial you kindly ask me to write for the book of course materials. I join to this copy the cassette where this text is recorded. I will bring in Delhi the other cassette on which my plenary paper is recorded. I hope that you have received now this paper. Later you shall receive the 4 samples of the book where the papers I wrote in English from 1990 to 1996 have been collected.

I will arrive in Delhi from Bangkok by a flight of Thaï International Airways T.G. 315 Wednesday 20th November at 10h.50pm and take a taxi for Hotel Ambassador. Please dont receive me at Delhi airport at the cost of your evening and night rest.

I am very happy to meet you soon in the arms of "Mother India".

With my best regards.

Truly yours.

A. Wisner

Paris, 20th September 1996

CHR No No Post

Mr le Professeur R.N.Sen
Head of Department of Physiology
University College of Science and
Technology
92 Acharyya Prafullachandra Road
Calcutta 700 009 (Inde)

Dear Pr Sen,
Dear Rabindranath,

I am really sorry to be so late in sending now my paper, you wanted to receive at the end of July. It has been very difficult for me to write this text though I have thought so much to India since - at least - 20 years with you strong help.

I am not only late but I know also that my paper is too long. It would be marvelous if you could take it all or with short reductions. If I have to come back to the 10 pages standard I will have to cut 1, 2 or 3 of the following parts.

part 1) The quotations of Goonatilake, Macaulay and D. Sinha (p. 1 - 4) but then non indian readers will not realize how severe the mutilations of indian science have been.

2) The indian school of work physiology (p. 4 - 7). I have wrote most of the facts and comments of this part in a paper published in the International Journal of Industrial Ergonomics. But how far indian and non indian scientists know how important are the researches of this school. Did they have read my paper in I.J.I.E. ?

3) The part entitled Ergonomic Work Analysis (p. 10 - 16) is directly inspired by my Toronto report. But do you think that Indian ergonomists and industrialists have read this report published in Ergonomics ? If not, I am loosing the occasion to diffuse an approach that seems to correspond to the indian demand ?

Would you kindly advise me. Anyway, be sure that I will use only 30 minutes to give my Congress Adress in Delhi.

With my best regards.

Truly yours.

A. Wisner

CONSERVATOIRE
NATIONAL
DES ARTS
ET MÉTIERS

ERGONOMIE ET
NEUROSCIENCES
DU TRAVAIL

Paris, 13th September 1994

Prof. Dr. R.N. SEN, D. Sc.
Professor and Head,
Ergonomics Laboratory
HB - 260, Sector - 3, Salt Lake City,
Calcutta, 700 091
India

FAX 091. 33 241 3222

Dear Professor Sen,

All my congratulations for your decision to hold the Second International Symposium on Ergonomics, Occupational Health, Safety and Environment in New Delhi in November 1996.

I see that you are still the active leader of Work Physiology and Ergonomics in India and one of the leaders in the world. It is not really a surprise.

I am both confused and pleased to receive from you so many kind proposals to which I have to answer carefully as I am getting old. Of course I accept as an honour to be a member of the International Scientific Advisory Committee. I could be the chair person of one of the sessions and act as a foreign faculty in the Pre-symposium Workshop but November 1996 happens to be two months after the end of my position as Professor Emeritus.

In principle I have decided to stop working in Ergonomics at this time (30th September 1996) but may be my wife's and my own health will allow me to attend this interesting Symposium. So please let me confirm later on if I am able to go to New Delhi.

With my best regards,

Yours sincerely,

Alain Wisner

LABORATOIRE
D'ERGONOMIE

41, RUE
GAY-LUSSAC
75005 PARIS

TÉLÉPHONE
(1) 43 54 18 27
TÉLÉCOPIE
(1) 43 25 36 14

E... @ cubmb. ... Under Certificate of Posting

5th September 1996.

Dear Prof. Dr.Wisner,

Many thanks for your kind hand written letter sent by Fax, received by me on 3rd September '96. Your hand written letter without any Secretarial help would be my prized possession, which shows your intense affection, love and best wishes for the development of Ergonomics in India. We all are grateful indeed for your continuous assistance in our efforts to apply Ergonomics for the progress and development of our country.

We would wait for your full paper to be published in the Proceedings of the 2nd ISE-OH-SE after the Symposium. Instead of the camera ready copies, you could send or bring the copies with you.

You could also send one or two copies of the fifteen papers in English which we would keep for the Industrial Participants to be seen and studied during the Pre-Symposium Workshop, but we need a few pages of (atlest) Synopsis of your Lecture to the Industrial Participants to be printed for distribution among them in the form of a book of Course Materials. These may kindly be sent, at your earliest.

We are extremely happy that you are taking all the troubles of coming to India in the month of November 1996 to act as one of the Foreign Faculties in the Pre-Symposium Workshop to be held from 21st to 23rd November at DIPAS, Timarpur, Lucknow Road, Delhi - 110 054 and give Keynote Address at the Symposium to be held from 25th to 28th of November on which date you would leave for France. If you could kindly let me know the Flight No. of your arrival, we would be able to receive you at the Airport.

We would eagerly look forward to your August visit and active participation and help to make the Symposium and the Workshops a grand success.

With profound personal regards,

Sincerely yours,

Robin

(R N SEN)

Prof.Dr. Alain Wisner,
Emeritus Professor,
Laboratoire D'ergonomie,
4 1 Rue Gay-Lussac,
75005 PARIS
FRANCE.

P.S. : May we request your permission to make a few minor typographical mistakes corrections in your Abstract, as for example, last line in 1st paragraph "Calcutta School of Work Psychology" to be changed to "Calcutta School of Ergonomics and Work Physiology" ?

हवाई पत्र
Aerogramme

Under Certificate of Posting

650 INDIA

Prof. Dr. Alain Wisner,
Emeritus Professor,
Laboratoire D'ergonomie,
41 Rue Gay-Lussac,
75005 PARIS
FRANCE.

दूसरा मोड़ SECOND FOLD

भेजने वाले का नाम और पता:-
Sender's Name and Address:-

Prof. Dr.R.N. Sen,

इस पत्र के अन्दर कुछ न रखिये
No Enclosures Allowed

Paris, June 21, 1996

Prof. Dr. R. N. Sen, D.Sc.
Ergonomics Laboratory
HB - 260, Sector - 3, Salt Lake City
Calcutta, 700 091
India
Fax: 19.91.33.241.32.22

Dear Professor Sen,
Dear Rabindranath,

Please find enclosed three copies of the summary of the introductory speech which you asked me to make at the Symposium you are organizing next November. I shall send you the full text (10 pages) of my speech by August 31.

I was led to understand that the Symposium programme would be organized in the Scope Complex. I would like to know the exact address of this building so that I can choose an appropriate hotel.

I did not take up the invitation of a hotel reservation through the official Congress agent since I can do it from France at a lower rate. Don't worry about this point.

I intend to stay in Delhi from Wednesday 20th to Wednesday 27th of November. As such, I would be pleased if my pre-Symposium Workshop on "Technology creation and transfer" could take place before the Congress since I will probably not be in Delhi after the Congress.

Furthermore, I would like my introductory "Keynote Address" speech to take place on November 25 or 26 since I may well have to catch a plane on the 27th.

I am very pleased at the idea of participating in this great event on my last professional trip to Asia.

Yours truly,

A. Wisner

Message

Expéditeur
Société :
Nom : FASSIER

Destinataire
Société : CNAM
Nom : VAUTRIN JEAN CLAUDE

Date : 22/04/96
Heure : 12:49:[illegible]

Return-Path: <rnsen@[illegible].ernet.in>
To: vautrin@cnam.fr [illegible] (Jacqueline)
Subject: Re: vautrin[illegible] not provide any subject!
From: rnsen@cubmb.ernet[illegible] (R[illegible]ndra Nath Sen)
Date: Thu, 18 Apr 96 [illegible]

Dear Prof [illegible]
Thank you very [illegible] for [illegible] 18th. April
received by [illegible] th. April [illegible]. We have
just sent you [illegible] certificate of
Posting the [illegible] announcement of
2nd. ISE-OH-S[illegible] may for the
Proc. of the [illegible]
and the Works[illegible]
be held in New [illegible]
answers of your [illegible] tomorrow.
With kindest personal [illegible] and best wishes
for a Very Happy and Prosperous Bengali New Year
to you and your family.
yours sincerely,
Robin.

Message

éditeur
ciété :
m : FASSIER

stinataire
ciété : CNAM
m : VAUTRIN JEAN CLAUDE

e : 22/04/96
re : 12:49:25

urn-Path: <rnsen@cubmb.ernet.in>
: vautrin@cnam.fr (Casanova Jacqueline)
ject: Re: vautrin@cnam.fr did not provide any subject!
m: rnsen@cubmb.ernet.in (Rabindra Nath Sen)
e: Thu, 18 Apr 96 07:41:30 IST

ar Prof Jc. Vautrin,
ank you very much for kind email of 15th April
eived by me today (19th April,1996). We have
st sent you by air mail Under Certificate of
sting the booklet of the 2nd. Announcement of
d. ISE-OH-SE. You need not have to pay for the
oc. of the 1st. ISE-Series. For ISE-OH-SE
d the Workshops (ITS and Data) Symposium would
held in New Delhi. I am sending all the
swers of your questions by tomorrow.
h kindest personal regards and best wishes
a Very Happy and Prosperous Bangali New Year
you and your family.
rs sincerely,
in.

Message

Expéditeur
Société :
Nom : FASSIER

Destinataire
Société : CNAM
Nom : VAUTRIN JEAN CLAUDE

Date : 23/04/96
Heure : 13:01:37

Return-Path: <rnsen@cubmb.ernet.in>
To: vautrin@cnam.fr (Casanova Jacqueline)
Subject: Re: vautrin@cnam.fr did not provide any subject!
From: rnsen@cubmb.ernet.in (Rabindra Nath Sen)
Date: Mon, 22 Apr 96 06:13:36 IST

Email : vautrin@cnam.fr

To
Prof. Dr. Alain Wisner,
Emeritus Professor.

Message

Expéditeur
Société :
Nom : FASSIER

Destinataire
Société : CNAM
Nom : VAUTRIN JEAN CLAUDE

Date : 23/04/96
Heure : 13:20:19

Return-Path: <rnsen@cubmb.ernet.in>
To: vautrin@cnam.fr (Casanova Jacqueline)
Subject: Re: vautrin@cnam.fr did not provide any subject!
From: rnsen@cubmb.ernet.in (Rabindra Nath Sen)
Date: Mon, 22 Apr 96 06:13:36 IST

Email : vautrin@cnam.fr

To
Prof. Dr. Alain Wisner,
Emeritus Professor.

Dear Prof. Dr. Wisner,
Kindly refer to your Email of 18th April 1996 and my part Email reply dated 19th April.
1. Your keynote address of 30 minutes duration is scheduled to be delivered in the morning session between 11 A.M.
to 12 noon on 25th or between 9 A.M. to 10.30 A.M. between 26th

to 28th November, 1996.
2. The full Proceedings of the 2nd ISE-OH-SE would be printed. Abstract within 300 words should be sent by 15th June and ten pages of A4 size full paper by 31st August.
3. The Symposium /Congress will be held in the Scope

Paris, April 16th 1996

Professor R.N.Sen
rnsen @ cubmb ernet in

Dear Pr Sen,
Dear Robin,

I am also late to answer your e.mail of 8 March. I am sorry that we have made a mistake in your e.mail adress. I hope that this time it will be correct.

I am writing to you to obtain some precisions about the Second International Symposium you are organizing in New Delhi next November. I understand that the symposium it self will be organized 25th to 28th November. May I understand that my keynote/plenary paper will be read during this period of time. I would like to know if this paper will be printed and if it is the case, when you have to receive it. Do you know how long I will have to give it orally.

My second question, is about, the workshop. During what period, these workshops will take place ? Is it possible for me to be programmed during one of the last sessions ?

I would like also to know where in New-Delhi the Congress and workshops will take place.

I will be happy to pay the price of the book you sent me but I will do that when I will be in New-Delhi. The cost of sending money from France to India is to high (nearly the amount of the price it self).

A I mention money problems, do not worry. It will be a pleasure for me to pay the Congress fees when I will be in India.

It is really a pleasure to think to this project.

With my best regards.

Truly yours.

A. Wisner

To: cottura@cnam.fr
Subject: letter
From: rnsen@cubmb.ernet.in (Rabindra Nath Sen)
Date: Fri, 08 Mar 96 19:11:00 IST

Dear Prof. Dr. Wisner,
Kindly refer to my Email letter sent in "reply"
to your Email of 11th.December,1996.
In that letter I indicated that your Email letter
was fortunately recovered though my Email address
was wrongly sent as "fnsen" instead of "rnsen".
I waited for a response but did not get any response.
I only received your kind postal letter and later on
your excellent published papers (15) which gave me
immense knowledge and information which took some
time for me to send you a response by your other
Email in which I am sending this reply. I am extremely
grateful. Kindly send an one line response so that I
know that this Email is suitable for our communication.
Your keynote address topic would be excellent for the
ISE-SE-SE as well as for the workshops.
With kindest personal regards,
yours sincerely,
Robin, 8th.March,1996.

Au demande de précision sur journée congrès et des workshops, le lieu, la durée des Keynotes et des workshops dialogue avec l'auditoire, comportement de l'auditoire universitaire/industriel, médias/autres acteurs.

Paris, December 7, 1995

Prof. Dr. R.N. Sen, D.Sc.
Professor and Head of
Ergonomics Laboratory
HB - 260, Sector - 3, Salt Lake City
Calcutta, 700 091
India

Dear Professor Sen,
Dear rabindranath,

Since I wrote to you recently, I have received two documents which answer my questions.

The Registrar of the University of Calcutta sent me Mr Samit Kumar Mitra's thesis. I shall try to read it quickly and send the report requested to the Registrar and yourself.

I also received an official invitation to present one of the Keynote Addresses to the Symposium that your are organizing in New Delhi on November 25 to 28, 1996. You also suggested that I should take part in the pre-Symposium Workshops. I am very flattered by these two invitations and am delighted to accept.

As regards the themes I could tackle, in the Keynote Addresses my first reaction would be to mention the problems encountered and the successful development of ergonomics in industrially developing countries, especially those, like India, which have developed rapidly and are sometimes referred to as New Industrialized Countries to demonstrate the power and originality of Indian development in which your role has been - and still is - predominant.

Along the same lines, but using a different method, I could dedicate a workshop to technology transfers seen from the anthropological angle.

However, I am not sure that my suggestions are right; I think it would be more reasonable for you to take a look at the tests I published recently in English so that you can make the choice yourself.

You mentioned the financial problems raised by such a participation. Thank you for whatever you can manage, without creating a burden on the financing of an International Congress that is always difficult.

I am sure I can pay my flight ticket and possibly my accommodation costs without any difficulty. As regards the inscription fee, see what you can do. Perhaps this decision could be left until I arrive in New Delhi.

I look forward to meeting you again and wish you all the best in this exciting but difficult initiative.

A. Wisner

N.B. Enclosed, you will find some 15 texts which partially reflect my recent activity. There is not always an English version of what I write.

CONSERVATOIRE
NATIONAL
DES ARTS
ET MÉTIERS

ERGONOMIE ET
NEUROSCIENCES
DU TRAVAIL

Paris, November 20, 1995

Professor Dr. R. N. Sen, D.Sc.
Professor and Head of the Ergonomics
Laboratory
HB - 260, Sector - 3, Salt Lake City
Calcutta, 700 091
India

Dear Professor Sen,
Dear Rabindranath,

I have three reasons for writing to you:

1) I have just received the book entitled "Occupational and environmental Ergonomics" which contains the interesting work presented in Bombay four years ago at the meeting of the I.S.E.

I know how much this book cost you in terms of worry and effort. Congratulations on the result.

2) Nearly five months ago, the University of Calcutta invited me to be member of the examination board for Mr. Sri Samit Kumer Mitra. At the end of July I wrote to the Registrar accepting this offer but I have still not received the thesis I am supposed to examine. I fear that there has been a transmission error somewhere.

Enclosed, you will find a copy of the letter which I sent to the administration concerning this matter. ✗

3) Some time ago, you informed of the preparation of the Ergonomics Conference that should be held in Delhi next November. I still hope to that I will be able to attend but I have had no news of the conference since your first letter. Could you please confirm the terms of your letter of July 1994?

Enclosed, you will find a copy of my answer in the case where the letter did not arrive.

Hoping to see you in November in India, I remain,

Yours sincerely,

A. Wisner

LABORATOIRE
D'ERGONOMIE

41, RUE
GAY-LUSSAC
75005 PARIS

TÉLÉPHONE
(1) 43 54 18 27
TÉLÉCOPIE
(1) 43 25 56 14

✗ I received the thesis yesterday. I am surprised to see that this student doesn't seem to yours

Paris, le 20 Novembre 1995

Prof. Dr. R.N. Sen, D.Sc.
Professor and Head
Ergonomics Laboratory
HB - 260, Sector - 3, Salt Lake City
Calcutta, 700 091
India

version française de la traduction par Young

Dear Professor Sen,
Dear Rabindranath,

Trois questions m'incitent à vous écrire :

1°) Je viens de recevoir le livre "Occupational and environmental Ergonomics" qui réunit les intéressants travaux qui ont eu lieu à Bombay il y a 4 ans à l'occasion de la réunion de l'I.S.E.

Je sais combien ce livre vous a coûté de soucis et de démarches. Je voudrais vous féliciter du résultat.

2°) J'ai reçu, il y a déjà près de 5 mois, une invitation de l'Université de Calcutta pour faire partie du jury de Monsieur Sri Samit Kumer Mitra. J'ai répondu favorablement fin Juillet au Registrar, mais je n'ai pas reçu la thèse que je dois examiner. Je crains qu'il y ait eu quelque part une erreur de transmission.

Vous trouverez, ci-joint, la photocopie de la lettre que j'ai, à cet effet, envoyée à l'administration.

3°) Vous m'avez informé, il y a déjà assez longtemps, de la préparation du Congrès d'Ergonomie qui doit se tenir à Delhi en Novembre prochain. Je continue à espérer de pouvoir m'y rendre, mais je n'ai pas reçu de nouvelles de ce Congrès depuis votre première annonce. Pouvez-vous me confirmer votre lettre de Juillet 1994 ?

Vous trouverez, ci-joint, la copie de ma réponse au cas où la transmission ne se serait pas bien faite.

Je me réjouis de vous voir probablement en Novembre en Inde et vous adresse toutes mes amitiés.

A. Wisner

BY AIR MAIL
PAR AVION

Under Certificate of Posting

Prof.Dr. Alain Wisner
Emeritus Professor
Laboratoire d' Ergonomie
Conservatoire National des arts
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ERGONOMICS LABORATORY
DEPARTMENT OF PHYSIOLOGY
UNIVERSITY OF CALCUTTA

From :
Prof. Dr. R. N. Sen, D.Sc. (Cal)
Professor and Head, Ergonomics Laboratory
Please Reply to : HB - 260, Sector - 3, Salt Lake City,
Calcutta - 700 091, INDIA
E-Mail No. : rn sen @ cubmb. ernet. in

University Colleges of Science, Technology & Agriculture
[redacted]
INDIA

Ref. No. PHY/ERG/RNS/ ISE-OH-SE/95

Dated.....20th Oct.,.... 1995

Dear Prof.Dr.Wisner,

* I am enclosing herewith the official letter of invitation to you for kindly delivering the Keynote address at the 2nd ISE-OH-SE.

I am also to request you kindly to act as a Foreign Faculty in the Pre-Symposium Workshops to deliver one or two lecture-cum-demonstration on the topics of your choice to the industrial participants.

We have sent by registered post the complimentary copy of the full proceedings of the 1st ISE-OH-SE as your personal copy. Kindly acknowledge the receipt of the copy.

* I am enclosing a flyer for the full proceedings (ISBN 81-900508-0-X) of the 1st ISE-OH-SE which has already been printed as a 255 + x pages of A4 size hard bound volume with a price of US $ 35.00 or equivalent without the cost of postage. Will the Librarian of your Organisation be interested in placing an order for this book entitled "Occupational and Environmental Ergonomics", at an early date ?

As one of the Members of the body of the International Scientific Advisory Committee of the 2nd ISE-OH-SE, will you kindly send advices and suggestions to make the ensuing Symposium and the Workshops a grand success ?

With kindest personal regards and very happy Vijaya and Dipawali Greetings to you, your family and colleagues,

Yours sincerely,

(R.N. SEN)
Hony.Secretary General, ISE-OH-SE

* Enclo : as above.

Prof.Dr.Alain Wisner
Emeritus Professor
Laboratoire d' Ergonomie
Conservatoire national des arts
41, Rue Gay Lussac
F-75005 Paris,
FRANCE.

UNDER CERTIFICATE OF POSTING.

SECOND
INTERNATIONAL SYMPOSIUM ON ERGONOMICS,
OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENT
(ISE-OH-SE)

PHY/ERG/RNS/ISE-OH-SE/95 Dated : 7th October,1995.

Prof.Dr.Alain Wisner
Emeritus Professor
Laboratoire d' Ergonomie
Conservatoire national des arts
41, Rue Gay Lussac
F - 75005 Paris, France.

Subject : Invitation to deliver Keynote/ Plenary papers at the 2nd ISE-OH-SE to be held in New Delhi in November,1996.

Dear Prof.Dr.Wisner,

The Indian Society of Ergonomics (ISE) and the International Ergonomics Association (IEA) are hosting jointly the Second International Symposium on Ergonomics, Occupational Health, Safety and Environment (ISE-OH-SE) in New Delhi from 25th to 28th November, 1996, which would be organized by the Defence Institute of Physiology and Allied Sciences (DIPAS). It is the most important meeting in this area in Asia. In addition to attracting high quality scientific papers, this always has been a prestigious event. It is the intention of the Organizing Committee to sustain and perhaps improve the performance of this International Congress.

It is with this intention that the Organizing Committee have decided to invite selected leading scientists around the world to deliver Keynote/Plenary papers to set the tone of the Congress. Since you are an internationally recognized scientist, I, the Secretary General of the Organizing Committee, have the pleasure of inviting you to deliver a paper on your selected topic.

As is the case in most of the conferences, the funds are extremely limited. Although we are not in a position to offer you financial assistance towards Air travel, we would provide you some local hospitality. I sincerely hope this will not prove to be a deterrent for you and funds will be available from your local sources. We wish you will be able to join us for the Symposium and share some of your research experiences. Will you kindly send the title of your Keynote/ Plenary paper for the Symposium, at your earliest ?

We also hope that you would encourage many of your colleagues to present papers at this Congress to make it a grand success. We look forward to your positive response and to have an opportunity to interact with you during your visit. Your helpful advice regarding the Symposium will be most welcome.

With kind regards,

Yours sincerely

(Prof.Dr.R.N.Sen)
Hony. Secretary General
Organising Committee (ISE-OH-SE)

Secretariate:
HB - 260, Sector - 3,
Salt Lake City,
Calcutta - 700 091, INDIA.
E-Mail : rnsen@cubmb.ernet.in

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Occupational and Environmental Ergonomics

Edited by

Rabindra Nath Sen, Subir Das
and
Haripada Chattopadhyay

Occupational and Environmental Ergonomics

This is an A4 size hard cover book (ISBN 81 - 900508-O-X) published by the Indian Society of Ergonomics (ISE). This volume is the edited version of the selected fifty original papers presented by internationally reputed scientists at the First International Symposium on Ergonomics, Occupational Health, Safety and Environment (ISE-OH-SE) held at Bombay, India, from 2-6 January, 1991. Professor Rabindra Nath Sen and Subir Das, Ergonomics Laboratory, Department of Physiology,University of Calcutta and Dr.Haripada Chattopadhyay, Department of Physiology, Presidency College, Calcutta are the editors of the book (Total pages 256 + x).

The chapters are : 1. Methods and Training in Ergonomics (9 papers); 2. Design Ergonomics (10 papers); 3. Ergonomics in Industry (7 papers); 4. Occupational Safety and Accidents Prevention (4 papers); 5. Work Organization, Shift Work, Performance and Productivity (10 papers); 6. Ergonomics in Agriculture and Fishery (4 papers); 7. Occupational Health, Environment and Legislation (6 papers). It also includes the Recommendations of the Symposium.

The book may provide guidelines to the students, teachers, engineers, medical personnel, management experts and other professionals interested in ergonomics and its application. These articles contain valuable information data analysis and solution of problems of different fields such as workers in industry, in agriculture and design ergonomics. These vital information will be useful not only to academic scholars but also to industrial management, Labour Ministry Officials, trade union leaders, managers of public sectors undertakings, not only in the developing countries but also in the developed countries.

The book costs US $ 35 plus Air mail/ shipping charge for outside India and Rs. 350/- plus the postage within India (a 15% discount on the price would be given to the ISE members). As only a limited number of copies have been printed, you are advised to order for a copy for your office or library from Prof.R.N. Sen, the Honorary General Secretary, The Indian Society of Ergonomics (ISE), HB - 260, Sector - 3, Salt Lake City, Calcutta-700 091, India.
Fax : (+91-33) 241 3222; E.Mail : rnsen@cubmb.ernet.in

ORDER FORM

To:The Honorary General Secretary, The Indian Society of Ergonomics (ISE)
HB - 260, Sector - 3, Salt Lake City, Calcutta-700 091,India.
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ERGONOMICS LABORATORY
DEPARTMENT OF PHYSIOLOGY
UNIVERSITY OF CALCUTTA

From :
Prof. Dr. R. N. Sen, D.Sc. (Cal)
Professor and Head, Ergonomics Laboratory
Please Reply to : HB - 260, Sector - 3, Salt Lake City,
Calcutta - 700 091, INDIA

University Colleges of Science, Technology & Agriculture
92, Acharyya Prafulla Chandra Road, Calcutta - 700 009
INDIA

Ref. No. PHY/ERG/RNS/ ISE-OH-SE/94

Dated 4 JULY 1994

To
Prof. Dr. Alain Wisner
Emeritus Professor
Laboratoire d' Ergonomie
Conservatoire national des arts
41, Rue Gay Lussac
F-75005 Paris
FRANCE.

Dear Prof.Dr.Wisner,

You will be glad to know that we are holding the 2nd International Symposium on Ergonomics, Occupational Health, Safety and Environment(ISE-OH-SE) under the auspices of Indian Society of Ergonomics (ISE) in New Delhi in November, 1996.

We have great pleasure in inviting you to act as a Chairperson in one of the sessions of the Symposium and also to act as a foreign faculty in the Pre-symposium Workshop and to act as a Member in the International Scientific Advisory Committee of ISE-OH-SE.

* I am enclosing herewith the 1st announcement of the 2nd ISE-OH-SE for your kind perusal. Your kind help and participation could only make the Symposium a grand success.

You will be glad to know that after 5 years of pursuasion I have just been able to get a Project entitled 'Assessment of impact of hot hazardous working environment on Indian industrial and agricultural workers and development of ergonomically designed personal protective devices' sanctioned by the Dept.of Environment and Forest, Govt.of India for a period of 3 years. Your expert suggestions and advice would be very much appreciated in this regard.

With kindest personal regards,

Yours sincerely,

(Prof. R.N.Sen)
Secretary General, ISE-OH-SE

*Enclo : as above.

William Anthony

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PROGRAMME OF

THREE AND HALF-DAY SEMINAR

ON

ERGONOMICS

(22nd to 25th February, 1972)

(Under the auspices of the Life Science Centre, Calcutta University)

★

ORGANISED BY

DEPARTMENT OF PHYSIOLOGY

UNIVERSITY COLLEGE OF SCIENCE & TECHNOLOGY

CALCUTTA UNIVERSITY

Tuesday, 22nd February, 1972

1-30—2-30 p.m.	Registration of the participants of the Seminar at the Department of Physiology, 92, Acharyya Prafulla Chandra Road, Cal.-9.
2-30—4-00 p.m.	INAUGURATION. Venue : Science College Central Lawn (Main Pandal). Opening song.
	Welcome address by Prof. P. K. Bose, Pro-Vice-Chancellor (Academic Affairs), Calcutta University.
	Annual Report by Dr. T. M. Das, Secretary, Life Science Centre, C. U.
	Address by Dr. S. C. Roy, President, Life Science Centre.
	Inauguration of the Seminar by the Guest-in-Chief, Prof. S. N. Sen, Vice-Chancellor, Calcutta University.
	Reading of Messages by Dr. R. N. Sen.
	"Popularisation of Ergonomics through the Life Science Centre of the Calcutta University"—talk by Prof. P. K. Bose, Director, Life Science Centre, Calcutta University.
	"Scope, importance and use of Ergonomics in developing countries" remarks by Prof. S. R. Maitra, Convener of the Seminar.
	Vote of Thanks by Dr. R. N. Sen, Department of Physiology, Calcutta University College of Science & Technology.
	National Anthem.
4-00—4-15 p.m.	GROUP PHOTO.
4-15—5-00 p.m.	Recess for the Mayor's Reception to Science Congress Delegates at Green Park (Opposite Science College).
5-00—5-30 p m.	Film Show—"Fitting the job to the worker" at the Saha Institute Auditorium (1st floor), Science College Campus.
5-30 p.m.	Popular Lecture of Indian Science Congress—Ninth B.C. Guha memorial Lecture on "Science Policy—time to think" by Dr. Atma Ram at the Bose Institute Hall.
6-30 p.m.	Cultural Entertainment of the Science Congress by "Rabindra Bharati", Science College Central Lawn (Main Pandal).

Wednesday, 23rd February, 1972

9-30—11-00 a.m. **SESSION ON MAN-MACHINE-ENVIRONMENT SYSTEMS IN ERGONOMICS**

Venue : Saha Institute Auditorium (1st floor), Science College Campus.

Chairman : Dr. A. Sen Gupta, Manager, Hœchst Pharmaceuticals Ltd., Calcutta-13.

(1) Chairman's Keynote Address.

(2) Sri B. P. Bajpayee — Ergonomics in Defence
Defence Institute of Workstudy,
Landour Cantt. Mussoorie, U.P.

(3) Shri S. Vaidyanathan — Ergonomics in Railways
South Eastern Railways,
Raipur, (M. P.)

(4) Dr. M. N. Gupta — Role of Ergonomics in Productivity
National Institute of Occupational Health, Ahmedabad.

(5) Sri P. K. Banerjee — Ergonomics in Product Design
Industrial Design Centre
Indian Institute of Technology,
Powai, Bombay.

DISCUSSIONS

11-00—11-15 a.m. Tea

11-30 a.m. Recess for special lecture—"Conduction in Mammalian Nerve Fibres" by Prof. A. S. Paintal in the Section of Physiology, Indian Science Congress.

12-30—2-00 p.m. LUNCH INTERVAL

2-00—3-00 p.m. **SESSION ON ANTHROPOMETRY AND BIOMECHANICAL PROBLEMS IN ERGONOMICS**

Venue : Saha Institute Auditorium (1st floor), Science College Campus.

Chairman : Dr. D. K. Sen, Director, Anthropological Survey of India.

(1) Chairman's Keynote Address.

(2) Dr. S. Chakraborty, Hindustan Lever Ltd., Calcutta-24. — Plant Physician's Approach to the Application of Ergonomics through Anthropometry

(3) Dr. S. R. Datta, Sri S. Ganguly, Dr. B. B. Chatterjee & Dr. B. N. Roy, All India Institute of Hygiene and Public Health, Cal-12. — Biomechanics in the Assessment of Rehabilitation of Below-knee-Amputees.

DISCUSSION

3-00—3-15 p.m. Tea

3-15—4-00 p.m. **SESSION ON EFFECTS OF CHEMICAL STRESS ON MAN**

Venue : Saha Institute Auditorium (1st floor), Science College Campus.

Chairman : Prof. J. J. Ghosh, Professor of Biochemistry, Ballygunge Science College, Calcutta University.

(1) Keynote Address by the Chairman

(2) Sri B. N. Chakravarty, Department of Applied Chemistry, C.U. — Air Polution in Calcutta

(3) Dr. S. R. Chowdhuri, All India Institute of Hygiene and Public Health, Calcutta. — Studies on the Effects of Some Dye Intermediaries

(4) Sri S. Chakravorti, Regional Labour Institute, Cal-55. — Effects of Toxic Substances in Occupational Environments

DISCUSSION

5-00—5-30 p.m. Film Show—"One Man and His Job" at the Saha Institute Auditorium (1st floor).

6-30 p.m. Cultural Entertainment (Children's Little Theatre) of the Indian Science Congress at the Main Pandal.

Thnrsday, 24th February, 1972

9.15-11 a.m. **SESSION ON HEAT, NOISE, VIBRATION & LIGHTING STRESSES IN ERGONOMICS**

Venue : Saha Institute Auditorium (1st floor), Science College Campus.

Chairman : Prof. D. P. Sadhu, Professor of Physiology, Bengal Veterinary College, Calcutta.

(1) Keynote Address by the Chairman

(2)	Dr. M. K. Chakraborty, Central Mining Research Station, Dhanbad, Bihar	Environmental Stress and Their Effects on Miners' Work.
(3)	Sri C. S. Nair, Defence Inst. of Physiology & Allied Science, Delhi Cantt.	Effect of Hot Environments on Physical Work Capacity.
(4)	Dr. S. S. Ramaswamy, Central Labour Institute, Bombay-22	Physiological Indices for Assessing Performance Capacity.
(5)	Dr. R. N. Sen, Dept. of Physiology, Calcutta University	Effects of Noise in Domestic and Industrial Conditions.
(6)	DIPAS, Delhi Cantt.	Noise in Certain Military Situations and its Effect.
(7)	Sri A. K. Sinha, Dept. of Physiology Surendranath College, Calcutta	Effects of Vibration on Man.
(8)	Sri P. K. Sanyal, Philips (India) Ltd., Calcutta.	Industrial Lighting and Work.

DISCUSSION

11-00—11-15 a.m. Tea

11-15—1-00 p.m. **SESSION ON WORK MEASUREMENT—TIME, MOTION AND METHOD STUDY**

Venue : Saha Institute Auditorium, (1st floor).

Chairman : Lt. Col. Ramesh Chandar, Dy. Director, Defence Institute of Workstudy, Landour Cantt. Mussorie, U. P.

(1) Chairman's Keynote Address

(2)	Sri P. K. Roy Choudhury, Effeciency Researh, Jardine, Henderson Ltd., Calcutta	Workplace Layout and Working Condition Improvement by Time and Motion study.
(3)	Sri N. K. Pal, National Productivity Council, Calcutta	Importance of Method Study in Achieving Higher Productivity.

SESSION ON WORK MEASUREMENT—PHYSIOLOGICAL COSTS OF WORK AND REST IN INDUSTRY, MINES, AGRICULTUE, SPORTS Etc.

Chairman : Prof. S. Banerjee, Chief Scientific Adviser, Dey's Medical Stores Mfg. (Pvt.) Ltd., Calcutta.

(1) Chairman's Keynote Address

(2)	Dr. A. R. Guha Roy & Dr. M. K. Chakraborty, Central Mining Res. Station, Dhanbad, Bihar	Physiological Study on a Coal Cutting Machine.
(3)	Dr. D. K. Ghoshal, Directorate General of Mines Safety, Dhanbad, Bihar	The Problem of Low OMS in mines —A Physiological Appraisal.
(4)	Prof. A Sen, Medical College, Calcutta.	Some Physiological Observations on Cycle-rickshaw Pullers.
(5)	Prof. S. R. Maitra & Dr. S. Chatterjee, Dept. of Physiology, Calcutta University	Physiological Responses of Local Students at Different Workloads.

(6) DIPAS, Delhi Cantt. — Physiological Responses of Air-Force Personnel during Cycle race at 11,000 ft.

(7) Sri A. Dutta, Sri P. Chatterjee, Trainers for Football players and Rowers, Calcutta — Performances of Football players and Rowers due to Training as Revealed by Physiological Responses and Simple Time Motion Study (with film)

JOINT DISCUSSION

1-00—2-30 p.m. LUNCH INTERVAL

2-30—3-30 p.m. PANEL DISCUSSION ON :

(a) Need for collaboration amongst people in Defence Services, Industry, Mines, Agriculture, Sports and Universities.

(b) Need for creation of a common platform for discussion on Ergonomics by people of different disciplines.

Venue : Saha Institute Auditorium (1st floor).

Chairman : Dr. B. Mukherji, Ex-Director, Central Drug Research Institute, Lucknow.

Keynote address by the Chairman followed by discussion by a panel of participants.

3-30—4-30 p.m. SESSION ON NEUROPHYSIOLOGICAL BASIS OF WORK —PERCEPTUAL AND MENTAL LOADS-SKILL AND SELECTION PROCEDURES

Venue : Saha Institute Auditorium (1st floor).

Chairman : Prof. S. K. Mitra, Professor of Psychology, Cal. University.

(1) Keynote Address by the Chairman

(2) Dr. A. K. Maiti, Department of Physiology and Biochemistry, College of Medicine, Calcutta University — Neurophysiological Basis in Work Therapy.

(3) Dr. T. Ganguly, Dept. of Industrial Management, Indian Inst. of Science, Bangalore-12. — Mental and Perceptual Loads in Industrial Situations.

(4)	Dr. P. K. Dey, Department of Physiology, Banaras Hindu University, Varanasi.	Basic EEG Pattern Changes in Human Subjects following Prolonged Exercises in Asanas.
(5)	Dr. H. Jana, Prof. of Physiology, Municipal Medical College, Ahmedabad.	Can Hypnotic Suggestion Improve Physical Performance of an Individual ?
(6)	Dr. S. C. Dey, Dept. of Applied Psychology, Calcutta University.	Selection and Vigilance Skill.
(7)	Sri P. K. Sathe, Management Consultant, Bombay.	Man and Motivation in Industry.

DISCUSSION

4-30—5-30 p.m. TEA AND VISIT TO THE DEPARTMENT OF PHYSIOLOGY, UNIVERSITY COLLEGE OF SCIENCE & TECHNOLOGY, CALCUTTA UNIVERSITY.

5-30 6-00 p.m. Film Show on Ergonomics

Friday, 25th February, 1972 :

9-30—11-00 a.m. SESSION ON ACCIDENT VERSUS ERGONOMICS, FACTORIES ACTS, SAFETY & OCCUPATIONAL HEALTH

Venue : Saha Institute Auditorium (1st floor).

Chairman : Dr. M. N. Gupta, Director, National Institute of Occupational Health, Ahmedabad

(1) Keynote Address by the Chairman

(2)	Shri P. Roy, Director W. B. Fire Service, Calcutta.	Fire Hazards
(3)	Shri M. M. Shetty, Director, Regional Labour Inst. Calcutta	Importance of Safety in Industry

25th February, 1972 (Contd.)

(4)	Shri S. R. Chakravorti Dy. Chief Inspector of Factories, Govt. of West Bengal, Calcutta	Application of Ergonomics in Relation to Factories Acts.
(5)	Dr. S. Bose, Department of Applied Psychology, Cal. University	Human Factors in Transportation Accidents.

DISCUSSION

11-00—11-15 a.m. TEA

11-15—1-00 p.m.

SESSION ON USE OF CYBERNETICS, OPERATIONAL RESEARCH, BIOSTATISTICS AND COMPUTER IN ERGONOMICS

Venue : Saha Institute Auditorium.

Chairman : Prof. S. Chakrabarty, Professor of Applied Mathematics, Calcutta University.

(1)	Chairman's Keynote Address	
(2)	Dr. S. Choudhury, Management Services Dept., ICI (India) Group, Calcutta-16.	Use of Operational Research and Computer in Job Enrichment.
(3)	Shri D. V. Gulati, National Institute for Training of Industrial Engineers, Bombay-87.	Use of Biostatistics in Ergonomics.
(4)	Shri B. Sarkar, Indian Institute of Management, Calcutta.	Statistical Methods in Ergonomics.
(5)	Dr. S. P. Mukherjee, Dept. of Statistics, Calcutta University.	Biostatistician's Approch to Ergonomics.
(6)	Shri T. K. Sarkar, Indian Institute of Management, Calcutta-50.	Introduction to Operational Research and its Applications in Ergonomics.
(7)	Prof. A. Ray, Former Head, Computer Division, Indian Institute of Technology, Kharagpur.	Use of Computer Technology in Ergonomics.

DISCUSSION

1-00—2-00 p.m. LUNCH INTERVAL

2-00—3-00 p.m. **PANEL DISCUSSION FOR REVIEW OF THE SEMINAR & CONCLUDING REMARKS**

Venue : Saha Institute Auditorim (1st floor).

General Chairman of the Seminar : Prof. S. R. Maitra,
Head, Department of Physiology,
Calcutta University College of
Science & Technology.

3-00—3-30 p.m. TEA

3-30—5-30 p.m. Film Show/Field Visits

N.B. : (1) Each paper in respective session should not take more than 10 minutes to allow for discussion.

END

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Phone : 35-8755

Prof.Dr. Alain Wisner
Emeritus Professor
Laboratorie d' Ergonomie
Conservatoire national des arts
41,Rue Gay Lussac
F-75005, PARIS
FRANCE


A DIAMOND
JCT

I have replied by EMail. we would try all our efforts to extend you as much local hospitality as we can. Mr. Mitra is not my student in Ergonomics.

With kindest personal regards,
Robin.

Prof. Dr. R. N. Sen
HB-260, Sector-3, Salt Lake City
Calcutta-700 091, INDIA

To: Prof. Dr. Alain Wisner
and family and
colleagues

Season's Greetings

&

all Good Wishes

for a happy &

Prosperous New Year

From: R. N. Sen and
family and colleagues

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Reprinted from the proceedings of the Seminar on "Higher Productivity through Building Insulation" Page 53 - 69, 1967.

"SOME STUDIES ON THE PHYSIOLOGICAL EFFECTS OF NOISE"*

Dr. Rabindra Nath Sen
Head, Industrial Physiology Division,
Central Labour Institute,
Eastern Express Highway,
Sion, Bombay-22 DD.

Introduction :

Noise is defined as unwanted sound. Nobody likes noise. In the present discussion some of the physiological effects of noise and the importance of providing proper sound insulations in building constructions would only be considered.

The physiological effect of noise is revealed by such measurements as metabolism (energy expenditure), pulse rate, blood pressure, rate of breathing, tensions in the muscles, increase of sweating, fall of efficiency, etc.

As we know, noise interferes with speech communication, may affect behaviour (cause irritation, annoyance, etc.), may produce a temporary hearing loss or even may bring permanent hearing damage. Annoyance is something distinct from harm to health or efficiency. It must not, therefore, be ignored.

Only recently, the harmful effects of noise in industry are being taken into consideration (1-3). How far the sound insulation in buildings or the use of personal protective equipment (ear plugs, ear-muffs etc.) could improve the conditions are also subject of several studies.

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* Paper presented at the Seminar on "Higher Productivity through Building Insulation" held in Bombay on 6th April 1967 under the auspices of IMDACA and Bombay Productivity Council.

When one is considering whether to reduce a particular noise or not, in view of the probable expenses of the operation, it may be valuable to bear in mind the various aspects of behaviour in noise.

For proper control of noise its accurate measurement is very important in situations where people complain about noise and it is also important to find out how much reduction of noise is effected after modifications are made for noise reduction at the source or during its transmission or by use of personal protective equipment.

An investigation was carried out in a nitric acid plant where there was complaint about noise. Another study was in the weaving shed of a cotton textile mill. A third study was in the residential area having noise originating from room air-conditioners of a hotel.

Method :

A GR type 1555A Sound Survey Meter and a GR Type 1558A Octave Band Analyser with a type 1560 P4PZT ceramic micro[2] phone were used to measure the sound pressure level at three different weightings, 'A', 'B' and 'C' and to analyse in detail the sound pressure level of noise at each octave band. A GR type 1552B Sound Level Calibrator and a type 1307A Transistor Oscillator were used to calibrate these instruments.

It is well known that different frequencies of noise have different effects and it is mostly important to consider the sensation of loudness. The term loudness pertains only to the magnitude of the sensation of hearing of a person. A noise may be high or low pitched, penetrating or dull, disturbing or soothing, but all may be assigned to the same loudness value. The total loudness in sones was computed from the measurements of the sound pressure levels in different octave bands (4).

By definition, a loudness of one sone has been arbitrarily selected to correspond to the loudness of a simple tone of frequency 1000 cps with a sound pressure level 40 db (reference 0.0002 microbar).

In order to find out the extent of speech interference in different regions in and around the factory, the speech interference level (SIL) in db was determined by taking into consideration 3 octave bands – viz., 600 to 1200, 1200 to 2400, and 2400 to 4800 cps as these are the most important ones for the understanding of speech.

The composite noise rating (5) with reference to the response behaviour of a community due to seven largely independent characteristics such as spectrum character, peak factor, repetitive character, time of day, level of background noise, etc. was also done.

Measurements of noise levels as well as the physiological responses of young and old workers in a weaving shed with or without using ear–muffs were made in another study.

In a separate study the levels of noise originating from different room air-conditioners were measured by the same method (6).

Results And Discussions :

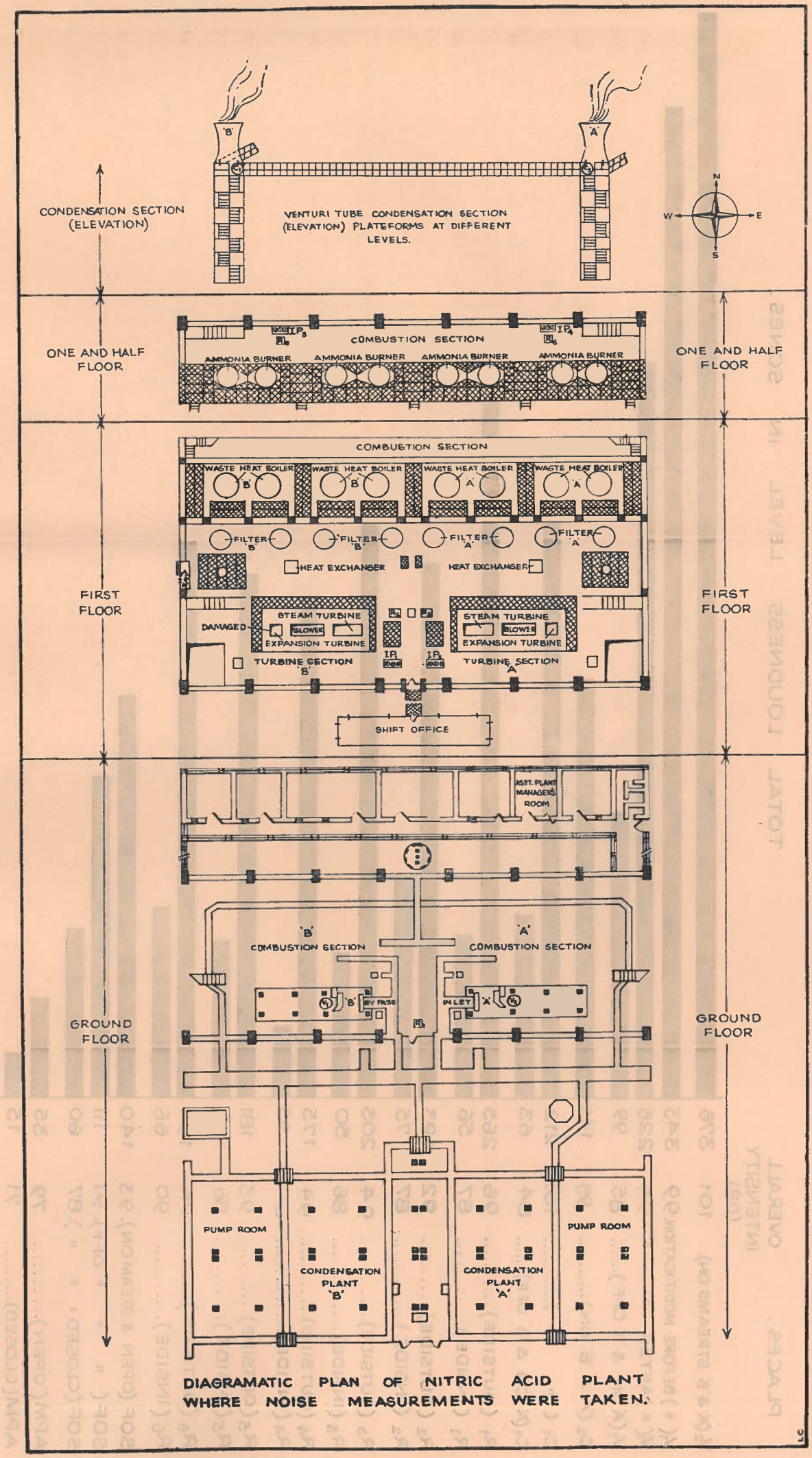
Figure 1 shows the positions in and around the factory where the measurement of noise was made. *(For Fig. 1, please see page 57)*

From Table 1 and Figures 2 and 3 it will be seen that the sound pressure level after modifications of the bypass duct of 'B' stream in the turbine section (with faulty rotor) was reduced by one–third, as would be revealed by the average total loudness. *(For Table I see page 56 and for Figures 2 & 3 please see page 58 and 59 respectively)*

Table 1

Sl. No.	Description of places where noise measurements were taken	Overall SPL † (db)	Max. SIL †† (db)	Average TLL ††† (sones)
1	At 'V1', below 'B' stream bypass with both 'A' & 'B' streams **on** (before modification of 'B' bypass)	99.3	92.8	343.0
2	At 'V1', below 'B' stream bypass with both 'A' & 'B' streams **on** (after modification).	94.0	88.3	225.8
3	At 'R1', **(outside)** sound insulated booth, ground floor, combustion section.	96.3	90.2	265.0
4	At 'R1', **(inside)** –do–	87.3	65.3	56.3
5	At 'R3', **(outside)** sound insulated booth, first floor, in front of Instrument Panel (IP2)	94.3	85.2	203.0
6	At 'R3', **(inside)** –do–	86.0	64.2	50.4
7	At 'R4', **(outside)** sound insulated (thermocole covered) booth at western side, near balcony, at first floor, turbine section.	93.5	83.5	174.5
8	At 'R4', **(inside)** –do–	83.5	56.8	24.7
9	At 'APM', Asstt. Plant Manager's room, ground floor, with doors **open.**	78.5	65.2	34.6
10	At 'APM', with doors **closed.**	71.0	50.2	14.5
11	At 'MAH' Mauzoal Apprentice Hostel room, southern side, doors and windows **closed.**	60.0	21.3	0.6
12	At 'SSH', near Store Shed, Westernside, inside factory compound, open air, midnight.	53.0	11.7	0.3

† = Observed Sound Pressure Level;
†† = Observed Speech Interference Level;
††† = Computed Total Loudness Level



DIAGRAMATIC PLAN OF NITRIC ACID PLANT WHERE NOISE MEASUREMENTS WERE TAKEN.

OVERALL INTENSITY AND TOTAL LOUDNESS LEVEL OF NOISE AT DIFFERENT PLACES IN AND AROUND FACTORY.

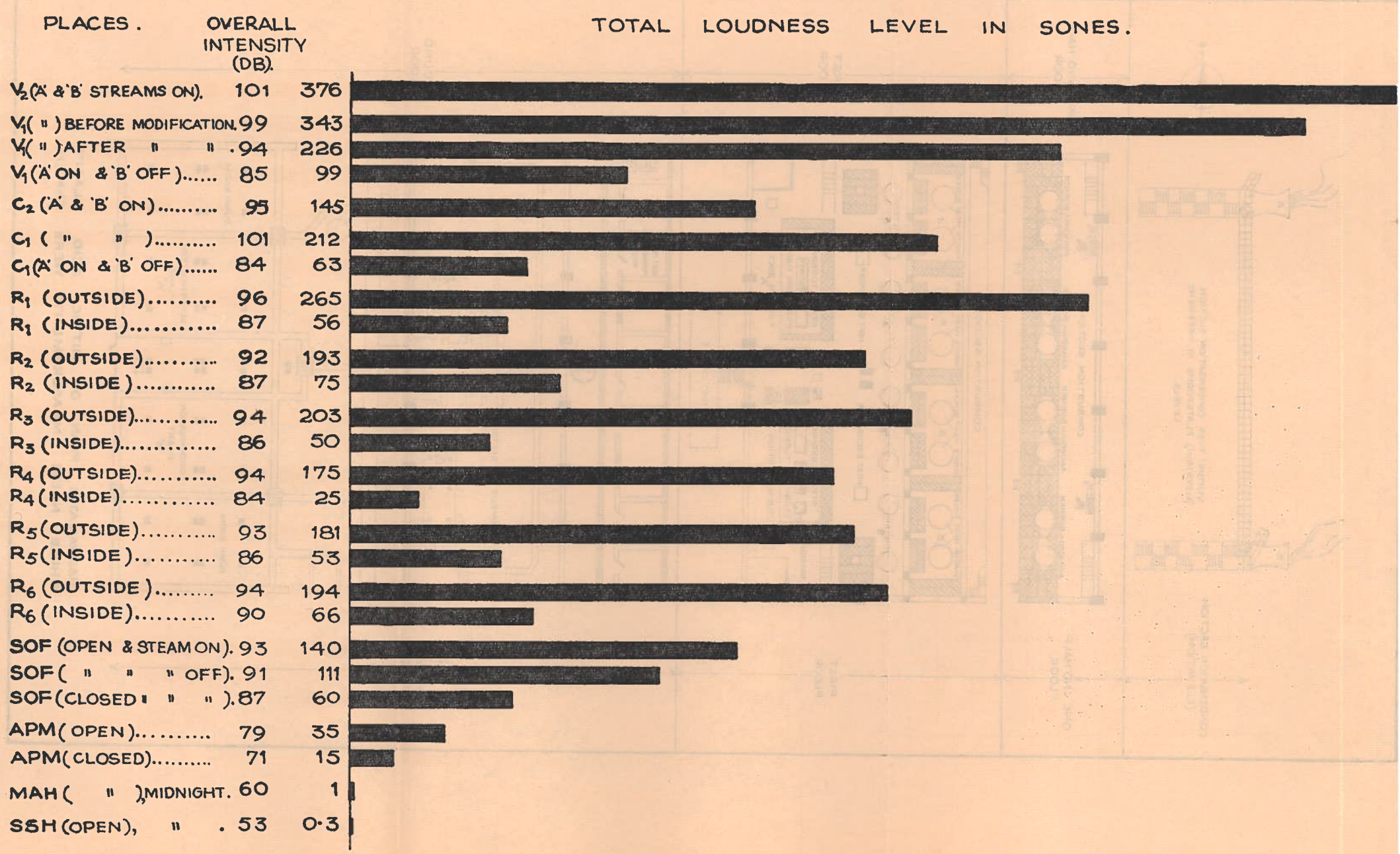


FIG: 2.

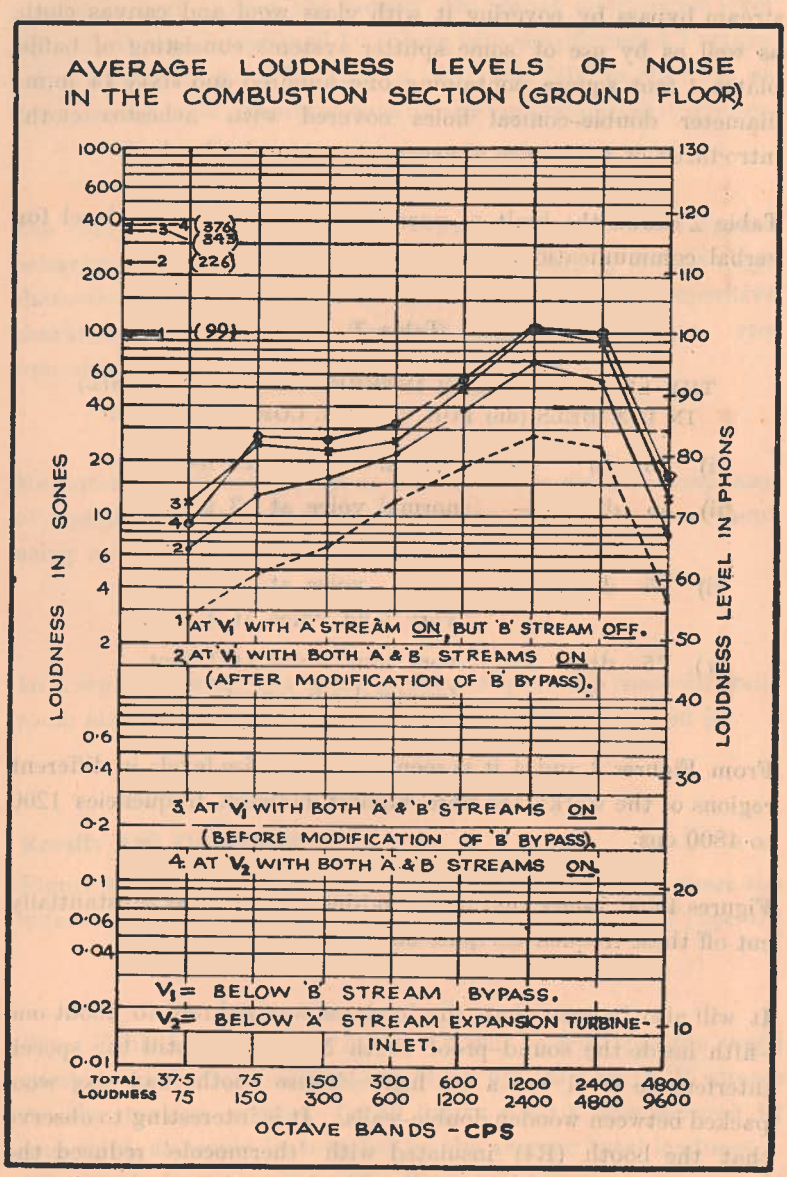

AVERAGE LOUDNESS LEVELS OF NOISE IN THE COMBUSTION SECTION (GROUND FLOOR)
LOUDNESS IN SONES
LOUDNESS LEVEL IN PHONS
1000
600
400
200
100
60
40
20
10
6
4
2
0·6
0·4
0·2
0·1
0·06
0·04
0·02
0·01
130
120
110
100
90
80
70
60
50
40
30
20
10
4 3 (376)
(343)
2 (226)
1 (99)
1 AT V1 WITH 'A' STREAM ON, BUT 'B' STREAM OFF.
2 AT V1 WITH BOTH 'A' & 'B' STREAMS ON (AFTER MODIFICATION OF 'B' BYPASS).
3 AT V1 WITH BOTH 'A' & 'B' STREAMS ON (BEFORE MODIFICATION OF 'B' BYPASS).
4 AT V2 WITH BOTH 'A' & 'B' STREAMS ON.
V1 = BELOW 'B' STREAM BYPASS.
V2 = BELOW 'A' STREAM EXPANSION TURBINE-INLET.
TOTAL LOUDNESS 37·5 75 150 300 600 1200 2400 4800
75 150 300 600 1200 2400 4800 9600
OCTAVE BANDS - CPS

FIG. 3

The modification was made on the inlet and outlet tubes of the 'B' stream bypass by covering it with glass wool and canvas cloth as well as by use of some splitter systems consisting of baffle plates, 1 foot square, containing one hundred and sixty 14 m.m. diameter double-conical holes covered with asbestos cloth, introduced at a distance of every 10 cm. inside the duct.

Table 2 shows the limit of normal speech interference level for verbal communication.

Table 2

THE LIMIT OF SPEECH INTERFERENCE LEVEL (SIL) IN DECIBELS (db) FOR VERBAL COMMUNICATION

i)	45 db	—	normal voice at 10 feet
ii)	55 db	—	normal voice at 3 feet, raised voice at 6 feet.
iii)	65 db	—	raised voice at 2 feet, very loud voice at 4 feet.
iv)	75 db	—	very loud voice at 1 foot, (minimal efficiency).

From Figures 3 and 4 it is seen that the noise levels in different regions of the workplace were highest between frequencies 1200 to 4800 cps.

Figures 4 and 5 show that the sound-insulated booths substantially cut off these frequencies quite effectively.

It will also be seen that the loudness was reduced to about one -fifth inside the sound-proof booth No. Rl, but still the speech interference level was a bit high. These booths had slag wool packed between wooden double-walls. It is interesting to observe that the booth (R4) insulated with 'thermocole' reduced the loudness to about one-seventh and the verbal communication was possible with a normal voice even at a distance of three feet.

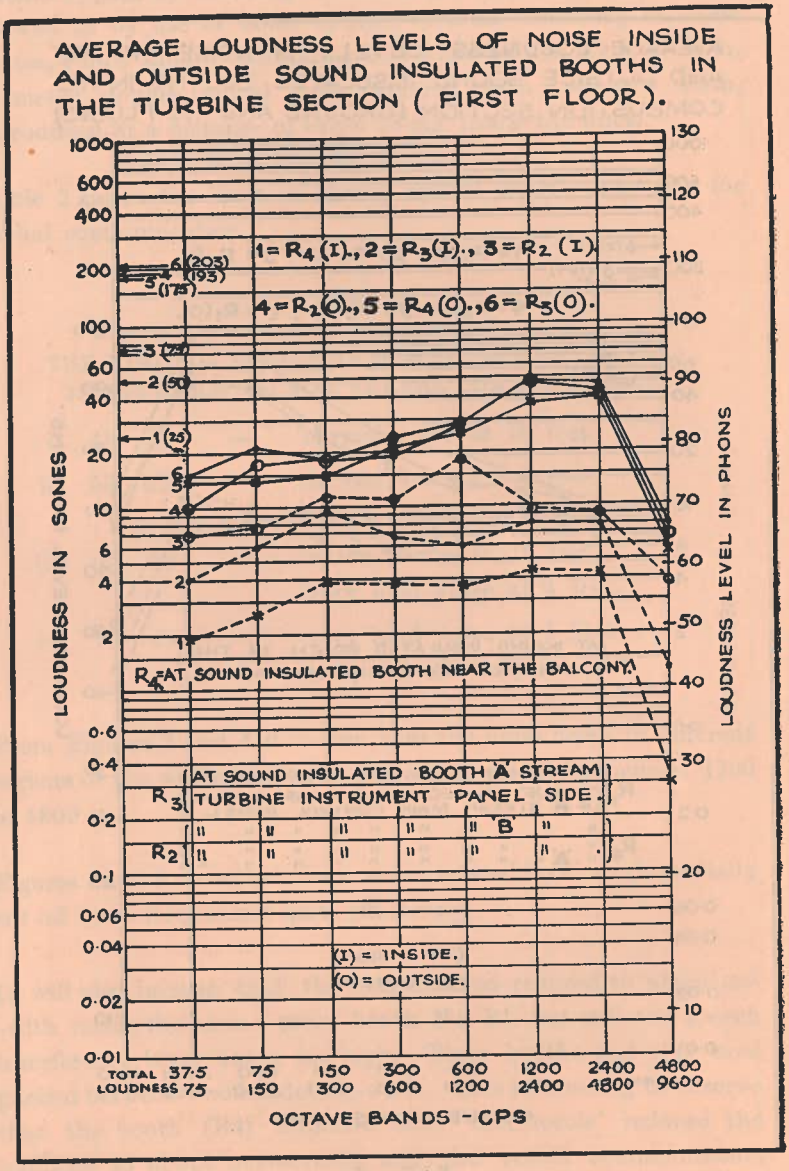

AVERAGE LOUDNESS LEVELS OF NOISE INSIDE AND OUTSIDE SOUND INSULATED BOOTHS IN THE TURBINE SECTION (FIRST FLOOR).
1=R4 (I)., 2=R3(I)., 3=R2 (I).
4=R2(O)., 5=R4(O)., 6=R3(O).
R4=AT SOUND INSULATED BOOTH NEAR THE BALCONY.
R3 AT SOUND INSULATED BOOTH A STREAM
R2 TURBINE INSTRUMENT PANEL SIDE.
" " " " " "B" "
(I) = INSIDE.
(O) = OUTSIDE.
LOUDNESS IN SONES
LOUDNESS LEVEL IN PHONS
1000
600
400
200
100
60
40
20
10
6
4
2
0·6
0·4
0·2
0·1
0·06
0·04
0·02
0·01
130
120
110
100
90
80
70
60
50
40
30
20
10
TOTAL LOUDNESS 37·5 75 150 300 600 1200 2400 4800
75 150 300 600 1200 2400 4800 9600
OCTAVE BANDS - CPS

FIG. 5

Thus of the six sound-insulated booths, the one (R4) (thermocole covered) in the first floor proved to be the most effective one. The average noise reduction inside these six booths was found to be 10 db in 100 cps, 18 db in 1000 cps and 21 db between 2000 to 5000 cps.

The temperature inside some of the sound-proof booths was quite high (dry-bulb temperature of 109°F and wet-bulb temperature of 77°F) for which the workers were reluctant to use the booths, but when arrangements for circulating cool air were made, these were often used by the workers.

The maximum permitted sound pressure level for heavy manufacturing industries in America, 1961 (7) is shown in the Table 3.

Table 3

MAXIMUM PERMITTED SOUND PRESSURE LEVEL IN DECIBELS (db) FOR HEAVY MANUFACTURING INDUSTRIES IN AMERICA 1961

Octave band cps.	*db*
31.5 — 75	80
75 — 150	75
150 — 300	70
300 — 600	64
600 — 1200	58
1200 — 2400	53
2400 — 4800	49
above 4800	46

It will be seen that the sound pressure level in most of the octave bands measured at various workplaces outside the sound-insulated booths in the plant showed much higher values than the maximum permitted.

From Figure 6 it will be seen that in Asst. Plant Manager's room, in shift office and in other rooms, there is substantial diminution in the level of noise when the ordinary doors were kept closed.

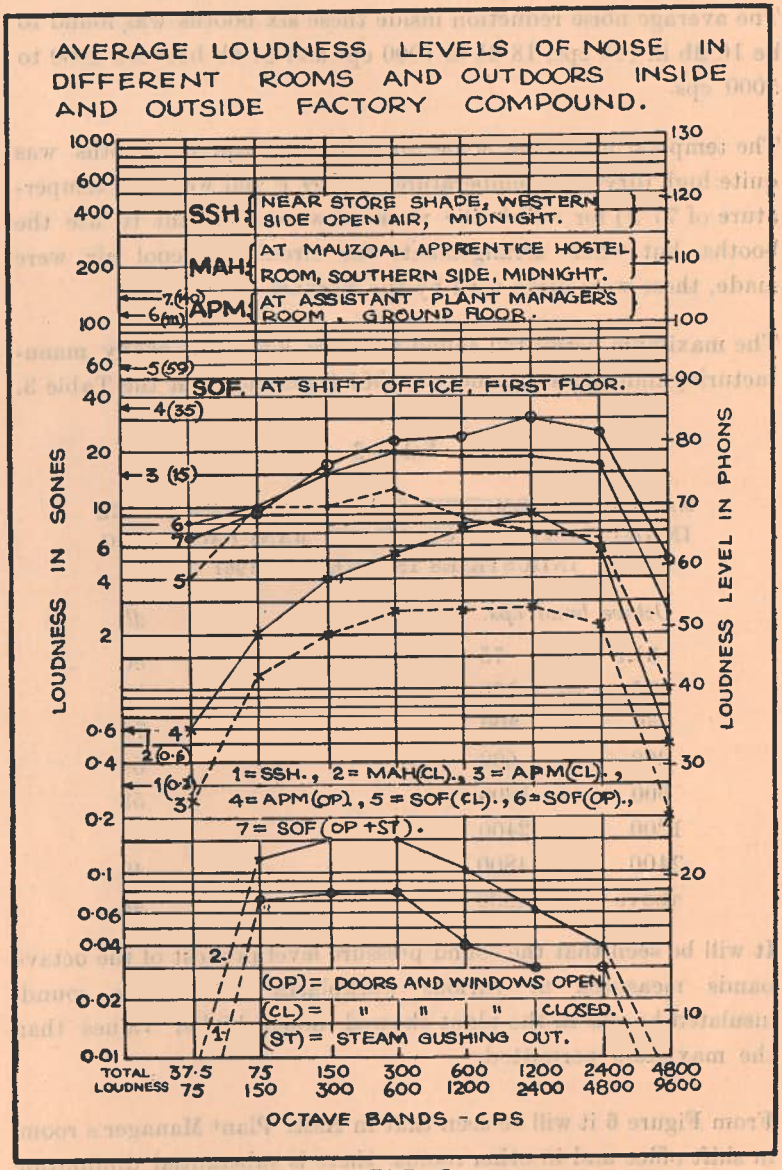

AVERAGE LOUDNESS LEVELS OF NOISE IN DIFFERENT ROOMS AND OUTDOORS INSIDE AND OUTSIDE FACTORY COMPOUND.
SSH. NEAR STORE SHADE, WESTERN SIDE OPEN AIR, MIDNIGHT.
MAH. AT MAUZOAL APPRENTICE HOSTEL ROOM, SOUTHERN SIDE, MIDNIGHT.
APM. AT ASSISTANT PLANT MANAGERS ROOM, GROUND FLOOR.
SOF. AT SHIFT OFFICE, FIRST FLOOR.
LOUDNESS IN SONES
LOUDNESS LEVEL IN PHONS
1=SSH., 2=MAH(CL)., 3=APM(CL)., 4=APM(OP)., 5=SOF(CL)., 6=SOF(OP)., 7=SOF(OP+ST).
(OP)= DOORS AND WINDOWS OPEN.
(CL)= " " " CLOSED.
(ST)= STEAM GUSHING OUT.
TOTAL LOUDNESS
OCTAVE BANDS - CPS

FIG.6

References:

1. Gupta, M. N., Sen, R. N., Singh, H.–Investigation of Occupational Hearing Impairment and Noise in a Nitric Acid Plant–Report No. 24, Office of the Chief Adviser Factories, Ministry of Labour and Employment, Government of India, New Delhi, pp. 52, 1965.

2. Pancholy M., Chhapgar A. F., Khanna R. K. and Tyagi R.C. Noise Survey in Indian Cities: Part II–Noise Levels during Night–time and Inside Buildings–J. Sci. & Indus. Res. **19A:** 565–568, 1960.

3. Idem.–Noise Survey in Indian Cities–Part III–Specific Noises Ibid.–**20D:** 57–60, 1961.

4. Mintz, F. and Tyzzer, F.G.–A Loudness Chart for Octave Band Data on Complex Sounds,–J. Acoust. Soc. Amer. **24:** 80–82, 1952.

5. Rosenblith, W.A. and Stevens, K.N.–Handbook of Acoustic Noise Control, Vol.2–Noise and Man, WADC Technical Report 52–204, U.S. Air Force, Wright–Patterson Air Force Base, Ohio, P. 183, 1953.

6. Chatterjee, S.K., Sen R.N., Saha P.N.–Determination of the Level of Noise Originating from Room Air-conditioners. Journal of the Heating & Ventilating Engineers and Journal of Air–Conditioning **38:** 429–433, 1965.

7. Elonka, S.–Noise, a special report, Power, PP 192–206, March 1962.

Noise measurements at midnight in an open area by the side of the storage shed showed that the average total loudness in residential quarters nearest to the factory was only 0.3 sones.

It is evident that sound level of other residential areas further away from the factory situated in a very calm and quiet environment would have background noise level quite low, much lower than in the residential areas near busy cities with noisy factories. The main complaint of these workers appeared to be due to the relative intensity of noise when they were coming to workplaces from their quiet residential areas and again when they were going back to their home. The loudness was thus increased by about 3500 times when they went to the factory from their quiet residence. The composite noise rating also gave a very high value ('H' rank).

All these show that there is enough scope for providing proper sound insulation in building factories. One of the main reason for high level of noise in the shop-floor was that the reinforced concrete shell type roofing (half dome-shaped undulated ceiling) was reflecting the sound back and causing reverbrations.

In another study the average sound pressure level of noise in the weaving shed and other places was measured. The values are shown in Table 4.

Table 4

THE AVERAGE SOUND PRESSURE LEVEL OF NOISE IN DECIBELS IN THE WEAVING SHED AND OTHER PLACES AT THREE DIFFERENT WEIGHTINGS

	Weighting :	*A*	*B*	*C*
1	In the weaving shed during usual work	98	99	100
2	In the weaving shed with all looms stopped but humidifying jets working (mid-night)	62	67	73
3	Outside the weaving shed (mid-night)	52	59	65
4	In the closed - laboratory (mid-night)	44	55	61

It will be seen that the level was quite high in the weaving shed with about 1000 looms working. In order to study the physiological effect of noise, the average physiological responses of a group of young and old workers were compared during usual work and while using ear-muffs. The values are shown in Table 5.

Table 5

COMPARISON OF AVERAGE PHYSIOLOGICAL RESPONSES OF OLD & YOUNG WEAVERS DURING USUAL FACTORY WORK WITH AND WITHOUT EAR-MUFFS

Responses	AGE GROUPS			
	21-30 Yrs.		40-50 Yrs.	
	Usual work	With ear muff	Usual work	With ear muff
Pulse Rate/Minute	99	91	99	99
Oral Temperature, °F	99.08	98.94	99.19	99.12
Pulmonary Ventilation, litres/min. (STPD)	11.2	9.8	11.5	11.2
O_2 Uptake, ml/min/kg. Energy Expenditure	8.6	7.9	7.8	7.5
(i) Kcal/min.	1.93	1.75	1.79	1.80
(ii) Kcal/hr/m^2	80.7	73.1	75.7	72.8

It will be seen that the physiological responses in young workers with ear-muffs were better than without ear-muffs, whereas the effect was not very prominent in old workers. This may possibly be due to some hearing loss already being present in older workers or they were more accustomed. The weavers with ear-muff also felt that they could produce more with much improvement in the quality of work if the personal protection from noise could be introduced. Improvement of physiological responses of workers by the use of ear-muffs in

workplace shows that reduction of noise may have the same productivity with much less physiological cost. The inconvenience of continuously wearing ear-muffs is obvious. Therefore, the reduction of noise through sound absorption by use of cheaper insulating materials need not be emphasised here.

Another study was undertaken when there was a complaint of sleeplessness by a resident due to the noise originating from room air-conditioners of a hotel. It will be seen from Figure 7 that about 19 air-conditioners nearby were producing noise due to the sound rebounding between the surrounding walls.

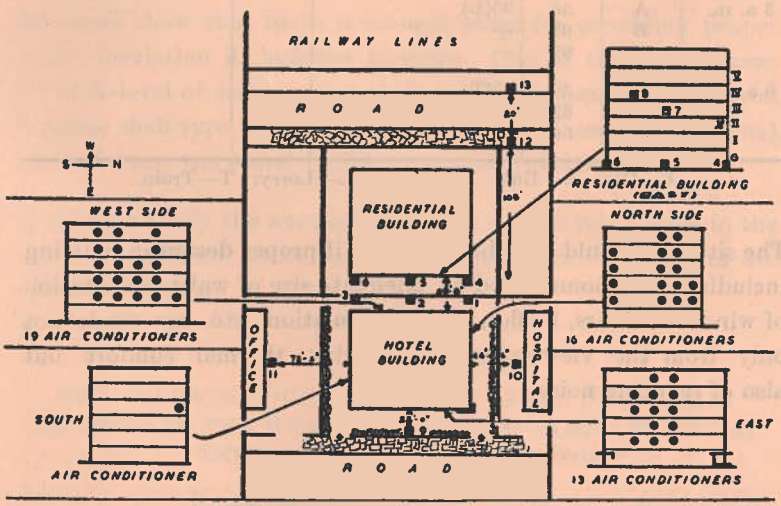


Fig 7.—Position of room air-conditioners and observation posts for noise level in hotel building.

When the air-conditioners were made 'off', the sound reduction was quite prominent; the decrease of noise was about 10 to 15 db. as evident from Table 6.

Table 6

LEVEL OF NOISE OF VARIOUS TYPES AT DIFFERENT TIMES AT NO. 4 LOCATION

Time	Weightings	Noise Level in db			
		Air conditioners on		Air conditioners off	
		Normal	Others	Normal	Others
6 p. m.	A	58	64(C), 63(T)		
	B	65	70(C), 75(T), 78(B)		
	C	72	73(B), 74(T), 73(H)	—	—
			80(4C), 77(T)	—	—
9 p. m.	A	58	65(B), 65(T)		
	B	65	75(C+T)	—	—
	C	70	80(C), 78(T)		
12 Midnight	A	56	61(C), 64(T), 61(T)	43	60(B), 55(T)
	B	61	69(C), 67(T), 72(T)	51	62(C), 65(T), 65(C)
	C	65	69(C), 70(T), 74(T)	54	65(C), 65(T), 75(B)
3 a. m.	A	56	65(L)	—	—
	B	62	—		
	C	65	—		
6 a. m.	A	58	65(T)	—	—
	B	63			
	C	66	—		
			—		

C—Car; B—Bus; H—Horn; L—Lorry; T—Train.

The situation could only be improved if proper design in building including bed-rooms based on adequate size of walls, orientation of windows, doors, baffles, proper insulation, etc. are made not only from the view-point of providing thermal comfort but also of reducing noise.

Acknowledgement :

The author is grateful to Shri N. S. Mankiker, Director General, Factory Advice Service and Labour Institutes for kindly giving permission to present this paper and also to the members of the Central Labour Institute, Bombay, for their help.

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(DURING THE XXVI WORLD CONGRESS OF PHYSIOLOGICAL SCIENCES, 1974)

Held in Calcutta

From 1st to 3rd November, 1974

Organised by :

THE DEPARTMENT OF PHYSIOLOGY

UNIVERSITY COLLEGE OF SCIENCE & TECHNOLOGY

UNIVERSITY OF CALCUTTA

AND

THE PHYSIOLOGICAL SOCIETY OF INDIA

92, ACHARYA PRAFULLA CHANDRA ROAD

CALCUTTA-700009, INDIA

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INTERNATIONAL SATELLITE SYMPOSIUM

ON

WORK PHYSIOLOGY & ERGONOMICS

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Dr. J. N. Mukherjee, VICE-PRESIDENT, P.S.I.

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Organising Committee :

Chairman :

Prof. S. R. Maitra

HEAD OF THE DEPTT. OF PHYSIOLOGY

CALCUTTA UNIVERSITY.

Conveners of Sub-committees :

Scientific : Dr. R. N. Sen

Reception : Dr. P. K. Banerjee

Publication : Dr. A. K. Medda

Finance : Dr. J. N. Mukherjee

Entertainment : Dr. A. K. Ghosh

Accommodation : Prof. A. K. Bose

Transport & Tour : Dr. P. Saha

Office Secretary : Sri A. K. Dasgupta

Asst. Secy. : Dr. (Mrs) P. Chatterjee

PREFACE

The Department of Physiology and the Physiological Society of India very cordially welcome the delegates to the International Satellite Symposium on Work Physiology and Ergonomics in this very old and well-known city of Calcutta.

In framing the basic nature of the programme we have felt it very important to try to increase opportunities for discussions, both at the formal sessions and informally, between colleagues with similar interests, to exchange ideas on the problems of man at work especially when there is food and energy crisis and also to aim for closer personal contact between the delegates. We have, therefore, cut considerably the number of formal presentations in the hope that this will lead to less rigid Symposium. The publication of these abstracts in advance may help the delegates. The index of the attending delegates is aimed to increase further the opportunities of personal contact breaking the geographical boundaries of the places of their residence.

In the end, we may request the participants to let us have the full text of their communications including the questions raised and comments made, before the end of the Symposium, so that every effort can be made to ensure early publication of the Symposium Proceedings.

Rabindra Nath Sen
Convener,
Scientific Sub-Committee.

ACKNOWLEDGEMENT

The members of the Department of Physiology, University College of Science & Technology, Calcutta University and the members of the Physiological Society of India wish to place on record their grateful thanks to the following for their help and co-operation :

Shri S. P. Bhatia, Director, Regional Labour Institute, Calcutta 700055.

Dr. D. N. Kundu, Director, Saha Institute of Nuclear Physics, Calcutta-700009.

Prof. P. K. Ghosh, Department of Applied Mathematics, Calcutta University, Calcutta-700009.

The Government of West Bengal.

The Managing Director, Jessop & Co. Ltd, Dum Dum.

The Manager, Hindustan Lever Ltd., Calcutta-700024.

The Managing Director Hindustan Motors Ltd., Uttarpara, Hooghly.

and to the following organisations for their generosity and support :

The University Grants Commissions, Government of India.

The Calcutta University.

The Advertizers.

A BRIEF HISTORY OF
THE DEPARTMENT OF PHYSIOLOGY
CALCUTTA UNIVERSITY

In the year 1911, the Post-graduate Physiology Department of the Calcutta University was established in the Faculty of Science by Late Prof. Subodh Chandra Mahalanabis at the Presidency College, Calcutta for the teaching and research in Physiology as a basic science for the first time in India. Naturally in those early days this department started providing trained physiologists for the teaching of the subject in the different medical, veterinary and other institutions in India.

At the beginning, the teaching of Physiology in this department was done with the teachers, most of whom were honorary. The co-operation of a few medical scientists with training in basic sciences were also available. The research activities could not grow at the beginning due to the lack of space and equipment, but the enthusiastic physiologists developed the research aptitudes by working in collaboration with the sister departments. Such interactions between the sister departments proved valuable in the long run to broaden their horizon, which also helped them in getting employment in suitable vocations which were not meant for the Physiologists. An urgent need for further expansion of the department was realised by the University to create better facilities and to accommodate more students in the Post-graduate department.

Hence the present Department of Physiology was ushered in the year 1937 in the campus of the University College of Science and was founded in only two rooms in two separate buildings. Here also Late Prof. S. C. Mahalanabis gave the lead to develop it and the University also put him in-charge to organise it. Since then the efforts of the Physiologists to develop this subject through teaching and research has been continued inspite of many difficulties of getting adequate funds and space, but the collaboration with the sister departments in research activities was possible in a more congenial atmosphere.

After Independence, the Government of India took initiative in developing the sciences in general and considerable amount of expansion in the teaching and research in science has been made by creating new Universities and research institutions. But nowhere else in India the teaching and research in Physiology has been developed with such broad concept and idea that has been done under this University. This uniqueness of the department gave it a national character and wherever some Physiologists were required for teaching and research, this department provided them with the requisite number. Side by side the departments of Physiology were opened in the different under-graduate colleges.

This in turn increased the demand for post-graduate studies at this department of the University. Now a good number of physiologists are being trained at this department annualy and are occupying important teaching and research positions in many Institutions in India and abroad.

This department also took initiative in establishing for the first time in India, a post-graduate course of study on Work Physiology and Ergonomics, as a special paper, since 1971. A National Seminar on Ergonomics was organised by this department in February 1972, under the auspices of the Life Science Centre of this University and was inaugurated by the Vice-Chancellor of the University of Calcutta.

Recently, a Committee consisting of the representatives of the University Grants Commission, Government of India, the Government of West Bengal and this University, was formed to consider the future development of this University during the next ten years. This Committee has very highly appreciated the activities of this department and recommended very strongly its further development by provision of additional space, equipment, staff and financial grants.

The department is now looking forward to serve the country and the Science through a wider programme of topics in a better way. When the necessary funds will be made available, new courses of studies such as High Altitude Physiology, Immunology & Microbiology will be initiated and the existing courses of studies in Biochemistry, Biophysics, Work Physiology and Ergonomics, Nutrition and Dietetics, Hormones, and Comparative Physiology will also get stimulus for further growth.

THE PHYSIOLOGICAL SOCIETY OF INDIA

The Physiological Society of India is a voluntary academic organization of the Physiologists in general registered under the Societies Registration Act XXI of 1860 and created since July 13, 1934 with the primary object of promoting the studies and researches of Physiological sciences and its utilization in India and harnessing them for the cause of humanity and national welfare. The foundation of the Society as the only national representative scientific body in the country was laid down by the eminent scientists, like, Prof. S. C. Mahalanobis, Sir Nilratan Sircar, Sir U. N. Brahmachari, Sir Kedarnath Das, Professors B. B. Sarkar, N. M. Basu, P. B. Sen and others. Since then almost all the scientists of physiological sciences in India and distinguished scientists from abroad, like, Professors A. V. Hill, Straub, Penfield, Konorski, Thaeur, Houssay, Engelhardt, Anitchkov, Bernal and others were associated with it. Apart from holding regular scientific meetings, seminars, the Society is publishing its official scientific journal as Indian Journal of Physiology and Allied Sciences continuously since 1947 and Annual volumes of Physiology and Experimental Medical Sciences. The Society is affiliated to the Indian National Science Academy. The present scientific programme of the Society includes regular scientific meetings, holding regional and All-India Symposium and Work-shop Seminars at different parts of India, Annual conferences along with the general body of the Indian Science Congress Association. The present membership role of the Society is 435 and the Volume no. 28 of the Indian Journal of Physiology and Allied Sciences has come out in the year 1974. It has been the proud privilege of the Society to have attracted the distinguished scientists from various countries for participating in the All-India Satellite Symposia on Work Physiology and Ergonomics held under the auspices of the 26th International Congress of Physiological Sciences, and for delivering special lectures as Prof. S. C. Mahalanobis Oration.

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5. Dr. Chakraborty, S.
6. Prof. (Mrs.) Chatterjee, A.
7. Dr. Chatterjee, B. B.
8. Dr. Chattopadhyay, H. P.
9. Dr. Edholm, O. G.
10. Dr. Hamley, E. J.
11. Dr. Jones, P. R. M.
12. Dr. Kalsbeek, J. W. H.
13. Dr. Karlsson, J.
14. Dr. Kogi, K.
15. Prof. Maitra, S. R.
16. Prof. Monod, H.
17. Prof. Sadhu, D. P.
18. Prof. Sen, A.
19. Dr. Thomason, H.

RAPPORTEURS :

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2. Sm. Banerjee, T.
3. Sm. Basu, J.
4. Sri Chakraborti, D.
5. Sm. Chatterjee, S.
6. Dr. (Mrs.) Chatterjee, P.
7. Miss Cursiter, H. C.
8. Dr. Datta, S.
9. Sm. Guha, A.
10. Sri Kar, M. R.
11. Sri Kundu, H.
12. Sri Nag, P. K.
13. Sri Nath, P.
14. Sri Roy, A. K.
15. Sri Roy, G. G.
16. Dr. (Miss) Roy, P.
17. Sri Sadhu, A.
18. Sri Sarkar, D.
19. Sri Sinha, A.

PROGRAMME

Friday, 1st November, 1974

9.00 A.M. Reception and Registration of the delegates

9.30 A.M. Inauguration of the Symposium :

Welcome address
Introducing the foreign scientists } Prof. S. R. Maitra

Inaugural address : Prof. P. K. Bose

Presidential address : Prof. (Mrs.) Asima Chatterjee

Vote of thanks : Dr. A. K. Maiti

11.00 to 11.30 A.M. Coffee break

11.30 to 1.00 P.M. Scientific programme : Session I :

Lectures on Work Physiology & Ergonomics

(PROF. S. C. MAHALANABIS MEMORIAL ORATIONS OF THE PHYSIOLOGICAL SOCIETY OF INDIA)

1. Work Physiology and Ergonomics in the developing countries (India) : Prof. S. R. Maitra
2. Work and Nutrition : Dr. O. G. Edholm

1.00 to 2.00 P.M. Lunch break

2.00 to 3.15 P.M. Session II : Methodology in Work Physiology :

Chairman : Dr. K. Kogi

Speakers :
1. Dr. P. R. M. Jones Abstract No. 1
2. Mr. P. K. Nag ,, ,, 5
3. Dr. E. J. Hamley ,, ,, 3
4. Dr. Sabita Mazumdar ,, ,, 17

3.15 to 3.30 P.M. Tea break

3.30 to 4.30 P.M. Session III : Work capacity and Muscular Exercise :

Chairman : Dr. E. J. Hamley

Speakers :
1. Dr. S. P. Chatterjee Abstract No. 6
2. Dr. H. Thomason ,, ,, 7
3. Dr. S. Mukherji ,, ,, 8
4. Dr. A. Maiti ,, ,, 9

8.00 P.M. Dinner by the Physiological Society of India (By invitation)

Saturday, 2nd November, 1974

9.30 A.M. Session IV : Circadian Rhythm, Thermal Stress and Work Load :

Chairman : Prof. H. Monod

Speakers :

1. Mr. M. R. Kar — Abstract No. 10
2. Dr K. Kogi — „ „ 11
3. Dr. M. K. Chakraborty — „ „ 12
4. Dr. R. N. Sen — „ „ 13
5. Dr. S. K. Das — „ „ 15

11.15 to 11.30 A.M. Coffee break

11.30 to 1.00 P.M. Session V : Ergonomics and Design :

Chairman : Dr. P. R. M. Jones

Speakers :

1. Prof. H. Monod — Abstract No. 16
2. Dr. A. R. Guharay — „ „ 14
3. Dr. B. B. Chatterjee — „ „ 2
4. Dr. S. Ganguli — „ „ 4

1.00 to 2.00 P.M. Lunch break

2.00 to 3.15 P.M. Session VI : High Altitude :

Chairman : Dr. P. O. Astrand

Speakers :

1. Mr. C. S. Nair — Abstract No. 21
2. Dr. H. P. Chattopadhyay — „ „ 18
3. Mr. U. S. Roy — „ „ 22
4. Mr. P. M. Gopinath — „ „ 23
5. Mr. A. Sinha — „ „ 25

3.15 to 3.30 P.M. Tea break

3.30 to 4.30 P.M. Session VII : Energy Expenditure and Nutrition :

Chairman : Dr. H. Thomason

Speakers :

1. Dr. M. K. Chakraborty — Abstract No. 19
2. Mr. P. K. Nag — „ „ 20
3. Dr. P.O. Astrand — „ „
4. Dr. J. W. H. Kalsbeek — „ „ 24
5. Dr. S. N. Koyal — „ „ 26

6.00 P.M. Entertainment—"Calcutta at Work" By Students of Work Physiology & Ergonomics, Calcutta University; "Mahua"—Dance Drama (English) by Loke Ranjan Shakha, Government of West Bengal.

8.30 P.M. Dinner (by invitation)
by Mrs. & Dr. S. P. Chatterjee on behalf of Work Physiology & Ergonomics Division, Science College, Calcutta University.
Venue—"Parijat"
DA 168, Salt Lake City, Calcutta-700064

Sunday, 3rd November, 1974

9.30 A.M.	Factory visit
11.00 to 11.30 A.M.	Coffee break
11.30 to 12.30 P.M.	Sessions VIII : Panel discussion on problems of Industrial Ergonomics and Free Themes :
12.30 to 2.00 P.M.	Lunch break
2.00 to 3.30 P.M.	Visit to the Regional Labour Institute/Factory Visit
3.30 to 3.45 P.M.	Tea break
3.45 to 4.45 P.M.	Session IX : Closing Session : Closing Remarks : Prof. S. R. Mukherjee
6.00 P.M.	Entertainment

4th, 5th & 6th November, 1974

Tour programmes : Calcutta by Day
: Visit to Sundarbans
: Visit to Himalayan Mountaineering Institute, Darjeeling

বন্যার্তদের সাহায্যে এগিয়ে আসুন

রাজ্যপালের ত্রাণভাণ্ডারে আপনার দান পাঠিয়ে দিন

প্রচণ্ড বৃষ্টি এবং ঘূর্ণিবাত্যায় পশ্চিমবঙ্গের একাধিক জেলা নিদারুণভাবে ক্ষতিগ্রস্ত হয়েছে। কিছু এলাকায় ক্ষেতের ফসল বিনষ্ট হয়েছে, হাজার হাজার ঘর-বাড়ির ক্ষতি হয়েছে এবং অসংখ্য মানুষ গৃহহারা হয়ে চরম দুর্দশার সম্মুখীন হয়েছেন। কালবিলম্ব না করে ব্যাপক ত্রাণ ও পুনর্বাসনের কাজ হাতে নিতে হবে। রাজ্যসরকার ইতিমধ্যেই দুর্গত এলাকায় ত্রাণকার্য শুরু করেছেন, কিন্তু ক্ষয়ক্ষতি এতই ব্যাপক যে, এর জন্যে জনসাধারণ ও স্বেচ্ছাসেবী সংগঠনগুলির সাহায্য একান্ত জরুরী হয়ে পড়েছে।

এই দুর্গত ও বিপন্ন মানুষদের সাহায্য করার জন্যে জনসাধারণ, প্রতিবারের মতো এবারেও অবিলম্বে মুক্তহস্তে সাহায্য করতে এগিয়ে আসবেন এই আবেদন। সাহায্যের জিনিসপত্র রিলিফ ডাইরেক্টরেট অফিস, ১০৩এ, এস. এন. ব্যানার্জি রোড, কলিকাতা ৭০০০১৪—এই ঠিকানায় পাঠিয়ে দিতে পারেন বা দিয়ে আসতে পারেন। ওখানে রসিদ দিয়ে জিনিসপত্র নেবার ব্যবস্থা করা হয়েছে।

দানবাবদ চেক বা নগদ টাকা রাজ্যপালের 'অল পারপাসেস বেনিভোলেণ্ট ফাণ্ডে' জমা পড়বে এবং শুধুমাত্র ত্রাণ বাবদেই তা খরচ করা হবে। চেক/মনিঅর্ডারে 'অল পারপাসেস বেনিভোলেণ্ট ফাণ্ড' কথাটি লিখে রাজভবন, কলিকাতা-এই ঠিকানায় পাঠিয়ে দিতে পারেন।

রাজ্যপালের 'অলপারপাসেস বেনিভোলেণ্ট ফাণ্ডে' দেওয়া দান আয়করমুক্ত।

পশ্চিমবঙ্গ সরকার প্রচারিত

Abstract No. 1

AN INVESTIGATION OF THE ELECTROMYOGRAPHIC RESPONSE IN MAN AT WORK

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The classical method of optimising a work place has been to minimise the energy expended by an operator, measured by indirect calorimetry. A technique requiring the subject to wear cumbersome gas collection apparatus, and the subsequent gas analysis calls for relatively expensive equipment. Energy expenditure estimations also require fairly long periods for the subject to equilibriate to each new condition, resulting in cumulative subject fatigue and time consuming experimentation when a large number of trials and conditions are examined. If rather than an absolute measure of energy expenditure, a relative one would suffice, for example, does one configuration when compared with another require more or less work effort then perhaps the electromyogram (EMG) suitably quantified (1.2), would reflect the muscular effort (3) involved for the task and thus provide a first order answer for many practical problems. The advantages of surface recorded EMG being

(i) the instantaneous nature of the response; thus significantly reducing experimental times and fatigue effects.

(ii) less encumbrance on the subject; provided a suitable technique of electrode attachment and lead running is adopted.

The underlying hypothesis is that since the surface EMG is positively correlated with increasing muscular effort (4,5), minimisation of the total EMG due to work place manipulation should give results which would be similarly predicted from energy expenditure.

Experiments were carried out when oxygen uptake was the indirect variable with the EMG being recorded simultaneously to see to what extent the muscle potentials were a practical and reliable prediction of the demands of the task. The results so far obtained indicate a low correlation with oxygen uptake at this level of work. However, as the whole body EMG can significantly discriminate between differing levels of work, it should not be ignored as a suitable method in the study of Man at work.

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Abstract No . 2

THE EFFECTS OF COMBINATIONS OF DIFFERENT LOADS AND SPEEDS DURING THE MANUAL CARRIAGE OF LOADS

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A series of experiments was conducted on five healthy adult male subjects to find out the physiological cost of carrying loads on the level at different speeds. The subjects had to carry loads of 20, 30 and 40 kg on the head at the speeds of 3, 4, 5 and 6 km/hour. The physiological parameters like Energy Expenditure (Kcal/min), Pulmonary Ventilation (L/min, BTPS), Peak Heart Rate etc. were monitored. The effects of different loads and speeds on the physiological variables have been scrutinized.

Abstract No. 3

THE USE OF A CONSTANT WORK/CONSTANT TORQUE ERGOMETER IN WORK CAPACITY TESTS

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Highly skilled subjects have been tested on a cycle ergometer incorporating an electro-magnetic breaking effect for a number of years in this laboratory(1). The introduction of a constant work/constant torque ergometer allowed comparisons to be made between the two types of machine in exercise testing. Results of the physiological cost of doing work on both machines will be presented and discussed.

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Abstract No. 4

AN ERGONOMIC APPROACH TO THE DESIGN OF INDIAN HAND-PULLED CARTS (THELAS)

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The design of man-machine system from an ergonomic point of view calls for a detailed analysis of the individual task requirements as well as the combined task requirements. Besides, the abilities and limitation of both components and the system as a whole need to be preconcieved at the starting point of the designing stage.

The Indian hand-pulled cart or a "thela" as it is commonly called, has gradually evolved over the years only through folk norms and without any systematic planning or design. This paper describes an investigation which was undertaken on a group of cart-pullers and also on a small sample of carts to find out if there is any relationship between the dimensions of these two components of the resultant man-machine system. A few interesting observations have been made which are reviewed here from the ergonomic angle.

Abstract No. 5

OPTIMAL WORK LOAD FOR INDIANS PERFORMING DIFFERENT REPETITIVE HEAVY MANUAL WORK

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The present study was designed :

(i) to ascertain the rates of usual work and the energy costs of carrying repeatedly seven different loads (about 30, 60, 75, 85, 90, 90 and 125 kg respectively) by seven different groups of Indian workers using different modes ;

(ii) to grade the work on the basis of physiological responses(1,2) and also with reference to the total productive physical work performed and the amount of money earned.

Some of the mean values of the rates of usual work at different modes and the corresponding energy costs of work per unit time, determined by using a K. M. Respirometer and a gas analysis apparatus, are given in the following summary Table.

Based on the analysis of work carried out, the job of these seven groups were graded into heavy to extremely heavy according to the classification of Sen *et al.* (3,4).

The different modes of handling of loads were compared by obtaining the same total work done and the corresponding energy expenditure. The optimal load was suggested.

From the physiological cost of work the optimal distribution of rest pauses/fatigue allowances(2) were suggested in each case.

The mean values of total energy expenditure during working hours including rest pauses and load-free-return-journey were 1900, 2660, 1725, 1850, 2240, 2230 and 2660 kcal respectively, indicating very heavy manual work, regardless of instantaneous peak load in any of these cases.

TABLE

Mean Values of Physical Characteristics and Physiological Responses of Seven Groups of Workers

Mode of Carrying (n=no. of workers.)	Place of Study	Body weight (kg.)	Load (kg.)	Physical work done (kg.m/min)	Total work done (kg.m $\times 10^n$/ day)	Money earned (Rs./ day)	Average work pulse rates (beats/ min)	Recovery pulse sum (beats)	work done (kg.m) / extra work pulse	Energy exp. (kcal/ min)	Gradation of job from (energy exp.)
Head (n=5)	Egra	49.9	30	4715	1.62	3.0	127.6	38	156.1	6.2	Heavy
Yoke (n=9)	Nalikul	45.2	60	8020	1.20	5.0	152.4	—	137.5	7.7	Very heavy
Yoke (n=2)	Egra	40.3	75	7350	1.03	5.0	143.0	151	121.6	10.1	Extremely heavy
Head (n=7)	Calcutta	48.8	85	6100	1.36	9.0	141.4	125	100.5	8.4	Very heavy
Back using strap (n=6)	Darjeeling	52.6	90	1990	0.57	4.5	132.2	40	44.5	6.6	Heavy
Back without strap (n=6)	Ghoom	49.7	90	1470	0.42	4.5	128.0	28	41.0	6.3	Heavy
Head (n=4)	Calcutta	46.9	125	7660	1.68	12.0	151.0	129	115.0	12.9	Extremely heavy

From the results it is concluded that if the daily energy expenditure during 8 hours' work-day is reduced from the high value of 2660 kcal to at least 1500 kcal, the physiological cost of work could be less and the productive life span of these groups of workers may thereby be increased.

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Abstract No. 6

AEROBIC CAPACITY OF YOUNG GIRLS—10 TO 18 YEARS OF AGE

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Aerobic capacity (VO_{max}) was found out for 60 girls of 10 to 18 years of age by treadmill running method. It increased from an average value of 861 ml/min in 10 years' girls to 1484 ml/min in the 17-18 years group. These values were 6.6 and 8.4 times the respective resting oxygen uptake values. VO_2 max per kg body weight was however reduced from an average value of 40 ml/min in prepubertal age groups to around 36 ml/min in post-pubertal girls. Maximum pulmonary ventilation (VE_{max}) increased from 36 l/min in 10 years' girls to 54 l/min in the 17-18 years group. Corresponding increase in tidal volume (TV_{max}) was from 527 ml to 1043 ml, respiratory rate reducing from 69 to 53 per minute. Respiratory equivalent, however did not show any significant difference and the average value was 40 l of air per l of O_2. On an average VE_{max} was 65% of the maximum breathing capacity and TV_{max} was 45% of the vital capacity. These two ratios also did not differ with age. The maximum pulse rate as well as the recovery pulse rate responses upto 3 minutes of recovery did not show any significant change with age.

VO_2 max and VE_{max} were found to be proportional to $height^{2.2}$ and $height^{1.7}$ respectively and these are close to the expected value of $height^2$. It appears that growth in aerobic capacity and its related functions in the girls are proportional to their growth of linear dimension and the reduction of VO_2 max per kg body weight in the postpubertal age group may largely be attributed to the increase in the body fat after the puberty.

Abstract No. 7

CARDIAC ACCOMMODATION TO WORK CAPACITY AS SEEN BY THE ELECTROCARDIOGRAM

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Previous work (1, 2, 3) has demonstrated the relationships between heart-rate and capacity to do work on a cycle ergometer in a group of time trial racing cyclists.

Investigations of the ecg, from which heart-rate is calculated, showed some further relationships with work capacity (4).

Continuous recording of ecg's (VM_5) during work to exhaustion in n=12 male time trial cyclists, was carried out. Two tests, two days apart, were used. High replicability between mean maximum work done between tests was seen (r=0.97). Analysis of the ecg amplitudes was not possible due to the effects of respiratory movement on them. Analysis of the time intervals within each ecg cycle (electrical cycle of heart) throughout the work to exhaustion demonstrated relationships of some of these intervals with work capacity. These findings will be discussed in detail.

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Abstract No. 8

BENEFICIAL EFFECT OF PHYSICAL EXERCISE IN DIABETIC SUBJECTS

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Oral glucose tolerance test was performed in diabetic subjects under resting conditions and under conditions of graded muscular exercise during the performance of the test. Cases of juvenile diabetics as well as cases of maturity onset diabetics were included in the study.

Following muscular exercise significant reduction of blood level was observed in glucose tolerance test in large proportion of the maturity onset diabetics, when compared to blood glucose levels under resting conditions. Some cases of maturity onset diabetics and all the cases clinically diagnosed as juvenile diabetics failed to show this response to muscular exercise.

On the basis of the analysis of the data presented, a new approach of theraputic use of physical exercise in the treatment of diabetics depending upon their response to muscular exercise, has been suggested.

The mechanism involved in the hypoglycemic response to muscular exercise with the possible involvement of the factors concerned have been discussed.

Abstract No. 9

ORGANIZATION OF MOTOR PERFORMANCES AS SUBSTRATE FOR BEHAVIORAL INTEGRATION

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Review of physiological feedback studies suggest that all major internal organic mechanisms of the body have reciprocal, dynamic feedback links with the action of skeletal-motor system. Every muscular activity in the physiological state involving any work performance is accompanied by appropriate change in different organizational levels of mental-emotional state, conscious or unconscious, and consequently, by feedback interaction, the integration of efferent motor response occurs. This welfare response in reciprocal behavioral-physiological interaction is intimately involved in controlling and modifying the bioenergetic, timing, synchronism of guidance operations of molecular, cellular, organic and organismic functions on a dynamic basis. Failure of such a built-in as well as learned physiological coping patterns in dealing with overt behaviour with various life stresses may act as a primary cause and excerbating agent in specific maladaptive behaviors involving a wide range of physical and mental disorders. Analysis of the beneficial clinical effects of certain behavior therapies, e.g., biofeedback, autogenic training, meditation, relaxation which employ physical conditioning based on motor performance reflect a close relevance of autonomic-somatic efferent re-organization to a variety of tropotrophic-ergotrophic interactions of the central nervous system. The organization of motor performances through well-balanced regulated exercise and skill development is a type of physiological learning which enables the brain to detect different patterns of kinesthetic, interoceptive and exteroceptive inputs resulting from the same motor effect, which in turn, converts to coordinated integrated efferent control of the limbic, extra-pyramidal-postural, extrapyramidal receptor-efferent, viscero-somatic efferent and pyramidal motor systems, thereby, developing a dynamic and dominant adaptation system for the variable control over distorted primitive behavior.

Abstract No. 10

CIRCADIAN RHYTHMS AND ADAPTATION IN SOME INDIAN SHIFT WORKERS AND CONTROL SUBJECTS

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In this preliminary study, eight volunteers were taken from healthy industrial shift-workers performing moderate type of factory work, 6 days a week and 8 hours a day. Another six volunteers taken as control subjects followed the routine of two shifts : day and night. Physiological responses such as oral temperature and pulse rate were taken hourly in all the subjects.

Of the physiological responses, pulse rate and oral temperature did not change significantly due to the shift changes ; on going to the night shift, both the rhythms were shifted slightly towards right on the time scale. However, the two rhythms were parallel to each other. This parallelism or association between them was maintained all throughout the normal and changed shift routines in control subjects, but these two were dissociated in the industrial shift workers specially during night shift condition when these were reverse to each other. Thus the pulse rate rhythm, as observed, is better adapted to the work schedule than the oral temperature. The rhythm of sleep-wakefulness in industrial workers was more or less similar in all the shifts, but in the control subjects, the night shifts were accompanied by less sleep hours than day shifts. The frequency of micturition in control subjects was higher during the night shift days than the day-shift days, but this micturition-frequency difference was less pronounced in industrial workers. It was also seen that those industrial workers who expressed their preference to the night shift than a morning one took less time to adapt their pulse rate and oral temperature to night-shift than to adapt to the morning-shift.

With further extensive studies, it may be possible to find out the important parameters which may be employed to pre-select shift workers adaptable for a particular shift in order to increase productivity.

Abstract No. 11

RELEVANCE OF CIRCADIAN RHYTHM TO FATIGUE OF YOUNG FEMALE DOUBLE-DAY SHIFT WORKERS INCLUDING MINORS

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In order to investigate the physiological background of adverse effects the shiftwork has no physical development and health of minors, variations of fatigue scales and perceptual-motor skills of young female shifters in textile and food industries were compared with those of daily workers. Those shift workers including a large number of minors worked two-shift systems in which often the morning shift began as early as 5.00 and the afternoon shift ended late around 22.00 hours. Change in fatigue scales was dominant for the drowsy factor dimension among shifters, but the disrupted-concentration dimension was also marked in morning as well as in afternoon shifts. More advanced hydrostatic effects due to sustained standing postures were found for shifters than for daily workers. While variation patterns of motor performance and perceptual threshold seemed to be virtually based on the circadian rhythm, being facilitated in daytime and significantly hampered during late evening hours, blockings in serial responding was more remarkable through the morning shift. These results may point to the importance of not only the end-of-work fatigue but also the findings related to disturbed physiological rhythm in association with sleep deficit which was pertinent, in particular, to the morning shift period.

Abstract No. 12

PERMISSIBLE LIMIT FOR DIFFERENT MINING WORK UNDER VARIOUS POSTURAL CONDITIONS

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Mining work in India is still largely dependant on manual labour. The age old method of getting coal by hand and transporting the same by shovelling in a basket and then carrying it manually is still well in vogue in India. These are all strenuous jobs and on many occasions, depending on the work situation, the miners have to carry out these work under different adverse postural conditions like stooping or kneeling in addition to the normal erect posture.

In order to find out the effect of various postural conditions on the physiological strain of the miners, a controlled study has been done on 6 pick-miners, 8 shovellers and 8 load-carriers in controlled conditions under the above three postures. From the statistical analysis of the experimental data, the relation between work rates and energy costs for these workers under various postural conditions has been found out. From the regression curves thus obtained the maximum permissible work rates for these work over a long period have been derived on the basis of the assumption that the miners can be allowed to carry on work upto 50 percent of their maximum oxygen up'ake without any undue fatigue, the thermal condition of work being wi'hin the permissible limit of 29°C effective temperature which has been found sui'able for mining work in India. The following Table gives the summary of the result :

Type of work	Posture	Recommended rate of work No. of strikes/min.
Pick-mining	(a) Erect (Standing)	13 — 14
	(b) Kneeling	25 — 26
	(c) Stooping	15 — 16
		No. of shovelful transferred/min.
Shovelling	(a) Erect (Standing)	14
	(b) Stooping	It is a heavy work and has to be done for short periods with alternating rest pauses.
		External load (kg)
Load-carrying	(a) Erect (Standing)	31.9
	(b) Stooping	15 8
	(c) Moving against gradient 1:12	18.2

Abstract No. 13

OCCUPATIONAL DAILY WORK LOAD FOR INDIAN INDUSTRIAL WORKERS AT THREE DIFFERENT THERMAL CONDITIONS

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It has been shown from a study on 84 acclimatized industrial workers (1-4) that the maximal physical work capacity (work for a short period) in different groups of Indian industrial workers depend on their age, heaviness of their jobs and thermal conditions. Based on L.P.I. the occupational work capacities of these workers were also suggested (5). It is, however, not known at which level of work and thermal condition the Indian industrial workers with different types of jobs can work safely without fatigue for 8 hours daily for months (work for long periods).

The aim of the present study carried out during 1964-1967 was to evaluate the optimal work load suitable for these workers based on the physiological responses such as pulse rate, oral temperature, oxygen consumption, sweat loss etc. during continuous work of three different rates separately on a standard bicycle ergometer at three different temperature conditions [about 70, 80 and 90°F Corrected Effective Temperature (Basic)] maintained in the laboratory and also during recovery thereafter.

It was observed that during the longer period of work the heart rate remained in a steady level in the lower work load and in lower temperature, but as soon as the environmental temperature and work load became higher, the heart rate did not remain steady and went on rising. The relation between pulse and work rates was found to be linear. The energy expenditure at rest and at submaximal loads was found to vary little with increase of temperature.

Based on the different physiological responses at different thermal conditions, the work rates which appeared to be safe and suitable for these Indian workers for day to day work for months without undue fatigue, were suggested.

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Abstract No. 14

ERGONOMIC AND PHYSIOLOGICAL STUDIES ON MINE RESCUE WORKERS

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Mines Rescue workers need to discharge their duties under very inclement environment, in the event of accidents or explosion in mines. They require skill and high degree of physical fitness. As such they undergo refresher practices at the rescue training galleries at the regional rescue station or at colliery pits. In practice or actual rescue operation they are supplied with pure oxygen for respiration from a breathing apparatus.

A physiological study has been carried out on rescue workers under practice at the training galleries and colliery pits.

The study has been made to arrive at the physiological costs of different rescue operations, safety and human limitations in performance. Their physical fitness indices were studied. On the basis of the study recommendations for recruitment and retirement standards have been made.

Abstract No. 15

PHYSIOLOGICAL CRITERION TO SET THE LIMIT OF CONTINUOUS EIGHT HOURS WORK EVERYDAY IN THE INDUSTRY

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The physiological criterion to set the limit of continuous 8 hours-work is not clearly known. In the present experiment it is reported that man should not work continuously for 8 hours work by employing more than 50% of his maximum work capacity (VO_{2max}). If 60% of VO_{2max} is involved, the subject exhibits the onset of fatigue by an increase of heart rate, blood pressure, rectal temperature and 0_2 consumption while sweat secretion usually after 6 or 7 hours of work or in other words the steady state relationship breaks. The fall of sweat secretion reveals fatigue of the sweat glands though water loss was compensated every hours equally. Thus the work at 60% of VO_{2max} produces higher strain on the cardiovascular metabolic and thermoregulatory systems and leads gradually towards fatigue and exhaustion when duration of work is for 8 hours. It is concluded that the limit of continuous 8 hours work would be 50% of VO_{2max} and this is applicable only when the working environment is comfortably cooler. It is peculiar that when water supply is more than one and half of loss during 60% of VO_{2max} work, sweat gland did not fatigue and 0_2 consumption and rectal temperature remain same while heart rate and blood pressure steeply rise and approach cardiovascular fatigue.

Abstract No. 16

INFLUENCE OF DYNAMIC AND STATIC COMPONENTS OF MUSCULAR WORK ON HEART-RATE WHILE "PUSHING TROLLEYS"

H. Monod, S. P. Dutta & J. Sanchez

Laboratory of Workphysiology, CNRS, Paris. France.

The paper describes a series of experiments carried out to assess the influence of static and dynamic components of muscular work on changes in heart rate while performing a simple task viz. pushing a trolley. Six healthy subjects (4 males, 2 females) have been considered for the investigation. An experimental set up consisting of a treadmill and a system of pulleys has been used to simulate body movements during the process of pushing a trolley. Experiments each of 10 min. duration have been performed at two speed levels (2 km/h and 3 km/h) and four load levels (3 kg, 6 kg, 9 kg and 12 kg). Heart rate has been continuously recorded during (i) walking on the treadmill at predetermined speeds without pushing (ii) pushing against a known load without moving (iii) walking at predetermined speeds while pushing against known loads. The results have been expressed in terms of cardiac cost, which may be defined as the total number of the heart beats for a particular work period above the mean level of resting pulse rate observed before the start of the activity in question.

A linear relationship has been obtained between cardiac cost (C_c) and the work load (P) for each of the three conditions described above. The three straight lines thus obtained are divergent; further it has been observed that for the same load, at either speed, the sum of the individual cardiac costs for pushing alone (static component) and for walking alone (dynamic component) is less than the measured cardiac cost when pushing and walking simultaneously at the same load and speed level. A logarithmic relationship has been obtained between the cardiac cost of pushing against a fixed load at a predetermined speed (C_{m_t}) and the cardiac cost of the static (C_m) and dynamic (C_t) components when the last is performed at the same speed or load level. This is of the form :

$$C_{mt} = C_m^{x1} \times C_t^{x2}$$

The multiple coefficient of correlation for C_{m_t} with C_m and C_t varied between 0.83 and 0.89 for each subject. The non-linearity of the above relationship may be explained by the fact that whereas static work or dynamic work alone could be considered relatively light, an association of the two components results in a work-strain which is high with the heart rate often near levels of 140-160 beats/min.

Abstract No. 17

ULTRASTRUCTURAL STUDIES ON THE EFFECT OF HEAVY EXERCISE AND TRAINING ON SKELETAL MUSCLE AND CARDIAC MUSCLE TISSUES.

Sabita Majumdar and S. R. Maitra

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Mitochondria in the rat and dog myocardium have been reported as undergoing a general enlargement and becoming somewhat swollen during forced swimming (1.2). The magnitude of these changes appeared to have been considerably less than that which is reported in the gastrocnemius muscle of rats that were sacrificed immediately after becoming exhausted after running.

The work of Maitra and Chatterjee(3) and also other have established that lactic dehydrogenase(LDH) and malic dehydrogenase(MDH) activity of skeletal muscle, cardiac muscle and liver has increased in relation to the grade of work done by the rat.

This fact has, therefore, been investigated under the electron microscope by studying the unltrastrusture of the tissues to confirm the cellular component which is responsible for this enzymatic alteration in response to exercise.

It has been observed that as a result of training the mitochondria increased in size and number with very prominent cristae. After an exhaustive exercise the cristae arrengements were completely disrupted and in some cases appeared like vacuoles. In the case of trained and exercised rats however, the damage was less severe than in that of the untrained ones.

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Abstract No. 18

CAUSES OF LOW RESPIRATORY SENSITIVITY TO HYPOXIA IN HIGHLANDERS

Haripada Chattopadhyay and Debendra Nath Sarkar

Department of Physiology, Presidency College, Calcutta-700012, India.

The mechanism of the physiological adaptation of the native highlanders, which allows them to work and live in the hypoxic environment of the high altitude with greater ease, is not yet fully understood. This peculiarity of the highlanders, like the Sherpas of the Himalayas, may have occurred either due to a genetic mutation or a genotypic selection, or due to an adaptive modification of the respiratory control system of the body on account of the continued hypoxia in the uterine and postnatal developemental phase.

Sherpa highlanders were divided into groups on the basis of the altitude of the place of their birth, as follows :—

(1) Those who were born and raised during the early period of their lives in an altitude of about 4,000 m., (2) Sherpa highlanders born and raised at 2,700 - 3,000 m., (3) Sherpas born and raised at about 2,000 m. and (4) Highlanders born and raised at about 1.000 m. Ventilatory response to hypoxia and hypercapnia produced by breathing different gas mixtures containing varying proportion of oxygen, carbon dioxide and nitrogen, were studied in all the groups including a control group of lowlanders of a different genetic type. It was found that the peculiar blunted response to hypoxia was markedly present in the first group only. In the second group born at about 2,700 m., this insensitivity was appreciably present, but not to the extent of the first group. But there was no significant difference between the ventilatory responses of the other groups. This indicates that the respiratory peculiarity of the Sherpa highlanders is of developmental origin.

Abstract No. 19

AVERAGE DAILY ENERGY EXPENDITURE OF THE COAL MINERS IN INDIA

M. K. Chakraborty, S. K. Sensarma & D. N. Sarkar

Central Mining Research Station, Dhanbad, Bihar, India.

The large labour force employed in mining is generally believed to expend more energy in their work than those engaged in most other industrial concerns. For this reason, it is worthwhile to know the miners' total energy expenditure not only in their professional shift duty but also for the whole day considering energy costs of all other off-duty activities outside the mine and during sleep.

To find out the state of energy balance, a comprehensive study was undertaken in a coal mine in Jharia. This study included a detailed time analysis of various mining work underground and the determination of the corresponding energy expenditures of the miners.

The study included altogether 132 coal mines, selected at random and engaged in various mining work. They were as follows: Pickminers 21, Shovellers 24, Load-carriers 25, Trammers 10, Machine Drivers 11, Machine Helpers 12, Drillers 14, Timber Mistries 7, and Timber Mazdoors 8.

The energy costs of all the operations including rest periods for each category of miners were estimated from their oxygen consumption during these periods by standard methods. The summated value of all the energy costs for the whole period of undergroud shift work gave the total energy expenditure for the whole shift.

The energy expenditures for all the off-duty activities were then calculated from the values reported for similar work by other Indian investigators. A summation of the energy costs during sleep, shift duty and off-duty periods provided information about the daily energy needs of the Indian miners.

The average total energy costs of different categories of miner varied between 2379 Kcal for machine drivers and 3309 Kcal for Trammers, the values for the other categories lying in between.

Abstract No. 20

ERGONOMIC COST OF SOME HEAVY MANUAL WORK IN BENGAL

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While about 33% of the 550 millions people in India are manual workers, it opens a wide field to the applied Ergonomist to bring effective labour productivity and active physical, mental and social life of the workers in their occupational pursuits. One can easily observe different agricultural and industrial workers in Bengal spending most of their time unproductively due to the lack of definite work routines specially those who work on daily wage basis, not to speak of those who are unemployed.

The object of this preliminary study was centered around the following questions :

(1) Do most of the Indian workers maintain positive calorie balance to do their moderate to heavy manual work ?

(2) If they are under-fed, are they able to keep their physical status, muscular abilities and reasonable speed of their work ?

The anthropometric surveys showed that the groups of under-fed people covered in this study are not strikingly different from the other adequately nourished people. However, meso-ectomorphic component is predominant in them and there are tendencies of not loosing body weight, although some workers reduced 4-6% of their body weight within about 2 years.

Little is known about their muscular abilities. But from the details of their daily routine, it seems they are quite capable. They sustain their daily effective life.

Is this a physiological adjustment in the form of low body weight and low basal metabolic rate in this hot climate ?

Do they maintain their work standards at the cost of longevity and functional life ?

There is a wide field of further research and a great deal of work needs to be done.

Abstract No. 21

EFFECT OF ALTITUDE ON GENERAL COLD ACCLIMATISATION

C. S. Nair, P. M. Gopinath, O. P. Tiwari & A. Das Gupta

Physiology Research Cell, Ministry of Defence R & D Organisation, Darjeeling.

Effect of simultaneous acclimatisation to altitude and cold and altitude alone at 3300 m on general cold acclimatisation was studied for 6 weeks on 20 human subjects who had never been to altitude. The findings indicate that simultaneous acclimatisation to altitude and cold is advantageous rather than stress-wise acclimatisation. Cold tolerance and cold acclimatisation is neither inhibited nor delayed if human subjects are forced to acclimatise to both the stress simultaneously from the day of their arrival at altitude. Cold acclimatisation after hypoxia acclimatisation did not offer any advantage over simultaneous acclimatisation to altitude and cold on human subjects at 3300 m. The native high landers of 3300 m maintained a lower peripheral and a higher core temperature in contrast to natives of Andes (4500 m) who exhibited a lower core and higher peripheral temperature.

Abstract No. 22

CARDIO-PULMONARY RESPONSES TO EXERCISE DURING ACCLIMATIZATION TO ALTITUDE AND COLD

C. S. Nair, P. M. Gopinath & Jaishankar

Physiology Research Cell, Ministry of Defence R & D Organisation, Darjeeling.

Effect of simultaneous acclimatisation to altitude and cold and altitude alone at 3300 m on 20 human subjects who had never been to altitude was studied for six weeks. Cardio-pulmonary response to submaximal exercise was used as a test to assess the degree of tolerance/acclimatisation to altitude. The findings indicate that simultaneous acclimatisation to altitude and cold is advantageous rather than stress-wise acclimatisation. Cold stress did not affect altitude tolerance or acclimatisation. In stress-wise acclimatisation viz. when subjects were acclimatised first to altitude and then to cold a reduction in altitude tolerance was observed on superimposition of cold stress. Moderate physical training and acclimatisation at 3300 m for six weeks did not improve the physical performance on return after sojourn at sea level. Simultaneous acclimatisation to altitude and cold at 3300 m makes the subjects better suited for higher altitude. The probable explanation for these findings are discussed.

Abstract No. 23

EFFECT OF PHYSICAL TRAINING AT 1800m ON CRITICAL FLICKER FREQUENCY (CFF) IN MAN

C. S. Nair, P. M. Gopinath & C. M. Kumar

Physiology Research Cell, R & D Organisation, Ministry of Defence, Darjeeling.

Critical Flicker Fusion Frequency(CFF) was recorded on 24 young soliders of 22-26 years age at 740m Hg(Delhi) and at simulated altitudes of 2100m and 3300m. After these measurements the subjects were taken to 1800m and CFF was recorded. They were divided into two groups. One group were given intense physical training and other group moderate physical training for six weeks. During this period the CFF was recorded at regular intervals. They were then taken back to Delhi were CFF was again determined. Results indicate that intense physical training restored deterioration in CFF; infact they showed a s'atistically significant improvement on re-test at sea level(Delhi). The improvement of CFF may be taken as improvement in the mental functions of the individual to physical training at altitude. Moderate physical training at 1800m also restored the deterioration in CFF but the pricess was delayed and the re-test values did not show significant improvement over the initial values. Possible cause are explained.

Abstracts of Papers not received till the date of Printing

Abstract No. 24

PHYSIOLOGICAL RESEARCH REQUIRED FOR A MODEL OF SINUS ARRHYTHMIA CHANGES WITH MENTAL LOAD

J. W. H. Kalsbeek & B. W. Hyndman

TNO, Netherlands.

Abstract No. 25

RESPIRATORY SENSITIVITY TO CARBON DIOXIDE IN MAN AT REST AND WORK

Ashis Sinha & Haripada Chattopadhyay

Department of Physiology, Presidency College, Calcutta-700012, India.

Abstract No. 26

VENTILATORY CONTROL AND ACID-BASE BALANCE DURING CYCLE ERGOMETER AND TREAD-MILL WORK

Sankar N. Koyal, B. J. Whipp, G. A. Bray, D. Huntsman & K. Wasserman

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Abstract No. 26

VENTILATORY CONTROL AND ACID-BASE BALANCE DURING CYCLE ERGOMETER AND TREAD-MILL WORK

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The cycle ergometer and treadmill are the two most common instruments used for exercise testing. To determine the extent to which gas exchange differs from these two forms of exercise, minute ventilation, the breathing pattern, and acid-base measurements were made at comparable levels of O_2 uptake.

Twenty sedentary male subjects with no history of cardio-pulmonary diseases whose ages were 21-33 years were selected for this study. Exercise was performed on a cycle ergometer (Lanoov) at 50, 100, and 150 watts 15 minutes each, or to fatigue forcing cessation of work. There were rest periods of 1-2 hours between work rates. Three work rates of similar duration and O_2 uptake were performed on the treadmill. Ventilatory and gas exchange variables were measured continuously breath-by-breath and processed by a mini-computer at rest and during each work test. Arterial blood was sampled at rest and during the last minute of each work rate for measurement of lactate, pH, PCO_2, bicarbonate, and PO_2.

At comparable levels of oxygen uptake the values for arterial lactate, VCO_2, V E, V T, were higher for cycle ergometer than treadmill exercise. These differences are best accounted for by a greater degree of metabolic acidosis, presumably secondary to increased anaerobiasis which occurred with cycle ergometer work. The increase in V E for the cycle ergometer over the treadmill work at a given V O_2 is linearly related to the difference in bicarbonate for the two tests. The increase in V E in the cycle ergometer test is accounted for by an increase in V T. There was no difference in breathing frequency at any given V O_2 between the two forms of exercise. We conclude that :

(a) A greater degree of metabolic acidosis results from cycle ergometer than treadmill exercise at the same work rates.

(b) The acidosis is partially compensated at the highest cycle ergometer work rates (P CO_2 decreases) while the less severe metabolic acidosis of highest level treadmill work is completely compensated.

(c) At the work rates above the anaerobic threshold, the increment in V E for a given V O_2 is directly related to the decrease in bicarbonate.

(d) Higher values in V E during cycle exercise is attributable to an increased tidal volume (V T). Respiratory rate doesn't differ between the two forms of exercise at the same V O_2.

Abstract No. 25

RESPIRATORY SENSITIVITY TO CARBON DIOXIDE IN MAN AT REST AND WORK

Ashis Sinha & Haripada Chattopadhyay

Department of Physiology, Presidency College, Calcutta-700012, India.

The respiratory sensitivity to Co_2, given by the slope of the Co_2 response curve of an individual is found to differ at different ranges of PA Co_2 in absence of hypoxia. The range of PA Co_2 in which the Co_2 sensitivity is maximum is 41-45 mm Hg in sea-level Indians and 37-41 mm Hg in medium—attitude subjects acclimatised at sea-level. It is proposed that the Co_2 thereshold and sensitivity should be measured from the Co_2 response curve occuring in the range of the maximum sensilivity to Co_2 rather than from the average Co_2 response curve conventionally drawn through different ranges of PA Co_2, since the Co_2 threshold (B) in the former case lies closer to the resting PA Co_2 than the Co_2 threshold in the latter case.

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21 Janvier 1975

Rabindra Nath

Doctor R.N. Sen
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CALCUTTA 700009
(India)

55.6068

11a MOHAN BAGAN LANE CALCUTTA

Dear Dr Sen,

I dont know if you remember me. The last time we met was in Strasbourg, in a nice alsacian restaurant in "Petite France", during the I.E.A. meeting in 1970.

Since this period, I heard a lot about yourself and your success in Calcutta.

I have a opportunity to visit Calcutta for two days during the week 10/14th February, if possible Monday 10th and Tuesday 11th, and I would be extremely happy to visit you and discuss about our common interests in developing ergonomics and work physiology.

I will leave Paris Tuesday 4th for Bangkok. My address will be : c/o Mr SUPANEE PANYARACHEM
WORLD TRAVEL SERVICE
SIAM CENTER BUILDING
965 RAMA I ROAD
THAILANDE BANGKOK

I will perhaps have a room in Hotel Europe, but it is not sure. The phone number is 3.0314 Bangkok.

I enjoy the idea of meeting you again.

Truly yours,

A. Wisner

The purchase of a foreign production system
The role of Ergonomics and Anthropotechnology
Synopsis of the Tutorial given in New Delhi on the occasion of the 11th Indian Ergonomics Seminar (November 1996)

A. Wisner *

The technology transfer

The technology transfer is an activity that is very old. But it has taken on considerable dimensions over the last 50 years. What is actually involved is an exchange. Although India is a major importer of technology, it is also a major exporter, hence its membership of the exclusive club of the New Industrialized Countries (N.I.C.) distinguished some 20 years ago by MacNamara. Here, we shall only mention the problems raised in India by imports of foreign technology.

Cultural machines and the Art of the Engineer

Although science is universal, the technology transfer raisers particular problems due to the fact that machines, and even more so machine systems, are cultural in as much as the engineers and technicians who design them think of the companies, managers and workers of their own country when they design a new technical system. Furthermore, the engineer who designs a system imagines it working in the industrial environment of his own country.

More often, a good engineer works through analogy with the situations he knows or thinks he knows according to his own engineering logic - the logic of design - which is unfortunately different from the logic of use which will be that of the users in the real situation of the installed technical system.

* Emeritus Professor at Conservatoire National des Arts et Métiers, 41 rue Gay-Lussac, 75005 Paris, France

Diversity of technology installation situations

Numerous aspects separate the conditions of use of a technical system in the buyer country from those that exist in the seller country. These differences are due to various parameters:

- geographical: climate, seismic risks, ports, road and rail networks, water resources, electricity supply, etc.
- technical competence: engineers (India trains a large number of top-level engineers), technicians, skilled workers, technical and university centres and experts.
- social resources: housing, schools, nourishment, health system, the extent of endemic parasitic or infectious diseases.

The countries, and sometimes the provinces in a country as large as India, differ from each other both historically and culturally. The age and the level of traditional craftwork and the constitution of a relatively dense industrial fabric are the main elements which play an important part in the success of a technology transfer.

Criteria for a successful transfer

The success of technology transfers can vary considerably depending on diverse criteria.

- Quantity of production. Without aiming to achieve nominal-level production - which is dangerous from the viewpoint of keeping the production system in good working order - there can be deceptions in the field of production volume.

- Production quality. In certain cases, the production quality does not reach a level necessary for it to be exported. This is a situation which leads industrialists to claim protectionism which - in time - is dangerous for industrial expansion. To obtain international-level quality, the technical system must not be downgraded or, worse still, atrophied.

- Keeping the technical system acquired in good condition, often at the price of considerable financial and human effort. Keeping the production system in good condition and preventing its deterioration or its atrophy not only means that great attention must be paid to maintenance - which is not always part of the culture of regions that are little industrialized - but also necessitates customs

regulations and financial resources which enable acquisition of the necessary raw materials and spare parts. Sometimes, such a practice is too expensive. But since maintenance remains a major concern in order to achieve a good level of quality and endurance of the installations, it is necessary to search for local supplies of replacement raw materials and to discover the processes for local production of the necessary spare parts. As such, the main demand is that of maintenance, requiring an effort that is sometimes considerable but well within the reach of a country as educated and industrialized as India.

All these considerations show that the purchase of a technical system is not enough to overcome all the difficulties which this purchase is expected to solve. A transfer is only successful if it is active. Therefore a theoretical framework and a methodology must be available in order to achieve the success of this active transfer.

Accompanying the foreign technological system. Comprehension of the system whose purchase is planned requires a considerable amount of work, not only from the technical viewpoint, but also from the viewpoint of the resources used in the country of origin: quality of raw materials, water supply, electricity supply, the extent of use of subcontracting, the maintenance done by suppliers of measuring and analysis equipment, the frequency of use of experts of all levels and the degree of initiative of managers and operators.

Negotiation of the specifications

After this considerable work of comprehension, the buyer is ready to negotiate the specifications so that the system can be adapted to the particularities of the region of India where it should be installed. The modifications requested may be important for the workers, but negligible for the manufacturer. For example: the dimensions of the workstation intended for operators who, on average, are 10 cm smaller than the "standard" operators for whom the system was originally designed. The modifications may be minor relative to the alphabet or the symbols used to guide operators, while bearing in mind that, in all probability, very few of the workers can read English.

The modifications which appear necessary are sometimes more extensive when the raw materials used in India are different from the country of origin and where the water or electricity supplies raise particular problems in the region of India where the system is installed. The reluctance or refusal of

the seller to satisfy these modification requests is linked to the fact that, where it agrees to an excessive amount of modifications, it could lose all its profit on the operation which mainly comes from reuse of the hours of study and drawings that were necessary to design the system offered for sale.

It can be seen that this phase prior to purchase is of great importance. It should include:

1) A specific definition of the reason why the system is purchased

2) An in-depth study of the resources of the Indian region where the installation is planned and the difficulties that could be encountered when the system is used in the planned installation. The best way to find out future difficulties is to carry out ergonomic work analysis (E.W.A.) in a similar company in the planned region or a neighbouring region. It is dangerous to imagine that all difficulties, or combinations of difficulties, can be envisaged through a top-down approach. It is much safer to carry out a bottom-up approach in which an in-depth analysis is made of the activities of operators in some key jobs in the company and where the origin of the difficulties of these operators can be found.

3) A study of the technical system whose purchase is planned. This should be done either in the seller country where the system was designed, or in a country similar to the buyer country. It would be wrong to blindly assume that the system works perfectly well in the seller country and that any difficulties that could arise in India are necessarily linked to the transfer. They could quite simply be linked to the inherent weaknesses of the technical system itself.

When one thinks about the questions raised as such, it is obvious that the purchase of a technical system by persons who have no knowledge of its industrial use could have disastrous consequences. As I see it, the Carbaryl plant in Bhopal was a terrible illustration of this. The determination of certain areas of India to industrialize and the search for arrangements that are apparently advantageous from the financial viewpoint, can lead to unfavourable and inextricable economic situations, the result of which can be tragic or, at least, negative.

The place of organization of the company and the work

In favourable cases which, luckily, are the vast majority, the result is only obtained by paying the greatest possible attention to the organization of the work and the company that will be created to adapt the technical system to Indian society. In a way, the organization is the bridge that links the machines coming from another country and another culture to the situation of the buyer country, to India and, more particularly, to the part of India where the plant will be installed. From the viewpoint of the theory of contingency, the fact that the company is located in India should be included as a dominant contingent element of the situation. However, when it is a foreigner who has to produce and take the data into account, there is a risk of the situation being complicated even further due to the superficial representation which this foreigner could have of Indian culture.

Therefore, it appears vital for the organization of the work and the company to be done by a team which includes a majority of Indians. However, we now know that a successful import is that of a system whose various technical elements are compatible and where - even more so - the organization corresponds to the requirements of the system. Therefore, there are two contributions which, in a way, are contradictory. Firstly, the ideal organization according to the designers and, secondly, the organizational characteristics that best correspond to Indian culture, more particularly to that of the region where the installation is planned.

This is only a question of principles, as demonstrated by the Finnish school of engineers with Engestrom following the work of the Russian school of Leontiev. For these authors, activities are performed through actions that can be broken down into operations. In a stabilized system, the actions then the activities themselves take place in a regular way and, to an extent, become automatic, taking on the status of an operation regardless of the complexity of human functioning. But if an anomaly disturbs the situation, the operator, once again, has to break down his activity into actions, or even operations. Yet, in transferred systems, such anomalies often arise. Perrow proposed the means of evaluating this complexity which can provoke defective operation, or even deterioration of the system. The transferred system can suffer from the very difficulties of the transfer which provoke an increased complexity of the task for the operator and, due to this, require an operation that is different from the one planned by the designer that worked rather well in the seller country or in similar situations.

Start-up of the transferred system

It is not simply a matter of forming a mixed seller-exporter team before the transfer. Such a team has to be maintained during the installation period of the new technical system and also during the first period of normal operation.

The normal character of operation conditions should be stressed since optimal conditions can be obtained artificially for the limited period of the test-run by cutting off the water and electricity supplies of the neighbouring town and by doubling the number of specialists. Of course, this is not a normal situation and, once this period is over, the dissociated installation team and the Indian operators can be faced with problems that are impossible to solve.

Often, the possible seriousness of the difficulties encountered with installation of the technical system on a particular site cannot be reduced without the aid of the national, regional or local authorities. The insufficiency of electricity and fresh water supplies, insufficient dimensions or poor equipment of the port, not to mention the poor quality of the roads linking the plant to the port or the state, or the limits of the education or social system, are generally questions which the company cannot solve on its own. Sometimes, they are the subject of tough negotiations with various authorities and the company cannot be satisfied with promises.

Conclusion: the technology transfer is a difficult operation

As such, the technology transfer is always a difficult operation, even if the supplier is Indian and is located in a major industrial region and when the new system is to be installed, for example, in an agricultural region which has a less reliable social and industrial fabric. But, as we have seen, a systematic approach is possible ... and efficient.

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- geographical: climate, seismic risks, ports, road and rail networks, water resources, electricity supply, etc.
- technical competence: engineers (India trains a large number of top-level engineers), technicians, skilled workers, technical and university centres and experts.
- social resources: housing, schools, nourishment, health system, the extent of endemic parasitic or infectious diseases.

The countries, and sometimes the provinces in a country as large as India, differ from each other both historically and culturally. The age and the level of traditional craftwork and the constitution of a relatively dense industrial fabric are the main elements which play an important part in the success of a technology transfer.

Criteria for a successful transfer

The success of technology transfers can vary considerably depending on diverse criteria.

– Quantity of production. Without aiming to achieve nominal-level production - which is dangerous from the viewpoint of keeping the production system in good working order - there can be deceptions in the field of production volume.

– Production quality. In certain cases, the production quality does not reach a level necessary for it to be exported. This is a situation which leads industrialists to claim protectionism which - in time - is dangerous for industrial expansion. To obtain international-level quality, the technical system must not be downgraded or, worse still, atrophied.

– Keeping the technical system acquired in good condition, often at the price of considerable financial and human effort. Keeping the production system in good condition and preventing its deterioration or its atrophy not only means that great attention must be paid to maintenance - which is not always part of the culture of regions that are little industrialized - but also necessitates customs

regulations and financial resources which enable acquisition of the necessary raw materials and spare parts. Sometimes, such a practice is too expensive. But since maintenance remains a major concern in order to achieve a good level of quality and endurance of the installations, it is necessary to search for local supplies of replacement raw materials and to discover the processes for local production of the necessary spare parts. As such, the main demand is that of maintenance, requiring an effort that is sometimes considerable but well within the reach of a country as educated and industrialized as India.

All these considerations show that the purchase of a technical system is not enough to overcome all the difficulties which this purchase is expected to solve. A transfer is only successful if it is active. Therefore a theoretical framework and a methodology must be available in order to achieve the success of this active transfer.

Accompanying the foreign technological system. Comprehension of the system whose purchase is planned requires a considerable amount of work, not only from the technical viewpoint, but also from the viewpoint of the resources used in the country of origin: quality of raw materials, water supply, electricity supply, the extent of use of subcontracting, the maintenance done by suppliers of measuring and analysis equipment, the frequency of use of experts of all levels and the degree of initiative of managers and operators.

Negotiation of the specifications

After this considerable work of comprehension, the buyer is ready to negotiate the specifications so that the system can be adapted to the particularities of the region of India where it should be installed. The modifications requested may be important for the workers, but negligible for the manufacturer. For example: the dimensions of the workstation intended for operators who, on average, are 10 cm smaller than the "standard" operators for whom the system was originally designed. The modifications may be minor relative to the alphabet or the symbols used to guide operators, while bearing in mind that, in all probability, very few of the workers can read English.

The modifications which appear necessary are sometimes more extensive when the raw materials used in India are different from the country of origin and where the water or electricity supplies raise particular problems in the region of India where the system is installed. The reluctance or refusal of

the seller to satisfy these modification requests is linked to the fact that, where it agrees to an excessive amount of modifications, it could lose all its profit on the operation which mainly comes from reuse of the hours of study and drawings that were necessary to design the system offered for sale.

It can be seen that this phase prior to purchase is of great importance. It should include:

1) A specific definition of the reason why the system is purchased

2) An in-depth study of the resources of the Indian region where the installation is planned and the difficulties that could be encountered when the system is used in the planned installation. The best way to find out future difficulties is to carry out ergonomic work analysis (E.W.A.) in a similar company in the planned region or a neighbouring region. It is dangerous to imagine that all difficulties, or combinations of difficulties, can be envisaged through a top-down approach. It is much safer to carry out a bottom-up approach in which an in-depth analysis is made of the activities of operators in some key jobs in the company and where the origin of the difficulties of these operators can be found.

3) A study of the technical system whose purchase is planned. This should be done either in the seller country where the system was designed, or in a country similar to the buyer country. It would be wrong to blindly assume that the system works perfectly well in the seller country and that any difficulties that could arise in India are necessarily linked to the transfer. They could quite simply be linked to the inherent weaknesses of the technical system itself.

When one thinks about the questions raised as such, it is obvious that the purchase of a technical system by persons who have no knowledge of its industrial use could have disastrous consequences. As I see it, the Carbaryl plant in Bhopal was a terrible illustration of this. The determination of certain areas of India to industrialize and the search for arrangements that are apparently advantageous from the financial viewpoint, can lead to unfavourable and inextricable economic situations, the result of which can be tragic or, at least, negative.

The place of organization of the company and the work

In favourable cases which, luckily, are the vast majority, the result is only obtained by paying the greatest possible attention to the organization of the work and the company that will be created to adapt the technical system to Indian society. In a way, the organization is the bridge that links the machines coming from another country and another culture to the situation of the buyer country, to India and, more particularly, to the part of India where the plant will be installed. From the viewpoint of the theory of contingency, the fact that the company is located in India should be included as a dominant contingent element of the situation. However, when it is a foreigner who has to produce and take the data into account, there is a risk of the situation being complicated even further due to the superficial representation which this foreigner could have of Indian culture.

Therefore, it appears vital for the organization of the work and the company to be done by a team which includes a majority of Indians. However, we now know that a successful import is that of a system whose various technical elements are compatible and where - even more so - the organization corresponds to the requirements of the system. Therefore, there are two contributions which, in a way, are contradictory. Firstly, the ideal organization according to the designers and, secondly, the organizational characteristics that best correspond to Indian culture, more particularly to that of the region where the installation is planned.

This is only a question of principles, as demonstrated by the Finnish school of engineers with Engestrom following the work of the Russian school of Leontiev. For these authors, activities are performed through actions that can be broken down into operations. In a stabilized system, the actions then the activities themselves take place in a regular way and, to an extent, become automatic, taking on the status of an operation regardless of the complexity of human functioning. But if an anomaly disturbs the situation, the operator, once again, has to break down his activity into actions, or even operations. Yet, in transferred systems, such anomalies often arise. Perrow proposed the means of evaluating this complexity which can provoke defective operation, or even deterioration of the system. The transferred system can suffer from the very difficulties of the transfer which provoke an increased complexity of the task for the operator and, due to this, require an operation that is different from the one planned by the designer that worked rather well in the seller country or in similar situations.

Start-up of the transferred system

It is not simply a matter of forming a mixed seller-exporter team before the transfer. Such a team has to be maintained during the installation period of the new technical system and also during the first period of normal operation.

The normal character of operation conditions should be stressed since optimal conditions can be obtained artificially for the limited period of the test-run by cutting off the water and electricity supplies of the neighbouring town and by doubling the number of specialists. Of course, this is not a normal situation and, once this period is over, the dissociated installation team and the Indian operators can be faced with problems that are impossible to solve.

Often, the possible seriousness of the difficulties encountered with installation of the technical system on a particular site cannot be reduced without the aid of the national, regional or local authorities. The insufficiency of electricity and fresh water supplies, insufficient dimensions or poor equipment of the port, not to mention the poor quality of the roads linking the plant to the port or the state, or the limits of the education or social system, are generally questions which the company cannot solve on its own. Sometimes, they are the subject of tough negotiations with various authorities and the company cannot be satisfied with promises.

Conclusion: the technology transfer is a difficult operation

As such, the technology transfer is always a difficult operation, even if the supplier is Indian and is located in a major industrial region and when the new system is to be installed, for example, in an agricultural region which has a less reliable social and industrial fabric. But, as we have seen, a systematic approach is possible ... and efficient.

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