

# HARD FACTS ABOUT SOFT MACHINES



*The  
Ergonomics  
of Seating*

Edited by  
Rani Lueder  
and Kageyu Noro

  
**Taylor & Francis**  
Publishers since 1798

**UK** Taylor & Francis Ltd, 4 John St., London WC1N 2ET

**USA** Taylor & Francis Inc., 1900 Frost Road, Suite 101, Bristol PA 19007

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**British Library Cataloguing in Publication Data**

A catalogue record for this book is available from the British Library

ISBN 0 85066802 6

*Cover design by Amanda Barragry*

*Typeset in Great Britain by Santype International Limited.  
Printed in Great Britain by Burgess Science Press, Basingstoke  
on paper which has a specified pH value on final paper  
manufacture of not less than 7.5 and is therefore 'acid free'.*

## Preface

A well-known British radio programme for small children (*Listen with Mother*) some years ago, would start with the storyteller saying, 'Are you sitting comfortably, then we'll begin'. It became a catchphrase, still in use, but begged a lot of questions! Not least amongst those questions is what 'sitting comfortably' really means.

Much of the work on seating has dealt with sitting at work, very little has looked at what in Britain are called 'easy chairs', the large heavily upholstered furniture which is observable in most homes. Domestic furniture generally 'design' emphasizes appearance over comfort which is equated with softness of upholstery. There is little evidence that the many years of seating research has had much effect on the design of personal furniture, or on the understanding of the public about sitting requirements.

Not least to be criticized in this is the concept that designers, a word which is imprecise in its coverage, are not necessarily the appropriate people to design furniture. Amongst those in this category have been architects for example, who have produced many striking designs of chairs, but at the same time chairs which are inadequate, unstable and downright dangerous. Until some ergonomics is a required component of an architect's training they should recognize the necessity of taking some good ergonomics advice.

Although work furniture has had so much more attention a visit to any office or factory will show that there is a long way to go before this work is translated into the wider world. Perhaps sitting is too easy an action, just bending at the hips and knees, and there you are. But the reactions of the body, over time, to this simple action are yet matters for investigation. The impact of Branton's view of sitting as an unstable posture, (Branton 1969), with its consequent requirement to study seated subjects over long periods and observe their behaviour in detail, still does not illuminate many studies. In particular the approach of attempting to interpret from behaviour what relevant model is operating, rather than working from a theoretical model is seen in the minority of investigations. There is nothing wrong with theoretical models, of course, providing they are representative of reality. Unfortunately our knowledge of the realities of sitting are still uncertain, and a dependence on theory without the support of empirical evidence will lead us into false, indeed dangerous, conclusions.

The revival of an international symposium on seating is long overdue, and these papers, developed and expanded from the Tokyo symposium are a welcome indication that the interest may now be maintained. Increased international concern in the health and safety of people at work is one of the driving forces behind this revival. The contributions in this book are a significant step in the science of seating and should lead to a better understanding of the mechanics, the dynamics and the effects of seating on the sitter. It will also, no doubt, lead to the recognition that technology can permit the increased personalisation of a seat, so that it is truly the seat that adapts to the sitter rather than the opposite.

There is still a long way to go in the understanding of seats and sitters, and a lot of work to do in the design of better seats. This exploration will require seat models which are truly ergonomic, taking account not only of the biomechanics and physiology of sitting but the task requirements and environment of the sitter as well. Then we will begin to see a closer identity between theory and practice in the applications of ergonomics to seating.

E N Corlett

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## *Notes on Contributors\**

**Rani Lueder**, CPE, is President of Humanics ErgoSystems, Inc., an ergonomics consulting firm in Encino, California. She has consulted in ergonomics and workplace safety since 1982, and is a member of the ANSI committee revising American National Standards for Computer Workstations. She also edited and co-authored *The Ergonomics Payoff: Designing the Electronic Office* (HRW). She is a member of the Human Factors and Ergonomics Society (US), the Ergonomics Society (Europe), and is Certified with the Board of Certification in Professional Ergonomics.

**Kageyu Noro** is the Associate Dean of School of Human Sciences, Waseda University. With the support of many staff members and visiting professors, his laboratory carries out varied studies, such as participatory ergonomics, kansei, seating, and virtual reality as high-technology ergonomics. He is known as the person who originated the concept of participatory ergonomics in 1984. The handbook *Illustrated Ergonomics*, developed with his concept of product-oriented ergonomics, edited by him, and contributed by 118 authors, was awarded one of the top prizes for Japanese books on science and technology in 1990. The 15-installment TV educational programme 'Ergonomics for Everyday Life' he edited as invited professor of the University of the Air, a Japanese broadcast university, is broadcasting on a Japan-wide channel. He is Chair of the Seating Research Committee (Zaken). He is the first chair of the International Working With Display Units (WWDU) Group.

**Marvin J. Dainoff**, PhD, is Professor of Psychology and Director, Center for Ergonomic Research, Miami University, Oxford, Ohio. He is also President of Marvin Dainoff Associates Inc., Consultants in Ergonomics. He received his PhD in Experimental Psychology from the University of Rochester in 1969.

**Paul Cornell** works at Behavioral and Environmental Research, Steelcase Inc., Grand Rapids, MI, USA.

**Keiichi Ohno** graduated from Nihon University in 1985. He joined Uchida Yoko Co., Ltd and took charge of the R&D for work stage furniture. He is now taking charge of marketing the chair with the R&D Department.

**John Roebuck** began his interest in human factors while working on his Bachelor of Science degree in mechanical engineering at the University of California at Berkeley. From UCLA he obtained a Master of Science degree in engineering with a biotechnology option. He has been employed at Douglas Aircraft Co., Collins Radio Co., Rockwell International Corporation and McDonnell Douglas. His experience has included engineering design, human factors research and consulting, technical editing, and management positions as proposal manager, project engineer and supervisor on contract studies and

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\* First-named authors only

principal investigator for internal research and methods development. His 25 years at Rockwell included work on Apollo, Space Shuttle and Space Station as well as many IR&D projects. Since February 1987 he has been self-employed as a consultant, doing business as Roebuck Research and Consulting. Since early 1988 he has worked part time at the Douglas Aircraft component of McDonnell Douglas developing anthropometric requirements for a proprietary computer-human model. He is the author or co-author of over 40 technical documents, including the text book titled *Engineering Anthropometry Methods* (John Wiley & Sons in 1975), and is currently writing a book on anthropometric estimation methods.

**Max Vercruyssen**, PhD, Assistant Professor of Gerontology and Psychology (University of Hawaii) and Assistant Professor of Human Factors (University of Southern California), is a gerontologist and ergonomist whose basic research has focused on the quantification and explanation of central nervous system changes, particularly in integrity measures like speed of behaviour, caused by environmental stressors, neurotoxins, and endogenous phenomena like organism ageing and practice (i.e., repeated exposures). His applied research consists mainly of laboratory investigations, the findings of which have been instrumental in developing federal and international standards for protective equipment (e.g., respirators and clothing ensembles). As a private consultant, Dr Vercruyssen has advised clients on seating arrangements for optimal workstation design, but posture became an experimental manipulation in his laboratory research when he discovered that it could alter the rate of information processing in humans and that such changes showed potential for explaining age-related slowing of behaviour.

**Yutaka Haruki** graduated from Graduate School of Letters, Waseda University in 1961, where he became a lecturer of School of Letters in 1966. He became an associate professor in 1969, and in 1974 became a professor. Since 1987, he has been professor of School of Human Sciences. His research targets the animal and the child, and has researched conditioning and human learning. Recently, he has been interested in the relationship between nonverbal behaviour and emotion, especially the effect that nonverbal behaviour has on emotion.

**Tom Bendix**, MD, PhD, works at Laboratory for Back Research, 7601 State University Hospital, DK-2200 Copenhagen, Denmark and Rehabilitation Engineering Center, University of Vermont, USA.

**Steven Reinecke**, Biomedical Engineer MS, has been affiliated with the Department of Orthopedics at the University of Vermont since 1980. In 1983 he joined the Vermont Rehabilitation Engineering Center for low back pain to study seating. In 1987 he became Principal Investigator for low back pain seating studies. He has consulted for a number of chair manufacturers in product development, product evaluation, and seating research. His research studies have ranged from bicycle seats, office chairs, and motor vehicle seats to wheelchair seating. His work has concentrated on the biomechanics of the body while in the sedentary position.

**A. C. Mandal**, MD, is Chief Surgeon, Taarbek Strandvej 49, 2930 Klampenborg, Denmark.

**Karl H. E. ('Eb') Kroemer's** interests are particularly in research and application aspects of anthropometry, biomechanics, and work physiology. Since 1981, he has been a professor at Virginia Tech (VPI&SU) where he directs the Industrial Ergonomics Laboratory. His academic degrees are in mechanical engineering from the Technical University Hannover in Germany. He worked as a research engineer at the Max Planck Institute for Work Physiology and as director of the Ergonomics Division of the BAU (the German NIOSH). In the USA, he was a research engineer with the USAF Human Engineering Division, and professor of ergonomics and industrial engineering at Wayne State University. He was a UN ergonomics expert in Romania and India. He is the author of more than 130 publications, among them several books.

**Joseph A. Sember III**, gained a Bachelor of Science degree in Civil Engineering from the University of Arizona. From 1973 to 1976, he was Project Manager on large military construction projects. In 1976, he became Manager of applications engineering at P. L. Porter Co., which is a manufacturer of seat recline systems. Since 1986, he has been Executive Vice President of Jasco Products, a manufacturer of pneumatic seat adjustment systems. In 1990 a company called Numotech Inc was formed by five medical and technical professionals to develop special seating systems for the wheelchair bound population. Joe Sember III is President of Numotech Inc. Together, Numotech, as the Research and marketing arm, and Jasco Products as the engineering and manufacturing arm have, over the last two years conducted an extensive research and development programme resulting in the systems and studies referenced in the chapter.

**Clifford M. Gross**, PhD, is President and Chief Executive Officer of Biomechanics Corporation of America. He has provided consulting, training and research services worldwide, across a wide number of industries and has published more than 50 articles and abstracts on workplace ergonomics, biomechanics and injury prevention. As guest speaker, he has addressed professional audiences around the world. Dr Gross has established corporate ergonomics programmes at many major US corporations including EI DuPont de Nemours, Dow Corning Corporation, Ford Motor Company, General Motors, Procter & Gamble, Michelin Tire Corporation, Consolidated Edison, Cooper Industries, Mobay Corporation, Union Carbide Corporation, Steelcase, Lear Seating and Thomson Consumer Electronics. The company which he founded and directs is the first public ergonomics firm in the United States.

**Am Cho**, is professor of the Department of Industrial Engineering, Dongguk University, Korea. Since 1986, he has been a member of executive committee of the Ergonomics Society of Korea. His research interests are virtual reality, working environment ergonomics, and seating.

**Tomoko Hibar** completed the school nurse training programme of the Faculty of Education, Kumamoto University in 1974. After the work of the junior high school of three years, she is working at Shirono elementary school of Kitakyushu municipal.

**Tadao Koga**, Dr Eng., joined Citizen Watch Co. in 1957 after graduating from the Department of Craft, Faculty of Art, Tokyo University of Art. He became

the lecturer of the Department of Industrial Design, Faculty of Design, Kyushu Institute of Design in 1969. He is researching the design methodology concerning physically handicapped persons and the aged's environment.

**Narumi Hirao**, MD, BS, graduated from the Department of Physics, Faculty of Science, Kobe University in 1976. Afterwards, she entered University of Occupational and Environmental Health, School of Medicine and graduated in 1986. She worked for Fujidenki Hospital as a doctor of internal medicine and the health doctor after working with Kantou Rousai Hospital as a resident. She has been working for Hyogo Hospital since 1992. She is interested in women's work problems.

**E. Nigel Corlett** is Professor Emeritus of the University of Nottingham and Scientific Adviser to the University's Institute for Occupational Ergonomics. Prior to joining the University at Nottingham he was Professor of Industrial Ergonomics at the University of Birmingham. Professor Corlett studied mechanical and production engineering and worked in industry as designer, factory manager, and head of design and development in a major domestic equipment company. His research has embraced biomechanics including seating, workspace and equipment design and organization design. He has edited or authored several books. He is Honorary Fellow of the Ergonomics Society, a Fellow of the Fellowship of Engineering and holds the DSc of the University of London.

**Youichi Suzuki** graduated from the Department of Industrial Design, Kanazawa Art and Technology College in 1964. He joined Kokuyo Co., Ltd in the same year. At present, he is Director of the Products Development Section of the Furniture Department, with responsibility for planning and development of office furniture.

**Mitsuaki Shiraishi**, graduated from Chiba University in 1983, having completed a masters course in Architecture. He was then employed by the Joint Okamura Corporation (Office Furniture maker) Field Ergonomics for Interior space and Industrial Design.

**Kozi Morooka**, Doctor of Engineering, is Head Professor of Tokai University Graduate School of Management Engineering. He was born in 1930. After many years of study he graduated from a Doctors' course at Keio University Japan, and went on to become Assistant Professor of Administration Engineering at Keio University, Honorable researcher of Wisconsin University of Canada, Professor of the Engineering Department, Tokai University, Lecturer of the Medical Department, Tokai University, and Visiting Professor of Windsor University, Canada, he is also a former member of the Japan Medical Association.

**Christin Grant** received her PhD in Urban, Technological, and Environmental Planning from the University of Michigan, where she specialized in environmental psychology. In the past 18 years, she has done numerous human factors research projects affecting the design of furniture, machines, and environments. A Research Fellow at the Center for Ergonomics at the University of Michigan, and a member of the Human Factors Society and the Environmental Design Research Association, she lives in Ann Arbor, Michigan.



**Ida Festervoll** is a consultant and a Physical Therapist at Håg a.s. She has consulted for 10 years on the development of ergonomic work chairs and seats for transportation, industry, banks and offices, and is Norwegian delegate to the European Standardization Committee CEN, TC 207 Office Furniture and TC 122 Ergonomics. She has 10 years of developing working chairs, and serving as consultant to one of Norway's biggest banks, where 90% of the employees have their own computer.

**Hector Serber** is President of American Ergonomics Corporation, a research and development firm dedicated to advanced ergonomic seating system design. Serber has been granted three US Patents #4,650,249, Ergonomic Seating Assembly (1987), #4,832,407, Variable Posture Chair and Method (1989) and for vehicular safety, Seat Assembly and Method (1993), #5244,252 as well as numerous international patents and patents pending in Europe and Asia. He holds a Tecnico Mecanico degree from Collegio Industrial de la Nacion, BA, Argentina, and studied Mechanical Engineering at California State University at Sacramento.

**Mark C. Volesky** is a Senior Product Engineer at Steelcase Inc. During the writing of this chapter, he was a senior research engineer at Steelcase. His responsibilities included monitoring ergonomics and VDT related legislation at all levels of government. He has served as consultant to the Canadian Standards Association (CSA) during the drafting of the Office Ergonomics Standards and has taught classes on ergonomics. He is a senior member of the Institute of Industrial Engineers and a past member of the Human Factors Society. Volesky earned his Bachelor of Science degree from North Dakota State University.

**L. B. Kruk** works at Marketing and Research, Proformix, Whitehouse Station, New Jersey, USA.

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# *PART I*

## *Introduction*



## *Introduction*



Kageyu Noro



Rani Lueder

The genesis of chairs and sitting is not known. A primitive version of the chair was discovered in the Toro ruins in Japan, circa 100 AD. During the Middle Ages, chairs were also used by high-level samurai who commanded field operations, and by priests during religious ceremonies.

Given this, it is surprising that chairs did not predominate until recently. In Japan, citizens began to use chairs during the Meiji era (1868–1912). In the West, seats were primarily used by royalty, and only gradually infiltrating the upper classes. Stewart (1986) describes a 1458 painting, in which robed justices of the French high court sprawled across the floor in session. Chairs became available to the emerging leisure classes during the reign of Louis XIV. ‘Commoners’ reconciled themselves to sitting on baskets, benches, and such.

Over time, technological innovations, first directed towards the achievement of specific ends, were incorporated into general purpose seating. For example, swivel-tilt seat capabilities were probably developed to facilitate navigation at sea. Today, the evolution of chair design is frequently driven by specialized requirements, such as to accommodate car driving or the disabilities.

Recent advances in the variety, complexity, and rapid pace of change of the materials and related sciences continue to accelerate innovations for all the various stages, associated with product design, manufacture, assessment and (ultimately) recycling. For example, intelligent computer systems, using computer-aided design and large-scale databases, are extending our ability to

take advantage of the almost infinite variety of materials and composites now available to allow chairs to perform in new ways.

These advances continue to promise breakthroughs that allow seats to become more comfortable, yet easier to use and adjust. Some models can already flex in new ways, improving both postural support and freedom of movement. Cushioning composites may impart both firm support and 'cushy' comfort; features that have historically been at odds. Seat tensioning and contours may respond to the specific user, and absorb shocks. Chairs are increasingly becoming lighter, safer, stronger, and more stable, and at less cost and with less waste. Some chairs have become 'intelligent', and impart 'memories' to accommodate different users, tasks, and positions.¶

These possibilities arrive not a moment too soon. Never before has there been such a recognition of the health consequences that may accompany seated work. A review of research over the last decade underscores the prevalence of physical discomforts experienced by computer users, as well as general office workers (Kroemer, 1988; Lueder, 1992; National Research Council, 1983; Sauter and Schleifer, 1991).\*

An increasing recognition of the health hazards incurred from lack of movement (Kilbom, 1987; Lueder, 1992) has accentuated concerns regarding the future impact of a technology-driven work process that systematically reduces the potential for movement – to a greater extent every year.

In Japan, attention to seating has also been heightened by a shortfall of workers since 1990. Employers have become increasingly focused on how to attract good workers with ergonomic seating. Concurrently, greater employee expectations in 'quality of work life' extended to their expectations of seating comfort.

Within Japan, this demand became so acute that there arose a severe shortage of ergonomic seats during 1990 and 1991. It also provided the impetus for 'The New Office Campaign' project by Japan's Ministry of International Trade and Industry, which accelerated corporate interest in ergonomic seating.

*Zaken* (a Japanese abbreviation of 'Posture and Chair Study Committee') was established in April of 1991 through financial support from the Japan Institute of Posture Research. The objectives of this committee are: to help organizations evaluate chairs; to provide users with information to improve their seated comfort; and, to promote an exchange of information between users and manufacturers.

This book is an outgrowth of this initiative. Originally based on the Proceedings of the 1989 Second International Symposium on the Science of Seating (Tokyo), it included fifteen papers from participants in seven countries†. This was the first such symposium since the 1968 International Symposium on Sitting Posture, organized by Dr Etienne Grandjean, and held at the Swiss Federal Institute of Technology.

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\* It should be noted that this attention is presently centered in the West. The frequency and types of physical problem of computer users in countries such as Japan are not well understood, but appear less pronounced at this time.

† This symposium was jointly sponsored by Waseda University and the Japan Society for the Promotion of Science. It was conceived and organized by Professor Noro, with the collaboration of Rani Lueder, MS (US).

¶ My thanks to Mr Bill Marks, Dupont, for his insightful comments. (RL)



The Symposium's objective was to address a few of the myriad of questions that remain regarding how to design ergonomic seats. Although a vast body of research on seating in recent years has greatly advanced our understanding, we are left with many gaps in how to address users' discomforts and support their activities. The answers that we have gleaned have only underscored how much remains to be discovered.

- Some issues are ignored, because little research attention has been directed to them. Such gaps may result, for example, from the difficulty of performing this research or an absence of sources of research funding. A sampling of such issues may include:

What is the relationship between comfort and physiologic well-being?

Do users have an intuitive sense of how they should sit?

How does posture affect our emotions and awareness?

How does one reconcile the various trade-offs implicit in designing a seat (e.g., the interaction of seat elements; the benefits of increasing support at the cost of promoting movement)?

How can tomorrow's technologies, such as artificial intelligence, be applied to address seating requirements?

- Some issues have 'fallen through the cracks', between the questions commonly investigated by ergonomists, and the answers needed by manufacturers and users. Such gaps may result, for example, from dogma (which besets all disciplines), resistance to paradigm shifts, or a limited understanding of the holistic interplay among seat considerations. A sampling of such subjects may include:

How does one begin to prioritize the costs and benefits associated with different seat features?

How does one compare highly adjustable seats with 'dynamic' versions, which ostensibly reduces the need for user intervention?

What kinds of chair do special populations need (e.g., pregnant women, school children)?

What user, task, and seat factors affect the kind and level of seat tension?

What are the implications of the wide variability in the population in the symmetry and shape of the spine (particularly the degree of lumbar lordosis), and other individual factors on seating design?

- Frequently, research has been fragmented, and reflected national orientations. Correspondingly, our attention is often limited to the perspectives imparted by our society.

The contributions we offer here, all fully revised and updated, cannot provide conclusive answers to many of the broad spectrum of questions that need to be answered, but we believe that they can stimulate new areas of research, new design applications, and further the international exchange of information.

Kageyu Noro  
and Rani Lueder

Editors  
Tokyo/Los Angeles  
August 1994

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