

If the whole of nature is one system in perpetual transformation, the attempt to isolate any part is bound to lead to failure.

In particular the separation of man as subject from the field of objective nature blinds him to the form of life proper to him. Man can only fully understand himself by fusing the objective knowledge which is gained by observation and self-acceptance, an innocence based on knowledge of individual prejudices of conventional morality are replaced by a positive enthusiasm for developing life.

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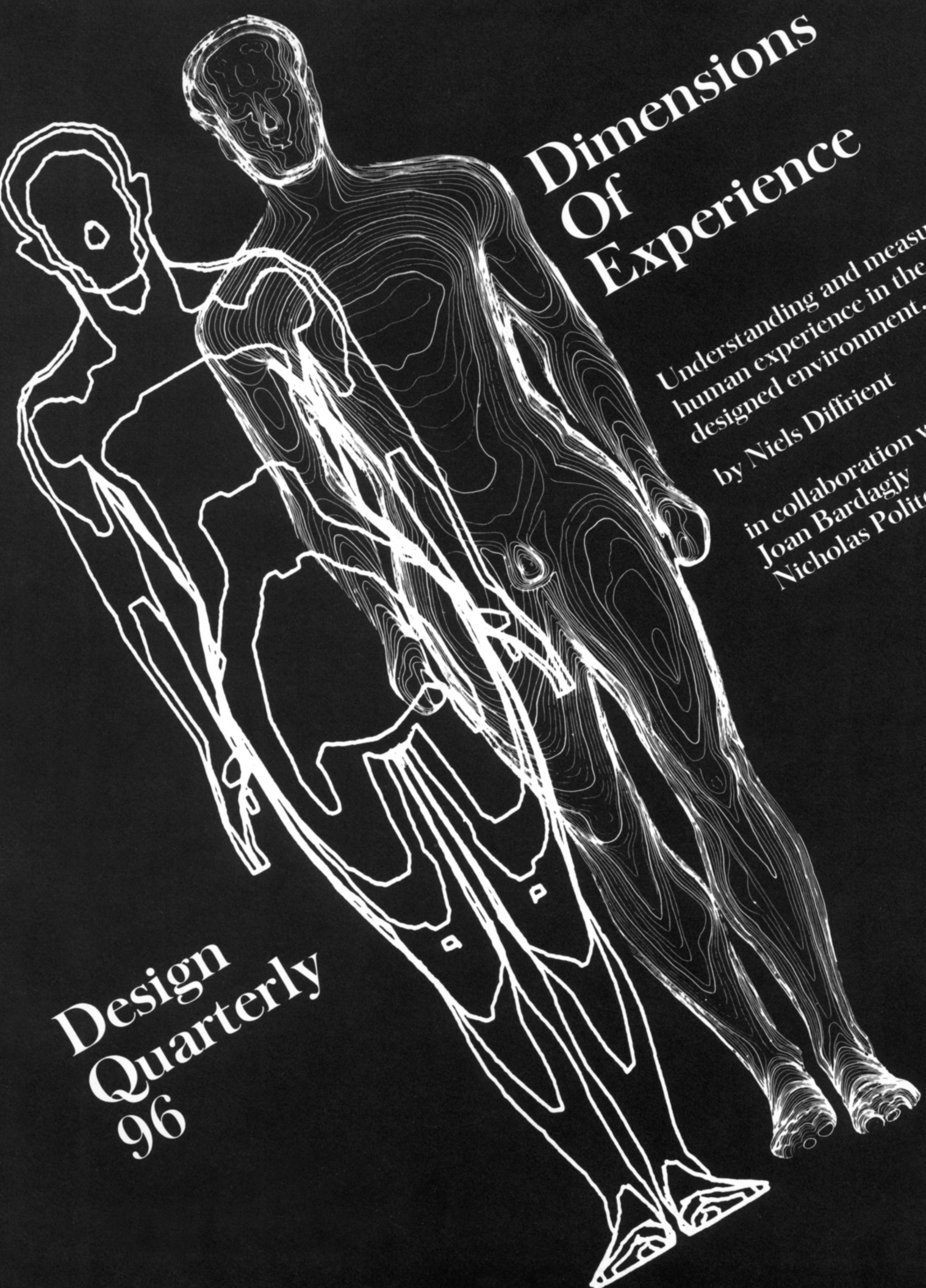
Editor's Notes

Design Quarterly 88, Industrial Design USA: Human Systems, published in 1973, introduced our readers to innovative work in human measurement by the Henry Dreyfuss office. In that initial material, human physical dimensions pertinent to the design of tools, furniture and architecture is included and significantly, a detailed segment of the information is devoted to people in wheelchairs. Early mock-ups of the recently published designers' tool, *Humanscale 1,2,3*, by Niels Diffrient, Alvin Tilley and Joan Bardagjy of Henry Dreyfuss Associates, are illustrated in *DQ 88*; it is described in its finished form in the "Techniques" section of this issue.

Dimensions of Experience describes a broadening of these physical measurement studies to include analysis of sensory experiences, crucial factors in the creation of elements for the man-made environment. This experiential ingredient is beginning to feed into the design equation from the fields of human engineering, medicine, biofeedback, social sciences, anthropology, psychology and philosophy, as a result of a shift in perceived human needs.

Thoughtful designers have moved from an emphasis on the aesthetics and function of isolated products to an awareness that the designed environment must be viewed holistically if it is to be genuinely humane. This attitude is expressed in a social/political sense as the "right" to a well-designed world, or as a concern with what is commonly called the "quality of life." What does this phrase imply to the designer? Is there a popular sense of human values that can be ascertained and related to systems of design thought and technology? In order to find answers to these questions, the designer needs quantitative and qualitative information about user experience—in other words, measurable information about how a broad cross section of the population responds to sensory experience. The disciplines described in this issue provide some of the tools essential to this discovery.

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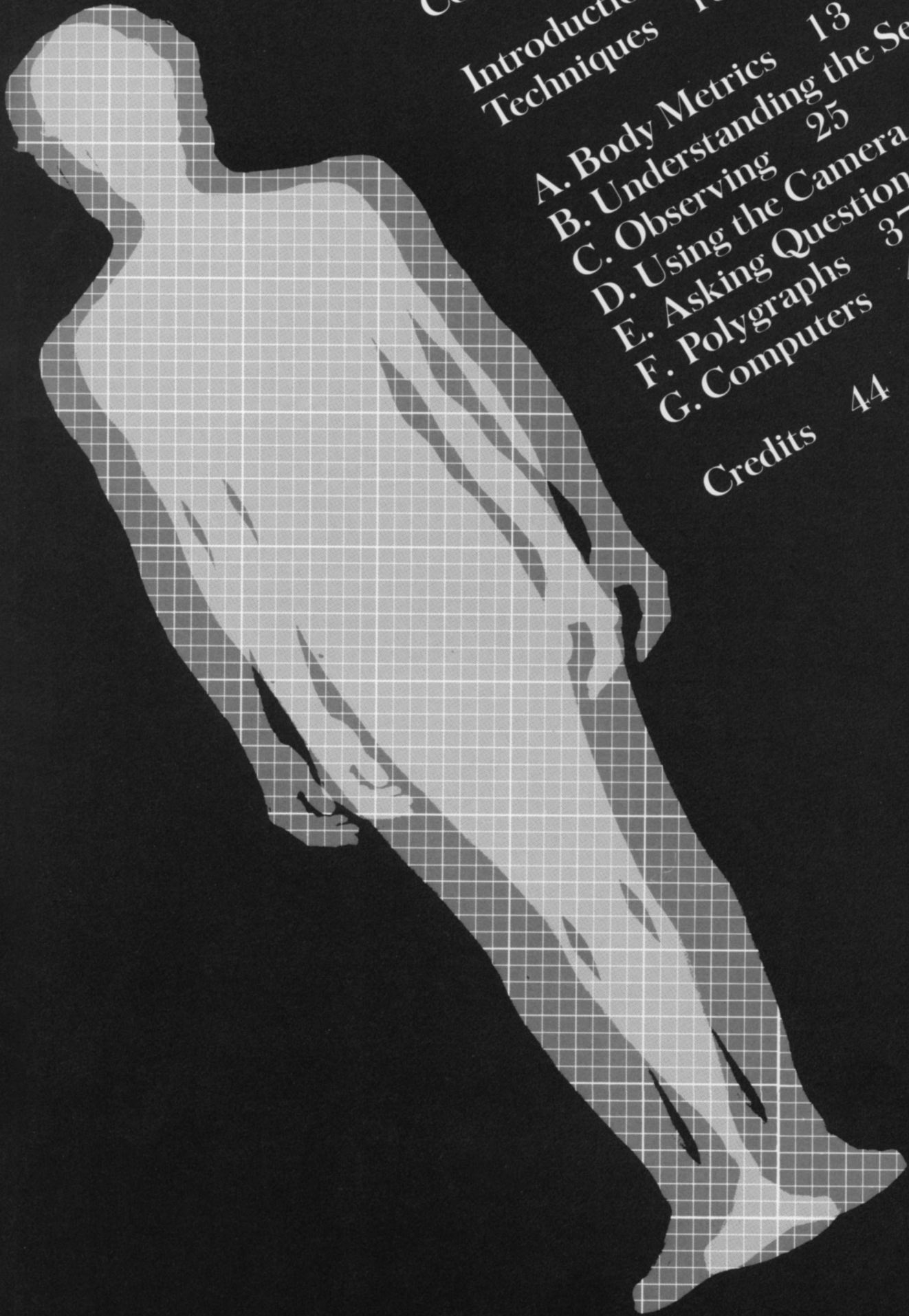
Dimensions Of Experience

Understanding and measuring
human experience in the
designed environment.

by Niels Diffrient

in collaboration with
Joan Bardagjy
Nicholas Polites

Design
Quarterly
96



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Introduction

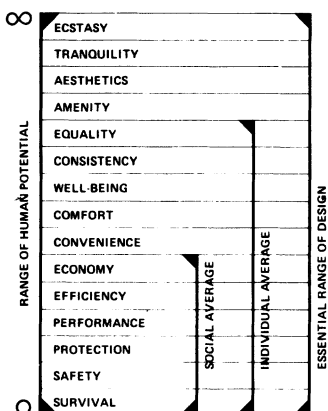


We can begin to define freedom by describing it as: The use and fulfillment of our humanity—its powers and wants—to the outer limits fixed by the material conditions and capacity of the time.

Richard Goodwin

The realm of freedom only begins where the labor which is determined by need and external purposes ceases. . . . Beyond it begins that development of human potentiality for its own sake, the true realm of freedom. . . .

Karl Marx



THE HUMAN SCALE OF EXPERIENCE

The Right to a Well-Designed World

The right to a well-designed world in a free society is like the right to free speech, justice and livelihood: it is basic. The principal difference between this inherent right and the more familiar ones is that we have not yet learned how to create a satisfying designed environment. That goal will be achieved when the components of the designed environment—living and working spaces, urban and rural areas, products and services—mutually enhance human experience.

Being subjected to an environment that does not work results in a loss of freedom. The loss can be measured by the displeasure, alienation and lack of regard shown to that environment by the populace. Unless people insist on improvement, the alternative is adaptation (of a degrading nature) to a poor environment.

Improvements will, however, have to go beyond the current corrective measures that deal essentially with survival issues. Reducing pollution, conserving resources, moderating energy use, developing a safer environment—these may be required for basic survival, but they do not assure more fulfilling life experiences. People need a great deal more to flourish.

A well-designed object or environment takes into consideration all factors from survival to aesthetics. Survival is rudimentary, immediate and imperative; aesthetics are long-term, subtle and cumulative in effect. Without either, or both, human potential is wasted.

The quest for aesthetics and amenity, which should be a central objective of design activity, is so lightly regarded in the institutions that shape the environment that it has become professionally embarrassing for a designer to champion the quest. Yet the human capacity to think and plan strategies for the future is unique, and the very existence of this gift to envision and sense improved forms of living implies its use.

The pursuit of false freedoms such as unlimited ownership of goods, unlimited use of resources, unlimited development of centralized power, results in a loss of true

freedom. For example, if a person has unlimited license to do anything he wills with his own land—defile it, pollute it, strip mine it, overbuild it—then he has the power to diminish the freedom of others. Personal liberty and true freedom, often confused, are in fact different. The former is legal sanction to take advantage of a system to its permitted limits. True freedom is the inalienable right to self-fulfillment irrespective of system. If the refinement of social existence is accepted as an appropriate expression of human potential, this potential is wantonly sacrificed in a strictly materialistic society.

Our institutions and technologies are an outgrowth of the problems that existed on our founding: survival and conquest of the elements toward a goal of material abundance. Our concentration should now be on amenable forms of community, but none of our systems is mature enough to handle them, and we have instead dissonance, frustration and misapplication of resources. Out of the original intent of our founding fathers to satisfy material needs in order to allow “the pursuit of happiness,” we have refined a technology of abundance to such a degree that it stifles that goal, and the distribution of wealth is dramatically unequal.

The right to a well-designed world has suffered greater compromise than our right to free speech or civil liberties. Why? In part, because the populace is not especially sensitive to, or highly conscious of, design. There is no universal education in it; our society allows people to remain aesthetically illiterate. In addition, there are no common, tacitly agreed upon standards of good design.

There can never be a well-designed environment until a majority of the population is sensitive to its right to a better quality of life; until people insist on and support only those things that are life-enhancing. This demands a new learning process that reinforces a sense of self at a very early age. Though it is a long-term solution, there are some hopeful signs to suggest that it may already be happening in some segments of society.

As this learning process develops, designers may begin to build a more effective profession, despite restraints built into the

social/technical system, if the philosophical base of existing design pursuits is enlarged and made operational. Otherwise, future professionalism will be diluted and its prime responsibilities may be assumed by new “design” activities. These paradisciplinary disciplines, most notably drawn from psychology, sociology, anthropology and physiology, have the scientific muscle to replace traditional design as a force in shaping the environment. If this occurs, design, as we know it in the best sense, could easily fall into the role of simply servicing sales and marketing needs of the large corporations.

This should not be interpreted as a call for destruction of corporate, government and other centers of power that act on the environment. But systems and strategies are fundamentally corruptible. Thus, the problem is not one of dissolving existing institutions, but of modifying them by restraint and prudence according to a realistic vision of change. This will require wisdom, new types of controls and a new popular sense of human values.

Many thoughtful people are advocating restrained use of technology and resources concurrent with a greater emphasis on the development of human potential. Their influence on society is significant. Even the popular press has recognized that technological and material growth are not sacrosanct. Designers should be in the forefront of this movement toward a more humane environment.

In the following pages, we will briefly explore some of the more pertinent aspects of these new ideas: a realization that too much of our environment is designed for functional goals and economic gain without consideration of the resulting human experience (*The Design of Experience*); a rediscovery of the potential in each of us that raises hopes for an improved environment (*Designer as Person*); new forms of knowledge that may serve as a base for more responsible professionalism (*New Design Knowledge*); the techniques from various disciplines that provide new tools and methods available to the designer (*New Design Techniques*). These pages do not pretend to offer a comprehensive or exhaustive analysis of the present state of design or its future. Rather, our hope is that in set-

ting forth a few compelling ideas and examples, notions in their infancy will become catalysts for future realizable programs.

The Design of Experience

Experience is the basic ingredient that shapes our lives. From our earliest days, even at birth itself, we receive sensory input, filtered by innate cognition, that accumulates within us to form our feelings and attitudes about life.

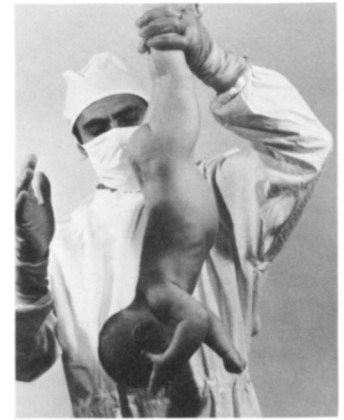
Emergence from the security of the womb is our first shocking confrontation with experience. One is not only faced with a new and hostile world, but almost immediately struck from behind. Only the love and presence of a mother helps one to overcome early shocks. If the mother is consistent and supportive, this experience can shape self-confidence to last a lifetime. If she is unconcerned and thoughtless, the imprint can be disastrous, for the bulk of one’s personality is formed by these early experiences.*

Experiments have shown that a young child receiving all the necessities of life without personal attention will develop into a frightened, withdrawn creature shaped by the experience of sensory deprivation. Even as we go beyond this very critical formative stage, experience continues to shape our character, beliefs and fears, and hence, personality itself.

Consider the early years of play—the most creative learning years. The child starts with a mind devoid of knowledge, and somehow through the experience of play learns body motor skills, language and thought assembly. The experience that is gained in the process of acquiring this knowledge shapes its quality.

The same can be said of the years in school. Learning, as interpreted by many, is simply stuffing the young person with

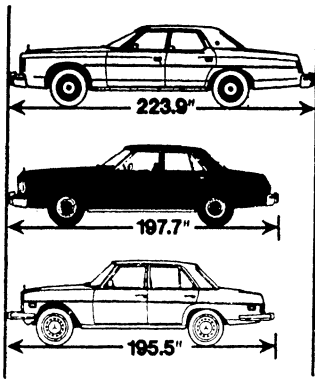
*Birth trauma is the subject of a recent book, *Birth Without Violence*, by Dr. Frederick Leboyer, a French obstetrician whose approach to childbirth eliminates the highly technocratic practices employed in most modern hospitals through the creation of a quiet, humane delivery room environment. He argues for a method that combines the equipment of modern medicine with an atmosphere devoid of trauma.



The truth is that design is a very ordinary activity, almost as old as sex and food gathering. Everyone indulges in it to some extent.
George Nelson

Sec. 2. The Congress hereby finds and declares that: (a) As technology continues to change and expand rapidly, its applications are: (1) large and growing in scale; and (2) increasingly extensive, pervasive, and critical in their impact, beneficial and adverse, on the natural and social environment.

(b) Therefore, it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems. . . .
Technology Assessment Act of 1972



The Madison Avenue types say that people express their preferences through their buying decisions. One might say, on this basis, that a condemned man, given the choice of hanging, drowning, or gas, can express a preference.
George Nelson

Bureaucracy is the logic of technology.
Richard Goodwin

Small-scale operations . . . are always less likely to be harmful to the natural environment than large-scale ones, simply because their individual force is small in relation to the recuperative forces of nature. There is wisdom in smallness if only on account of the smallness and patchiness of human knowledge . . . The greatest danger invariably arises from the ruthless application, on a vast scale, of partial knowledge. . . .
E. F. Schumacher, after Leopold Kohr

facts. But we now understand more fully that motivation is paramount to learning. The school experience should therefore more appropriately be aimed at encouraging and supporting individual growth—in short, shaping the learning experience rather than force-feeding facts.

Like the adequately clothed and fed baby who suffers from a lack of personal care, adults become alienated when systems, constructions and mass-made products are adequate but impersonal, betraying a lack of concern and thoughtfulness. This applies not only to the physical environment, but to the broadest aspects of the term “design”—to the design of financial schemes, government laws, use of resources, and so on. Manipulating any of these things, including the man-made environment, requires prudence and knowledge, because the changes will eventually affect human experience.

The man-made environment grows out of the unique, natural human capacity to innovate and plan, then to act. But when high-technology innovations develop, backed by broad powers and economic justifications, the effect on the experiences of great masses of people may be negative. One may argue that technology has improved the care and feeding of people, but what is the nature and quality of our experiences during this process?

Any analysis of experience in today’s world must take technology into account. Design can be better understood when one realizes it has been almost wholly devoted to technological goals. It performs in the arena of commerce and production; economic gain is the rule by which it is measured. But to be truly successful, design must operate with a broader base of evaluation than that provided by technology and economics.

The individual who in the past was a craftsman, making things with his hands, is today most likely a designer determining the shape of constructions, products, situations, and systems conceived remote from the user. The craftsman enhanced life’s experience because the human scale of his work allowed for adequate personal expression. But the modern designer has no such restraint. He contributes to a massive technological process

that forms the basis of contemporary society, yet is remote from it.

Technology’s breadth and pervasiveness in all channels and values of life must be understood. Experiences growing out of a technological culture are the result not just of machines, but of a supportive process of thought. Any system that can be stated and repeated is a technology and becomes method or system. Objectified knowledge, transferable and measurable, is the foundation of technology. Whenever one follows a rule rather than a feeling, one is enhancing a technology. Technique is a defined process available to refinement and perfection entirely within its own limited value system—meaning that each technology possesses the elements of its own misuse. Perfection of a technique is not necessarily related to improvement that is worthwhile to people. Technology is by nature seductive: its existence implies its use. If a process or product is developed to the point of general understanding, someone will employ it, even if it has inherent pernicious side effects. Technologies increase because problems arising within the system tend to be solved by the continual application of new technologies.

One of the more pervasive aspects of technology is its propensity for growth. The tendency to exceed reasonable human scale results in a sense of impotence and resignation on the part of individuals who would prefer a different kind of world. This level of experience, which forces a degrading adaptation to the system and its rewards, is cumulative; it can be measured in a loss of awareness of how to live effectively in what increasingly seems to be a faceless society.

The macro-scale tendency in technology has seriously affected design. It has spawned large-scale planning efforts far beyond anyone’s comprehension. Even with the help of the indomitable computer, these massive efforts have brought society some of its most ingeniously designed wastelands.

Ever-increasing technological potential was accepted as the norm until quite recently, when pollution and the depletion of resources finally cast doubts upon its future. While solutions to the problems of errant technology and aberrant scale

are not immediately apparent, there are some interesting candidates that have the potential to help solve design-related problems. The most important is a shift in perceived human needs, a subtle but pervasive emphasis on experience rather than product. Some of the early signs can be seen in the growth of the human potential movement. Starting with a heightening of popular interest in various kinds of psychotherapy, it now ranges from consciousness-raising to tai-chi-chuan. Human experience-related fields such as sociology, behaviorism and anthropology also have become associated with design activities.

Proposed city zoning ordinances provide another example of how the quality of design can be shaped to enhance human experience. Controls that restrict new buildings from taking sunlight away from adjacent buildings; incentive zoning rewards for the planting of trees; recommendations that improve safety of occupants in apartment buildings by allowing greater observation from tenants in lobbies, play and parking areas and other public places—all are examples of zoning practices that encourage a more humane environment.

The most important point here is that a judicious use of verified data about people's experience can result in sensible rules that liberate traditional building forms from their domination by technology and economics.

The concept of urban zoning has implications for "experiential zoning" whereby the design of activities common to all—driving a car, working in an office, riding in an airplane, even using one's own kitchen—might be improved. Products and systems employed in each would have to respect the nature of the experience that resulted from their combination. For example, take the office work experience: if the provision of comfort for sitting, convenience of equipment, sound and temperature levels, vibrations, quality of lighting, availability of outdoor views, interactions with fellow workers were rewarded—say by reduced taxes—we might develop a much more sympathetic market for improved office design.

Other experience-based movements that have design implications are those that

champion minorities or the oppressed. The women's movement, for example, has enlightened us to the fact that the environment has been designed around the old societal stereotype, housewife. Homes, buildings, systems and products tend to reinforce and imprison women in this role. Sexual equality and freedom for self-actualization, will eventually affect design as women's genuine participation in government, the marketplace and the public arena grows.

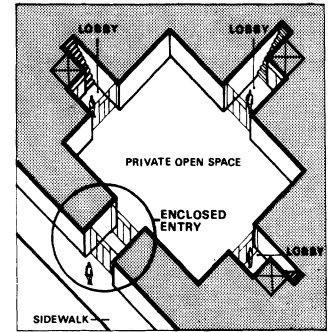
These examples tell us that technical and material refinement will not, of themselves, produce desirable human experiences. Even the controls intended to limit technological abuses will not produce desirable experience, because they are themselves technologies. The decisive ingredient in shaping and sustaining the quality of experience lies in self-knowledge. For the designer this is doubly vital, because he is imposing experiences on others.

Designer as Person

We are all aware that another level of being exists within us, in some ways more real than consciously perceived realities. Those things we call "truths" (as distinct from "facts") in our conscious awareness are so only because of verification from an inner reference that we innately trust. Awareness of this inner reality is, in the final analysis, the only valid way of perceiving human value in design. It is access and flow between the conscious and subconscious that turns knowledge to wisdom and talent to genius. All great works in art and literature have pursued a single expression which links the inexplicable self to conscious reality.

Design without personal values is simply a technical exercise that is empty and without feeling. Designs that fail are those that do not embody the inner feelings of the designer. Ultimately, he must trust these feelings in order to produce valid designs for people.

Even broad scientific knowledge about human behavior does not guarantee the automatic assembly of good, humane, satisfying design. Greater knowledge can, however, act as a lubricant for bringing forth and verifying intuitive insights.



People from different cultures not only speak different languages but, what is possibly more important, inhabit different sensory worlds. . . . so that experience as it is perceived through one set of culturally patterned sensory screens is quite different from experience perceived through another. . . .

Edward T. Hall

. . . my life has been singularly poor in outward happenings, I cannot tell much about them, for it would strike me as hollow and insubstantial. I can understand myself only in the light of inner happenings. It is these that make up the singularity of my life. . . .
Carl Jung

*Men are men
before they are lawyers
or physicians
or manufacturers
and if you make them
capable and sensible men
they will make themselves
capable and sensible
lawyers and physicians
Thomas Jefferson*

*... the best professionals
do what they can to de-
professionalize themselves.
Manas*

*... passions which induce a
confident utterance about the
facts are personal, because they
submit to the facts as univer-
sally valid, but when we reflect
on this act non-committally its
passion is reduced to subjec-
tivity.
Michael Polanyi*

Restraints against self-knowledge in the designer are technique, professional mores, peer standards and inadequate activity parameters.

Current professional mores are the by-product of technological growth. In order to support human values, design activities must be enlarged beyond their current prescribed limits. The humane designer can contribute to this goal by increasing his understanding of self and others. Then, the term “profession” might assume a degree of responsibility for human experience. Responsibility in a profession only exists when there is a personal voucher against misuse of talent and power.

A designer operating in the current social system is faced with a dilemma: he can match the expectations of the system, or he can do more and be out of pace with the system. Most often a designer (or any person) falls into one of three categories of involvement with society: (1) he operates completely within the confines and objectives of society, and in time obtains the normal rewards of financial security and position; (2) he operates with one foot in the social system and one foot out, accepting reduced societal rewards and partially ameliorating the guilt imposed by inattention to the urgings of the inner self; (3) he removes himself entirely from the system, sacrificing material gain and power, seeking reward in self-satisfaction.

Category 1 (above) has resulted in the value-free generation of techniques that are the basis for a large segment of design activity in which architecture is not so much the creation of humane spaces as it is the production of architectonic sculpture; industrial design is not defined by the adaptation of technology to humane purposes, but by stylistic extensions of mass production; graphic design is not a vehicle for communication, so much as a subtle and seductive exercise in two-dimensional form; large-scale planning is not the restrained, wise guidance of sympathies between small-scale design decisions, as it is the exercise of power to modify environments at grossly large scales.

Resisting these misapplications of technique requires a strength that grows out of personal conviction. The “client”

seldom can be looked to as a source of enlightenment, because he is involved in the same system that produces the inappropriate application of design techniques.

The present condition of the design professions might have been predicted from the attitudes and experience of past decades. There was a concentration on aesthetics as applied to products and space, but not on aesthetic experience in a human sense. The only experience considered valid was that of people with the same leanings as the designer. There was, on the other hand, considerable research in the technology of building and production, as well as in compatible marketing and sales strategies. The history of design in the technological era rarely included any assessment of, or feedback from, the experience of the users. In general, design education (along with much other technical education) involved a concentration on technique without a value base.

In the past decade education (including design education) became profoundly concerned over this apparent lack of values in the curriculum and management of schools. Students eschewed traditional design techniques and concentrated on social problems. As a result, out of the schools flowed socially sympathetic individuals who resisted the system at the price of sacrificing their education in vocational skills. The misapplication of technique is not a result of knowing the skills, as we are now learning; it is a result of not knowing how to direct them.

How can a designer learn more about himself as well as others? Knowledge of human nature cannot be gained through any specialized segment of information. A person can only be understood holistically; one who seeks knowledge in this way becomes a generalist, the most fitting role imaginable for the designer. If design solutions are to match the needs of people they must encompass all needs and generalization is a logical way to approach research and application.

As a framework to review self-understanding, consider the individual aspects of the physical, intellectual, emotional and meta-physical—which, incidentally, form the basis of programs of personal awareness centers around the country. There is no

in-depth education in these areas in design schools for broadening human knowledge. Indeed, obtaining such wide knowledge requires a personal commitment and search beyond any single educational source. Any significant degree of enlightenment in all four areas leads to the realization that they are inseparable and must be considered as a whole. It is this “whole” knowledge of human characteristics that can give the designer a foundation for humanly satisfying design. The quality and application of this information will be a matter of judgment growing out of self-knowledge.

New Design Knowledge

The new forces in design are psychology, sociology, anthropology and human engineering. These titles are umbrellas for many subdivisions and specialties. There are, in addition, related factors, more exotic and perhaps of questionable significance, that are nonetheless potential influences. For the most part, they are the outgrowths of personal and group therapy, altered states of consciousness and metaphysical beliefs. In addition, there is biotechnology, an extension of science and medicine, with considerable implications for design.

All these activities have design implications because they deal directly with shaping and understanding human experience. They are also, in the case of the scientific offshoots, more “reliable” than intuition-based design because a performance record and a growing body of information surround them. Insofar as affect on people is concerned, traditional design lacks both these cornerstones of professionalism.

A profession, it can be said, may be defined by the tools it uses. Accordingly, architects, industrial designers and graphic designers would have to be considered expert in the manipulation and perfection of physical conditions. Few tools define them as experts in the human condition.

At the same time, the most impressive capability of the designer—though this is only tacitly accepted—is his intuitive sense of aesthetics and amenity. But this capability has been corrupted and dis-

organized. It has been used to seduce consumers and to camouflage useless concepts. It has also been bastardized in trite, stylistic applications.

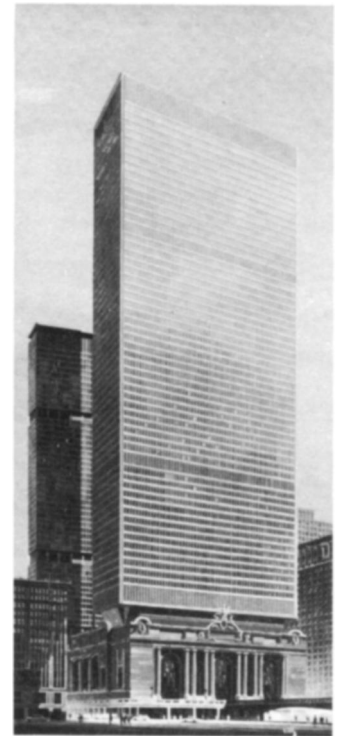
Aesthetics, amenity, and all that these terms suggest, are the real muscle of design. There is no design goal of greater consequence than the creation of an improved human experience.

One might easily be led to think that the history of design bristles with accomplishments that reinforce the pursuit of quality. Not so. Instead we find a steadily developing reinforcement of the quantitative goals of production units and profit dollars. These are the goals of managers, not designers, but designers have had to adopt them to survive because no well-informed market exists for true amenity on a broad scale. The new “design sciences” could well bring a tangible reinforcement of the intuitive qualities in design. They cannot replace, but they can augment the qualitative ingredients of aesthetics and amenity.

Fortunately, there is compelling evidence to suggest that current conditions will change. The leading edge of scientific thought, exemplified in the writings of Rene Dubos, Jonas Salk, Michael Polanyi, and the late Jacob Bronowski affirms that there is no science without human value as an integral component. The older, value-free approach to learning and discovery is faltering.

In nature, every force generates a counterforce. This law has some metaphorical parallels in the social system. As cracks appear in the massive, energy-using consumer society, we see, waiting in the wings, new forces of human concern, qualitative values and realistic scale.

There are also parallels with design, which have been inextricably linked to the dominant conditions of technology and its related economics. Problems that develop in the socio-technological realm are design problems. The largest is the search for an integral sense of human value in the technological system, a problem implicit in the success of the industrial revolution. The countervailing forces are those that have a clear understanding of

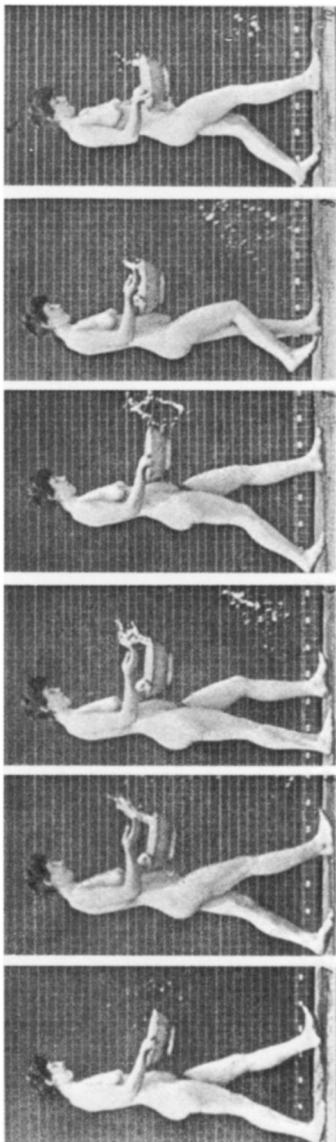


If you go to an architect with a problem all he can give you in answer is a building.
Howard Gossage

... the trouble with science is that it provides only information about the world, without the meaning.
Theodore Roszak

... dreaming of systems so perfect that no one will need to be good.
Gandhi

The classical philosophy of science as morally neutral, value free, value neutral is not only wrong, but is extremely dangerous as well. ... science can seek values, and can uncover them within human nature itself. ... even though not adequately and finally proven, techniques are now available for finding out what is good for the human species, that is, what the intrinsic values of human beings are.
Abraham Maslow



human conditions in the natural and man-made environment. Out of these areas will grow the most essential design developments.

There are some who had said that emerging design methodologies and computerization offer greater problem-solving potential than a human-value orientation. This is true only at a secondary level. Without sound values as reference points for the problem-solving process, the truism of computerdom—"garbage in, garbage out"—holds. For purposes of this review, therefore, the entire area of methodology will have to be left in the realm of techniques, available for good or ill, or awaiting the superimposition of a tenable value structure.

Before getting into the techniques section of this publication, let us review and briefly describe those sciences which relate to the man-made environment and may serve as the substantiating foundations for a new era of design. This summary describes processes and techniques as understood by a designer, not a scientist—a significant difference. The thesis of generalization implies that knowledge about people can be made available in a holistic sense for non-specialized purposes. Thus, the review will be as non-technical as possible.

Three major social sciences relate to environmental design in important ways: psychology, sociology and anthropology. Because they tend to overlap so much in relation to design, they are here grouped together.

These sciences contain the seeds of salvation for urban planning and architecture, as well as for environmental planning, landscape architecture, interior design and other related fields. Aside from their apparent human benefits, the sciences appeal to architects and designers because they can be incorporated into the design process as "teammates" without changing the traditional form of design practice (though the emerging alliance may be indicative of an incomplete assumption, as we'll see in the description of human engineering).

A dominant hybrid science called environmental psychology encompasses all three of these sciences and orients them to design. It focuses primarily on the study of

human behavior in the built environment. (Closely related is behavioral psychology, which studies individual behavior as a key to personality and motivation.)

By including study techniques that make findings directly available for application, environmental psychology goes beyond most "pure" sciences. Architects and designers can use its findings about human actions and feelings as a basis for planning. But perhaps the greatest potential benefit of the design-related sciences is that they can provide accurate feedback about design performance. How do people respond to varying conditions of lighting, temperature, crowding, isolation, noise, traffic, high-rise living, and other kinds of environmental stimuli, or the lack of them? These are some of the questions environmental psychology poses, and attempts to answer through observation, research and analysis. The assumption here is that people respond behaviorally to their surroundings, whether they are consciously aware of it or not, in ways trained observers can interpret.

Observation and interrogation are the principal tools of the environmental psychologist—and for that matter of the sociologist and social anthropologist. Observation has been technically augmented by video, still and movie cameras. Time-lapse photography, for example, is currently a popular method for condensing observed information as a record. Its increased popularity demonstrates Eadweard Muybridge's prescience in his early stop-motion studies of the human body.

So-called "unobtrusive measures" are another observational approach to gathering data for social and behavioral purposes. Unobtrusive measures obtain information without interfering with normal behavior. For example, determining popularity of exhibits in a museum by examining the condition of the floor areas around them is an example of information-gathering by that method.

Interrogation is the other major tool of the environmental psychologist. There are several types of questionnaires or interrogating procedures used by psychologists, generally designed to obviate personal biases of the respondent. Many readers will recall Vance Packard's account in *The Hidden Persuaders* of how

to query personal preferences. The best way to find out what sort of product someone wants is to ask him, "What would your neighbor be apt to buy?" Don't ask a person what he would buy, because wanting to appear practical, he would list what "should" be bought rather than what he actually wants so that he wouldn't appear to be uninformed.

Despite some successes, there have also been problems in applying environmental psychology to design. One is the considerable difficulty of building "bridges" between different disciplines: designers must understand the language of scientists, and vice versa. And feedback has limited uses; it does not appear capable of reinforcing the potential of new, innovative designs, but simply of correcting old approaches.

Conceivably, the architect-behaviorist alliance could result in the scientific perfection of an immature design form. How this pitfall can be avoided is uncertain, but it may be mitigated by focusing on the intimate-scale activities of people—the kinds of activities that human engineering, ergonomics and bio-mechanics are concerned with.

Human engineering has grown to be a catchall phrase that encompasses anthropometrics, ergonomics, biomechanics, as well as aspects of psychology. While logically it should overlap environmental psychology, in practice it focuses closely on the individual and the immediate environment rather than on group involvements and larger contexts.

Why should it be desirable to have more reciprocation between human engineering and environmental psychology? Scientists have often displayed tunnel vision, excluding work in related fields from consideration. But information culled from narrow sources cannot be useful to design. From a practical standpoint, the individual and his intimate situation are always part of a larger context. To design either without reference to the other results in incomplete design, and sometimes in notable fiascos.

An example is the design of the desk and chair as a work station, and the separate design of architectural space in which they will be placed. Put together to make

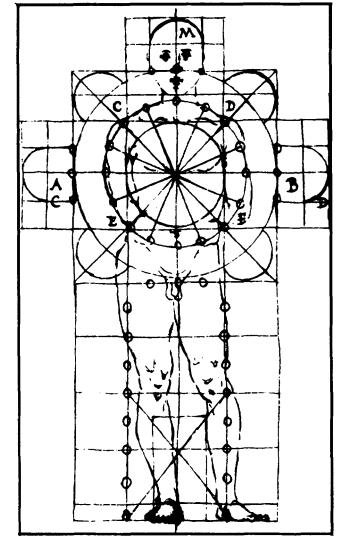
an office, the two often result in an unsatisfying experience for the occupants. It's not always clear why. Were they studied as a gestalt with all the other elements that go with them, the total interaction might be better understood.

In general practice, human engineering and anthropometrics are often linked because the principal focus is body dimensions. This becomes a complex study involving great samplings of people to ascertain a range of norms by sex, body type, age, ethnic difference, handicaps and other factors. The data is used as the basis for fitting situations and artifacts to people.

Though the implications of such data are obvious, a cross section of examples shows that this rudimentary science is not in enlightened use among designers. Though a pair of shoes may be bought to fit different foot sizes, chairs generally cannot be bought to fit individual bodies. Counters and tables, let alone shelf heights, generally prevent small people from comfortable use of these necessary elements in our environment. Controls on automobiles and appliances are in different and conflicting locations, though the functions are nearly always the same. Stairs and ramps often ignore dimensions of stride, and cause accidents. The force needed to operate some controls is often beyond the capacity of women, children and even some men.

Ergonomics and biomechanics investigate the nature of work done by an individual. Sophisticated techniques and instrumentation determine how safely, efficiently and with what degree of comfort a person performs a prescribed task. These measuring devices are necessary because too often a tool, a work posture or a motion is taken for granted. Measuring subjects often discloses muscular fatigue and discomfort. The results of such testing can lead to time/energy/comfort savings for workers. Faulty workplace designs can be corrected, and then measured to show improvement.

A final word about some of the more exotic processes that may affect design. Take biofeedback, for example, which lies in the area of biotechnology. To measure body functions, it uses some of the same instrumentation that



Vitruvian man inscribed within a Renaissance church plan

What the individual feels or thinks about his or another's behavior has until now defied accurate measurement in terms of physical change. There are too many varieties of experience, too many shadings of meaning when it is communicated, and so our interior feelings that color all behavior have not been considered legitimate subjects for the scientific study of behavior. . . . It is important to know how the body expresses its emotional and mental activities through changes in its physiologic functioning. . . .
Barbara B. Brown

Human life is so complex and the course of evolution so full of bewildering situations that it is only a cosmic intelligence that can guide it rightly to the destined goal.
Gopi Krishna

biomechanics uses: the electroencephalogram, electrocardiogram, electromyogram and galvanic skin response test. The most publicized of these is a form of EEG that reads a discreet electrical brain energy called Alpha. The Alpha wave comes from the portion of the brain related to stress and relaxation. A subject receiving his own Alpha wave pattern can learn to control stress. In reverse, it could also show stress brought on by environmental experiences. Other measurements of different parts of the body are also clues to feelings. Where biofeedback has as its goal the personal understanding of one's own body for health purposes, it could also be helpful as a technique for monitoring environmental influences.

All psychologically-based therapy activities, including altered states of consciousness, metaphysics, parapsychology and others, have basic potential as design-related activities because they tell us things about people that are often obscure.

Not too long ago, these pursuits were considered questionable or extreme. But as we see their influence permeating our daily thinking, it begins to be obvious that these sources of new knowledge and those listed previously may well integrate with the standard repertoire of the designer's functioning knowledge.

It has traditionally been accepted that, while the designer is not an engineer, he must comprehend engineering basics in order to conceive a logical mechanical or structural design. It now seems equally logical that the designer, though not a biologist or psychologist, should have knowledge of the human-oriented sciences and techniques in order to provide humane design.

New Design Techniques

The following section consists of descriptions of a collection of techniques and processes that provide information about people. The techniques are gathered from a variety of sciences and disciplines, many of which are not currently related to design. They indicate the wealth of means available to help designers understand and record the effects of design on human experience. Also, they represent ways to gain feedback on existing design

performance and, potentially, to predict and innovate improved design by testing both in laboratories and in actual situations.

For convenience they are organized into seven different categories—body metrics, understanding the senses, observing, using the camera, asking questions, polygraphs, computers—though in fact many of these techniques fall into more than one category. Only a sampling of the kinds of data available in each area is given.

Some of these techniques have already been used by designers to improve the quality of their work: many more are used by those designing in social, behavioral, or physical realms. These so-called “new designers” are, however, specialists, in that they generally limit their research and recommendations to the confines of their disciplines. A sociologist (social designer, or social engineer), for example, restricts his interest to the interrelationships of people, and does not ordinarily concern himself with, say, physical comfort. But in the context of this work, it is important to look beyond a limited, specialized viewpoint. Designers concerned with satisfying the whole person cannot be restricted to one set of techniques associated with a single specialization. If we think in terms of the concept put forward earlier—that is, of experiential design or zoning—it becomes clear that any given human situation contains a multiplicity of conditions and inputs crossing over the boundaries of many specialties, and encompasses rudimentary as well as esoteric values.

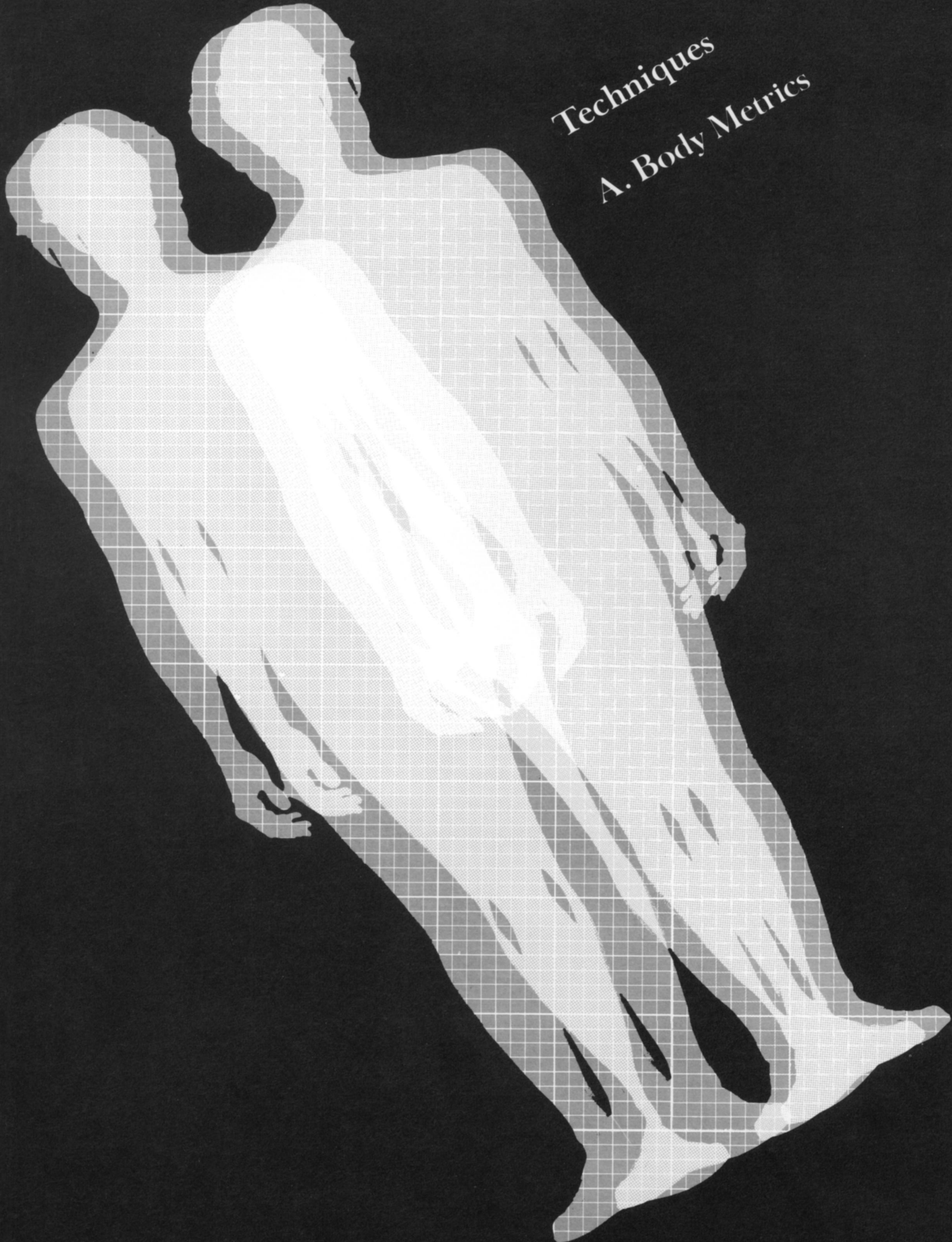
Knowledge acquired from the techniques uncovered here is generally unavailable because it is segmented into separate disciplines. Originally, these examples were found scattered through many different sources and obscured by technical jargon; some were in popular references totally unrelated to design decisions.

Made available in understandable terms, and in an interrelated (instead of piecemeal) fashion, this knowledge provides the designer/generalist with new information about people that might well serve as a basis for the understanding of human values and experience in a technological world.

Unbalance was caused by a different rate of change in the technical organization compared to the social organization. It was evident that social codes, customs and routines of the worker could not adapt themselves to the technical innovations as quickly as the innovations (new machines and processes) could be made. The result was distrust by the workers and widespread resistance to change. . . . Western Electric's Hawthorne Works, Laurence Whyte

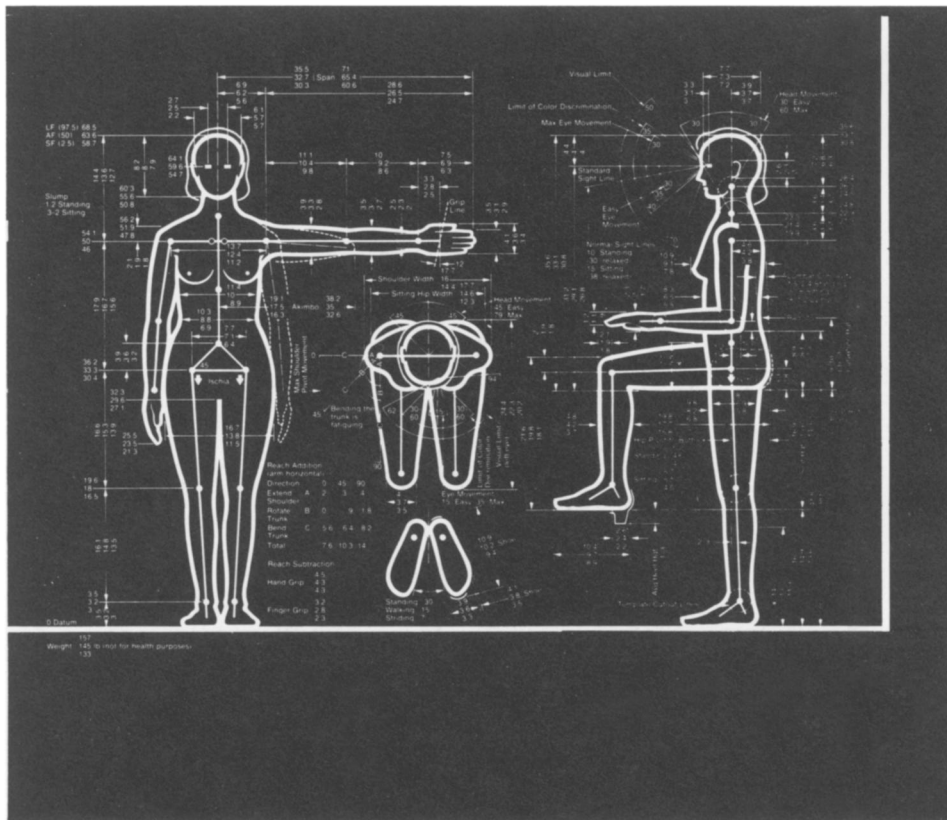
Techniques

A. Body Metrics



A. Body Metrics

A1 Human Engineering

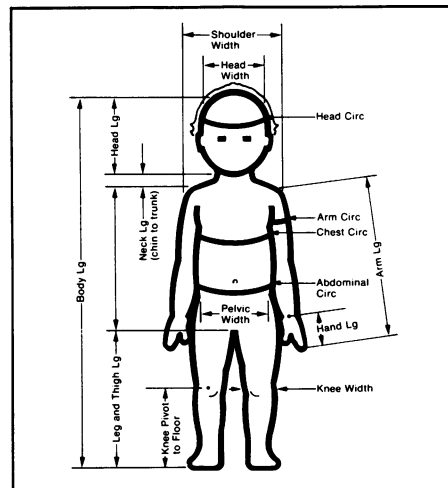


Human engineering has become an umbrella phrase that covers sciences concerned with measuring body dimensions and reaches, physical strength and endurance, working of the joints and muscles, among others. These sciences include anthropometrics, ergonomics and biomechanics.

Using human engineering data it is possible to determine optimal posture and arm reach parameters for 95 percent of the typists at a work station, or, to determine the best knob sizes and forces for the design of finger grips on control panels.

Humanscale 1/2/3 is a tool that presents detailed information about physical dimensions for use by designers and planners. Prepared by Henry Dreyfuss Associates, it consists of three adjustable 8½ x 11 inch selectors, and a manual containing measurement information and charts.

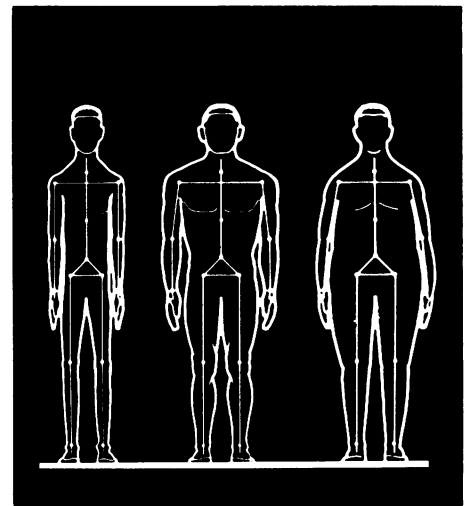
The selectors contain human engineering data and dimensions in a wheel/dial format. Data about reach, seating height, limitations and design requirements for the handicapped appear in appropriate windows by a turn of the dial. Answers can quickly be found to questions like these: What is the highest shelf a 5-foot, 2-inch (157.2 cm) woman can reach? How high should a chair be for an 8-year-old



child? What is the most comfortable back angle for a truck operator's seat?

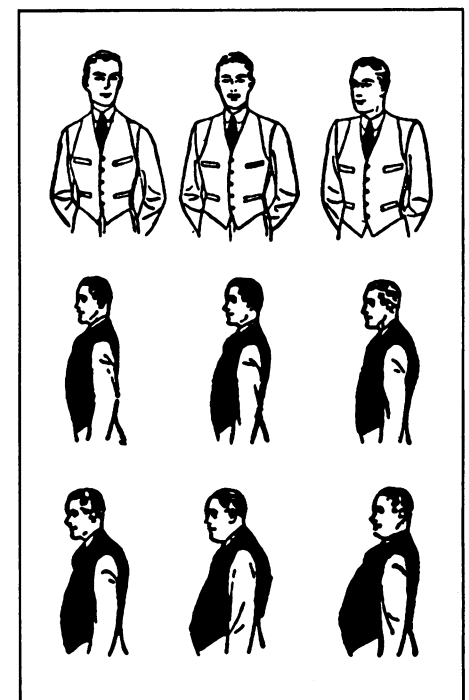
Selector 1 contains basic body measurements of men, women and children. Selector 2 serves as a guide to seating of all kinds. The third selector describes the reach limitations and design requirements for the elderly and the handicapped, including people in wheelchairs and those using crutches and walking aids. The data gives recommendations relating to architectural spaces and passages, furniture design and fixtures.

A2 Body Typology



The classification of body types as ectomorphic, mesomorphic and endomorphic originated as an anthropological tool but has been refined by Henry Dreyfuss Associates for use in design work. Not only do people have different basic body builds, as the chart shows, but they have different dimensions for various parts of the body. All must be accommodated in product and equipment design.

A3 Good Fit



Taking the human measure to achieve good fit isn't by any means a by-product of the space age. It's as old as the sartorial trade.

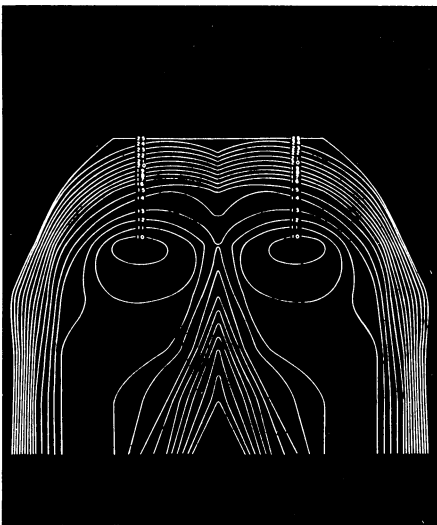
A4 Seat Comfort



A testing machine developed by Henry Dreyfuss Associates aids in the design of seating, permitting the evaluation of user response to a wide range of variations in contour, inclination, cushioning, and

seat and armrest height. Rods in the back of the seat can be adjusted to change the contour of the back rest, making it comfortable for the user and in correct alignment to the curvature of the spine.

A5 Rear Metrics



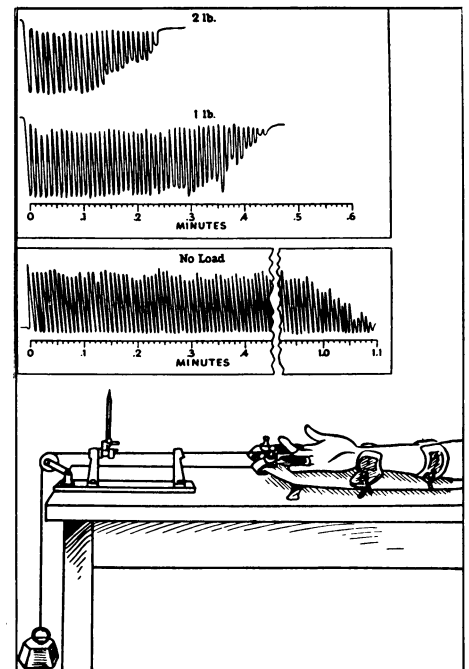
The weight and pressure distribution of buttocks and legs can be measured for seating to be made of contoured fiberglass. A subject sits on a layer of soft plaster-of-paris covered with a very flexible film of plastic. When the plaster hardens, the contour is averaged out so that both halves are symmetrical. (The numbers on the contours in the above illustration are units of inches.) The resulting cast is then used as a mold in which to form the fiberglass. This technique has been used to develop comfortable seating for machine operators.

A6 Ergometer



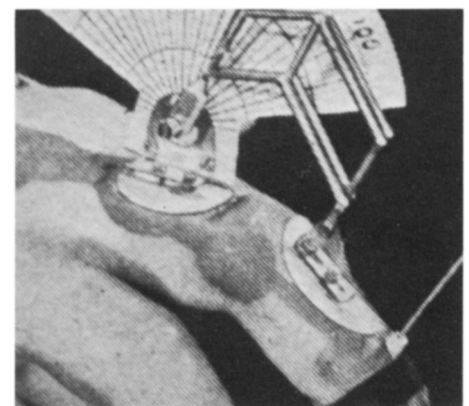
Human endurance varies with the individual being measured and the kinds of motor tasks being performed. An ergometer (respirator) measures energy expenditure (metabolic activity) during performance of physical tasks. Endurance while pedaling a bicycle with the hands is being measured in this picture. Ergonomics determines the O₂ input and the CO₂ output of the body. The results can be evaluated to ascertain the difficulty of a given task as a factor of energy use.

A7 Finger Ergograph



The ergograph, which measures range and strength of joint movement as well as fatigue factors in human motions, has been developed in many varieties for numerous applications. A finger ergograph shown above measures the lifting effort of the second finger while the first and third fingers, inserted into metal cylinders, are held stationary.

A8 Wiggle Meter



The wiggle meter, or electrogonometer, records muscle movement in the hand and fingers. Developed by researchers at Case Institute of Technology, it helps in understanding muscle activity in healthy hands and hands crippled through arthritis, polio, stroke, or various injuries. It is useful in designing objects for the handicapped and devices operated by normal hands—especially instruments requiring precise manual control.

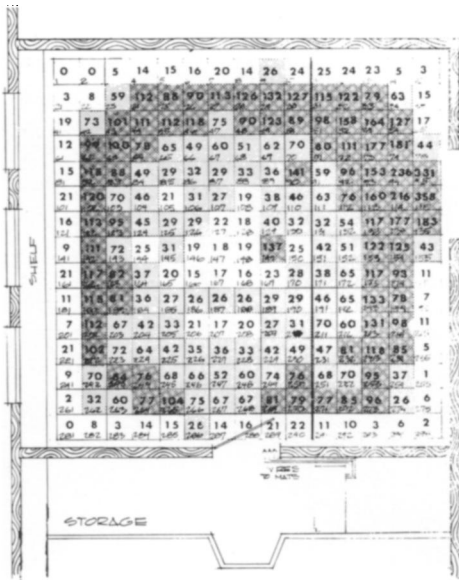
A. Body Metrics

A9 Heat Suit



The heat suit covers the whole body except the head. It can simulate external temperatures and monitor body response to them. Energy expenditure of subjects performing various movements can be recorded under different temperature conditions by using a respirator.

A11 Footsteps Show Preference



The Hodometer (from the Greek "hodos," meaning pathways) is designed to measure locomotion through architectural space. By using pressure sensitive foot mats attached to recording devices, it unobtrusively measures locomotion and doesn't interfere with freedom of movement.

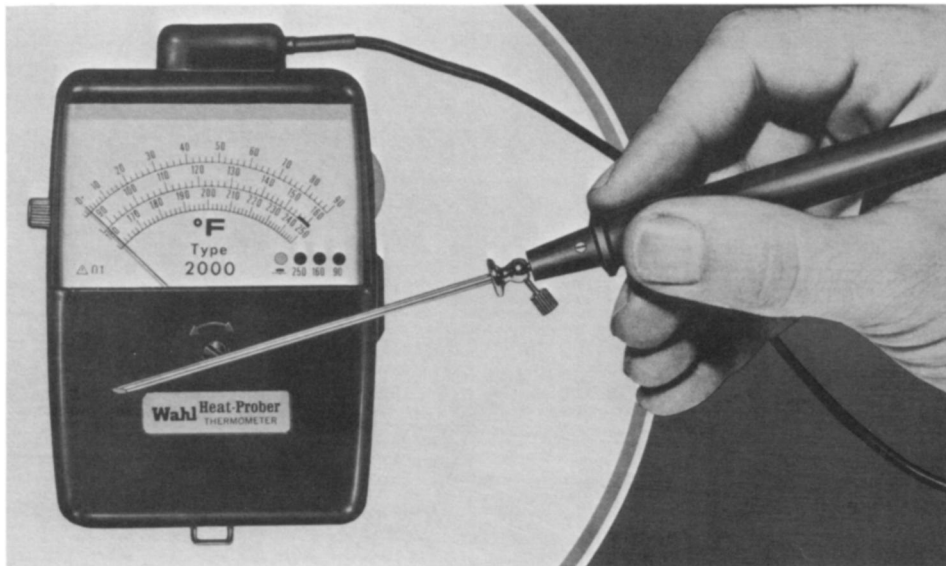
(Natural behavior as well as experimentally-induced behavior can be studied.) The hodometer counts foot movements, identifies which areas of a given space have been occupied, and measures the length of time people spend in a room.

This device has an interesting range of applications. It was first used in a study (conducted by social psychologist Robert Bechtel) of exploratory motion in the University of Kansas art museum. Preferences for objects and environments can be more accurately inferred from foot movement data than from verbal statements of preference.

Implications of this test are important in evaluating environments and in conducting user studies, not only for museum personnel but for planners of all public buildings. Another interesting application of the hodometer is in the study of how color in the environment affects behavior.

More elaborate research could furnish valuable data for designing environments intended for specific purposes: hospitals, classrooms, or even, the various rooms in houses and apartments.

A10 Temperature Taking



Accurate temperature readings of inaccessible objects or parts of structures can now be taken by using sophisticated instruments. Temperatures of liquids or solid objects can be determined by remote instruments that measure the infrared energy emitted by them. Special chart recorders provide temperature readings over periods of hours or even

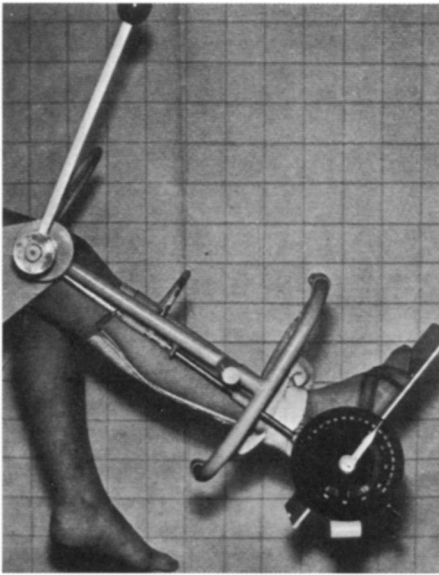
days, and are used for monitoring specialized requirements in transportation and industry, schools, hospitals, offices and museums. Internal and inaccessible parts of objects, environments, solids, liquids and gasses can be measured by "prober" thermometer devices. Small sensing devices containing heat sensitive elements which change chemical structure and



turn different colors can be used to find if temperatures have exceeded predetermined critical tolerances.

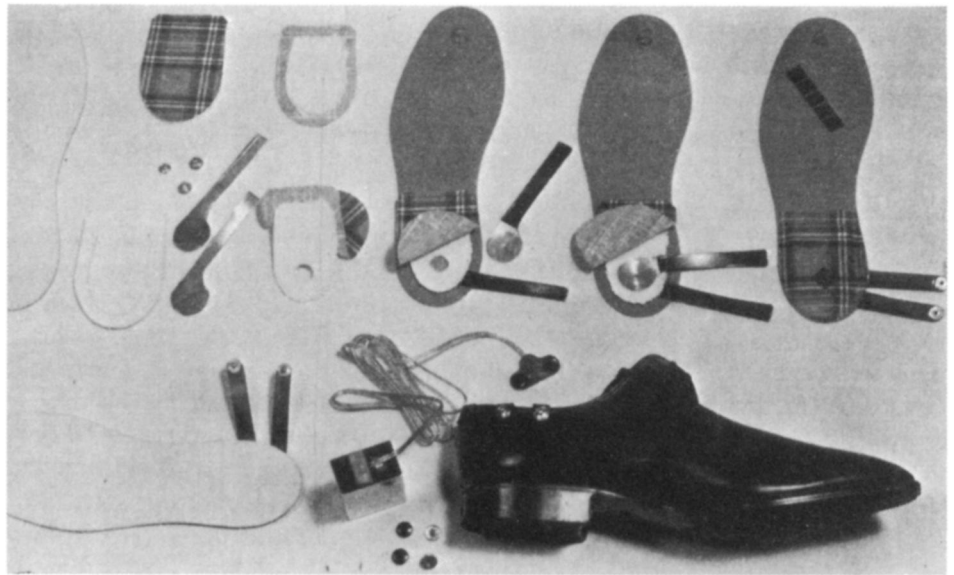
The National Bureau of Standard's thermesthesiometer determines equivalent skin temperatures that occur on a surface like the toaster above.

A12 Measuring Foot Motion



Anatomical factors that determine limits of foot movement can be measured with special equipment. Data derived from such tests is used to design the proper layout of foot-levers or pedals in accordance with anthropological and anatomical requirements.

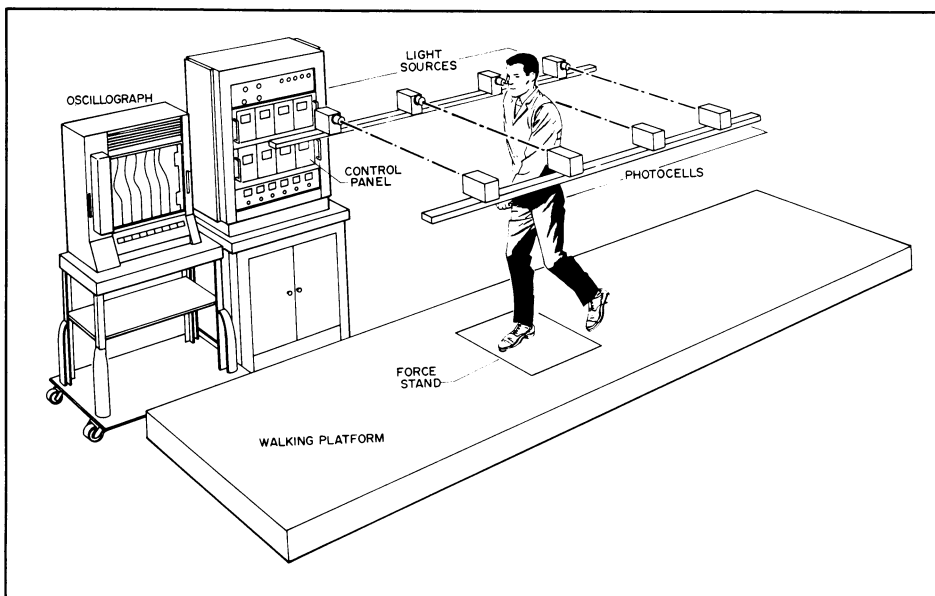
A13 Step Counting



The electromagnetic step counter determines the number of steps taken by individuals during their normal daily activities. It has been used to measure differences in individuals engaged in the same kind of work. The step counter is activated by a switch in the heel of a

shoe. Generally, a wide variation is found in the step frequency of individuals except when they are engaged in specific routine tasks of a repetitive nature.

A14 Footstep Signatures



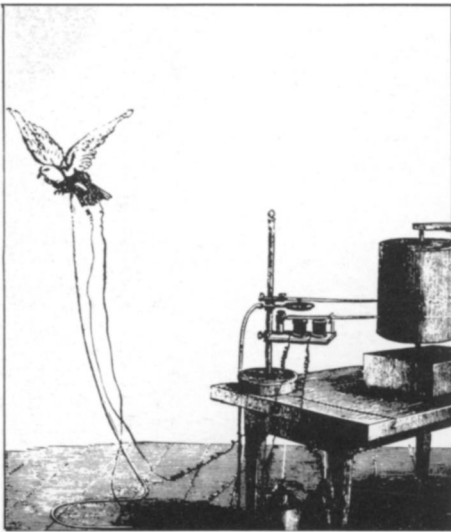
Man spends a significant portion of his time moving about on foot—in work, travel, play—yet this seemingly simple process is actually extremely complex biologically and not very well understood scientifically. Part of the problem of measuring walking activity is that each step develops a varied mixture of rapidly changing vertical weight, horizontal shear, and rotational twisting forces. Unidirectional force-measuring systems therefore provide only partial data.

Researchers Henry Pontius and Ralph Vecchio designed what Pontius calls “a force stand that registers all the interactions between the human foot and the ground surface during both a complete step and major components of it . . . the human footstep force signature.”

Steps can thus be measured three-dimensionally. Photocells, mounted at shoulder height of the experimental equipment, check walking velocity and allow footstep forces to be plotted as a factor of speed. This kind of information is potentially useful to designers of various products in which a walking operator is involved.

A. Body Metrics

A15 Telemetry



Telemetry is a method originally used years ago to track the movement of animals. Devices transmitting electrical signals to a chart recorder are attached to an animal, who is then set loose.

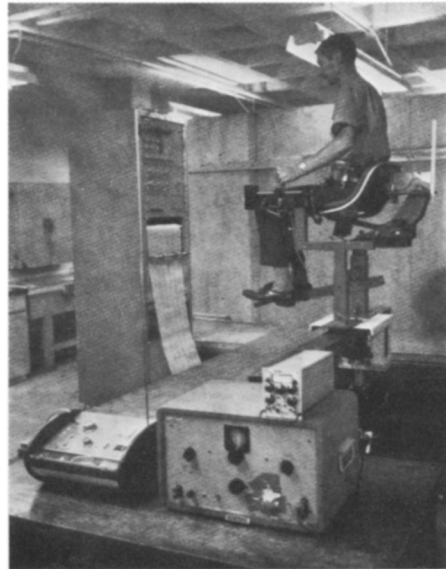
Telemetry has been used to track human travel patterns. It is also used with polygraphy as a signal transmitter.

A16 Distance Monitor



Spacings between moving objects—production-line parts, vehicle traffic, or ship clearances—can be monitored with a prototype Siemens device made in West Germany. A piezoceramic oscillator emits and receives the ultrasonic pulses and echoes. Elapsed time denotes distances up to 100 feet.

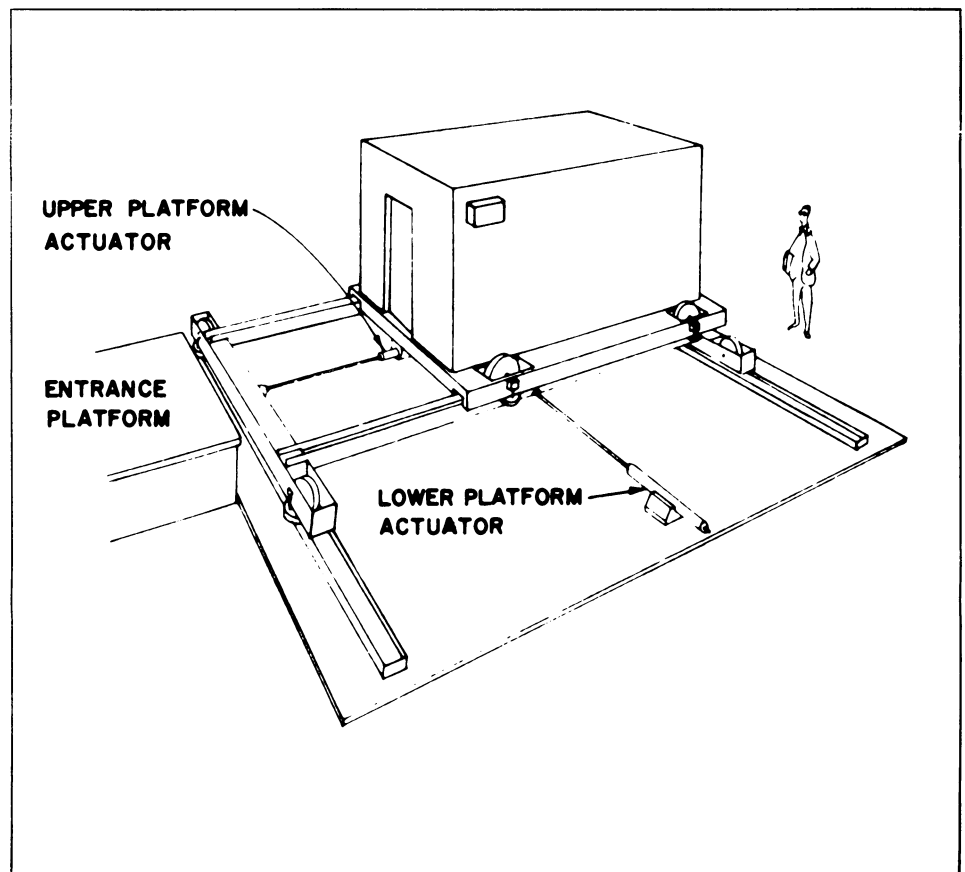
A17 Motion Simulator



At what point does horizontal motion become noticeable to people? What is their threshold of tolerance for sway? The HATS-I motion simulator measures how much movement is acceptable to the average person, and under what conditions.

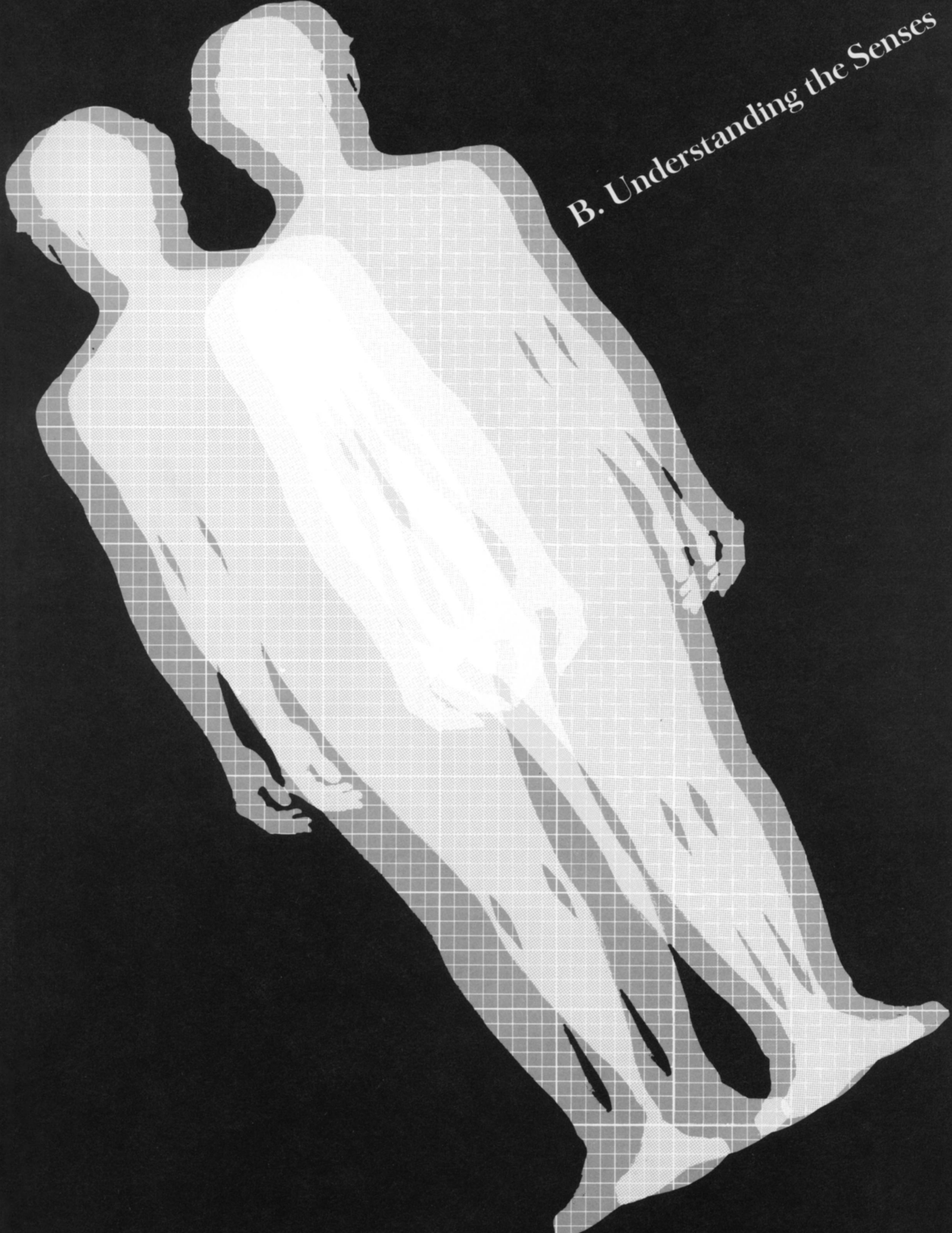
Among other uses, it helps determine the maximum amount of sway permissible in a high-rise building. Similar tests were developed to measure sway in the World Trade Center towers to avoid such harmful effects as dizziness, headaches, and impaired eyesight.

A18 Sway Detection



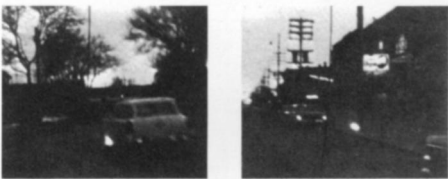
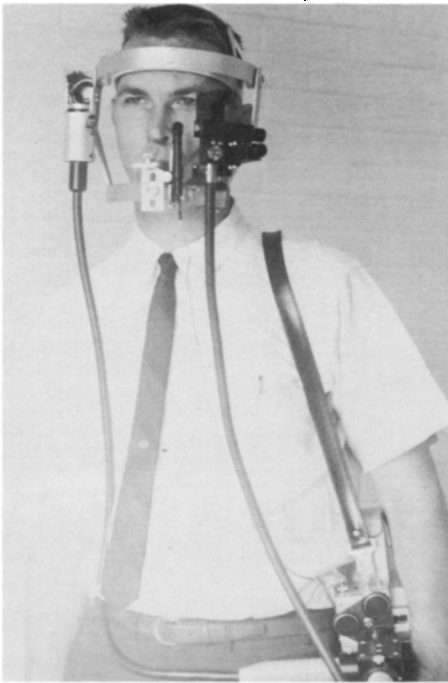
An electro hydraulic vibration device studies the effects of some forms of motion common in ground vehicles. Heart rate, tracking error, hip and shoulder acceleration, and subjective judgments can be recorded under different test conditions. In this photo, linear acceleration on a subject's hips is measured.

B. Understanding the Senses



B. Understanding the Senses

B1 Eye Movement Recording

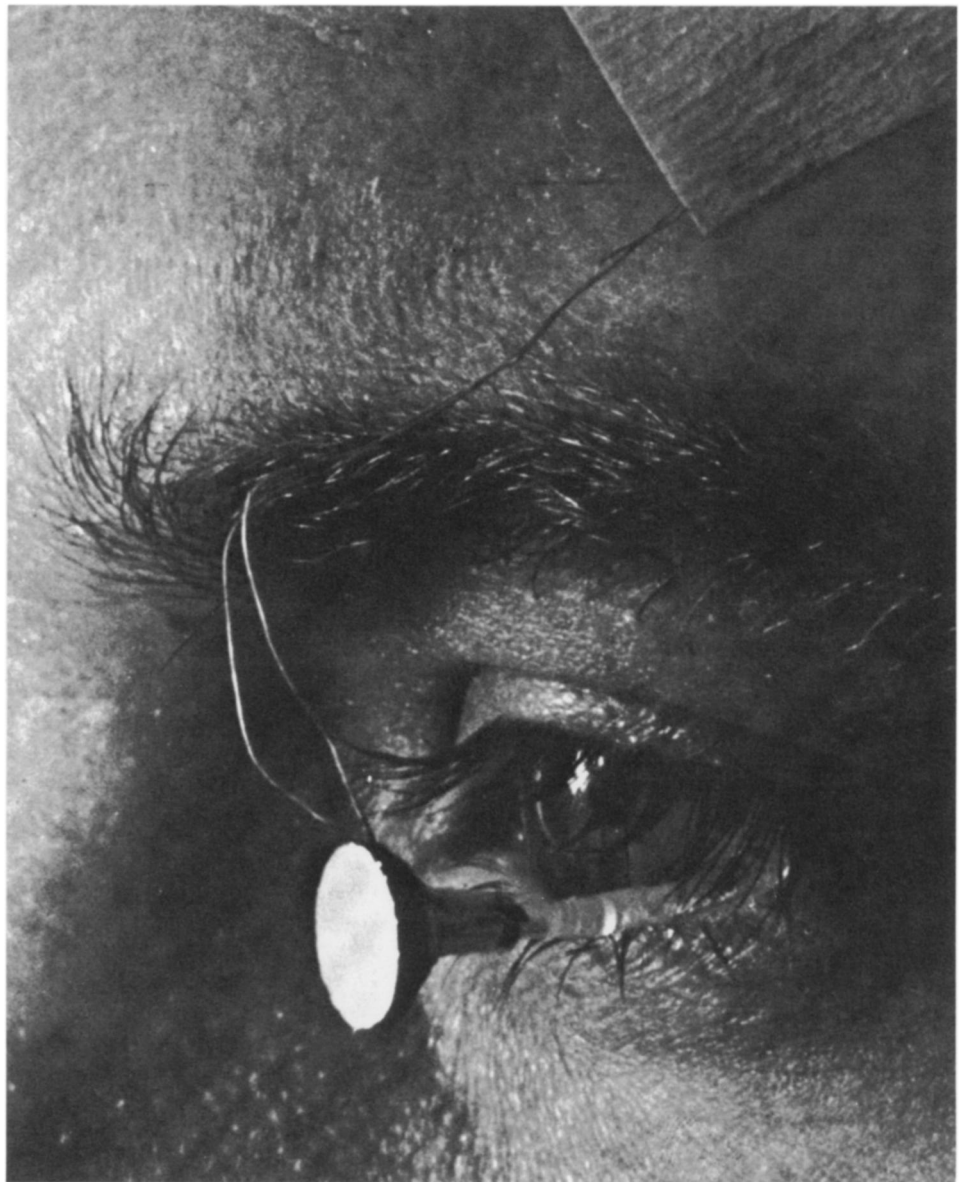


The seeing eye moves so rapidly that the pattern of eye movements can only be recorded by instruments. Correlating a viewer's eye movements with a photographic record of the scene before him reveals those features that attract and hold his attention. This technique also pinpoints details the viewer has overlooked.

Environmental researchers have used eye movement recorders to analyze people's visual response to such experiences as traveling by expressway into the city.

Stephen Carr and Dale Schissler, for example, did a study on urban roadway imagery using eye movement recorders (*Environment and Behavior*, Vol. 1, 1969.) Such studies recall Kevin Lynch's milestone book, *The Image of the City*, published in 1960. Lynch surveyed city dwellers to determine what parts of their cities were most clearly and vividly imprinted in their memories, and how these spatial images related to each other. The purpose of his study is to provide highway planners and urban designers with useful data to aid them in shaping people's perceptual experience of the city.

B2 Light and Eye Movements

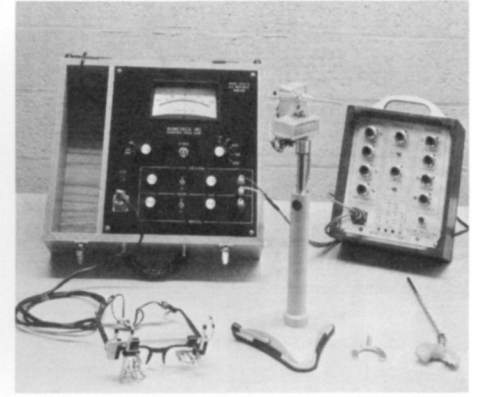
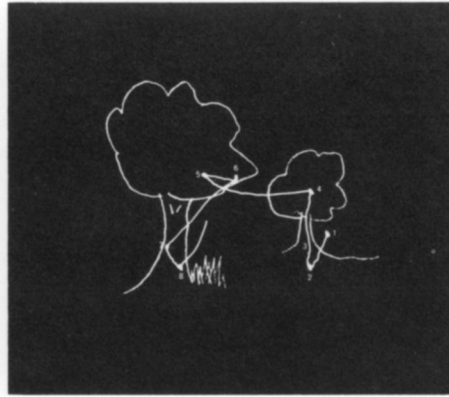
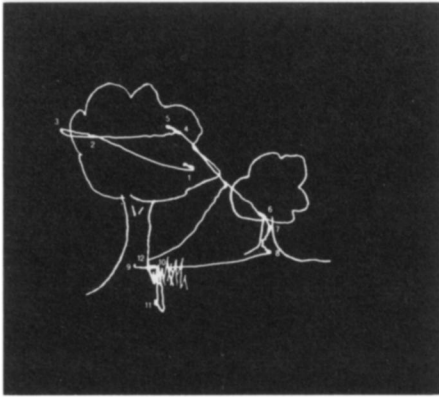


Seeing under poor conditions is taxing, but until recently no one successfully established a clear-cut index indicating the amount of effort required to see under varying illumination conditions. A few years ago Dr. Frederick W. Hebbard began to research the correlation between the tiny, unconscious movements made by the adjustment muscles of the eyes, and the quantity and kind of light available ("Micro Eye Movements: Effects of Target Illumination and Contrast," *Illuminating Engineering Research Institute*, April, 1969). He conducted his experiments with the use of a special contact lens, with an attached mirror, mounted in the eye. The light reflected from the mirror was recorded on film to indicate the optical path of the eye.

Dr. Hebbard found that the eye exerts less effort to see under high levels of illumination than under very low illumination; in good light it makes narrower sweeps, therefore, needing fewer retinal cells to see an object. He also found that high illumination focused on a task area, with ambient darkness, also caused the tiny eye muscles to work harder than when the surroundings were lighted with the same illumination.

In another experiment he found that sudden changes in illumination, from high to low, increased the burden on the eye muscles. Sustained glare also causes more and wider eye sweep because the eye has to combat discomfort by exposing fresh retinal cells to the image.

B3 Visual Perception: Eye is Not a Camera



How the eye scans pictures and scenes, perceives elements and objects, absorbs and retains information presented through visual media is of more than academic interest to professionals involved in the preparation of visual materials. Although the functioning of the eye has often been likened to a camera, it is actually quite different. Eye movement recorders (such as those made by Polymetric Company, and Biometrics, Inc.) have been developed to measure vertical and horizontal eye motion, responses to light-intensity, and pupil size changes. They have been used in visual perception research, reading disability diagnoses and various kinds of neurological, cognitive and psychological performance studies.

They have also been applied in human engineering studies—how people track objects

or controls on instrument panels, how they respond to signage, graphics, packaging and other visual communications.

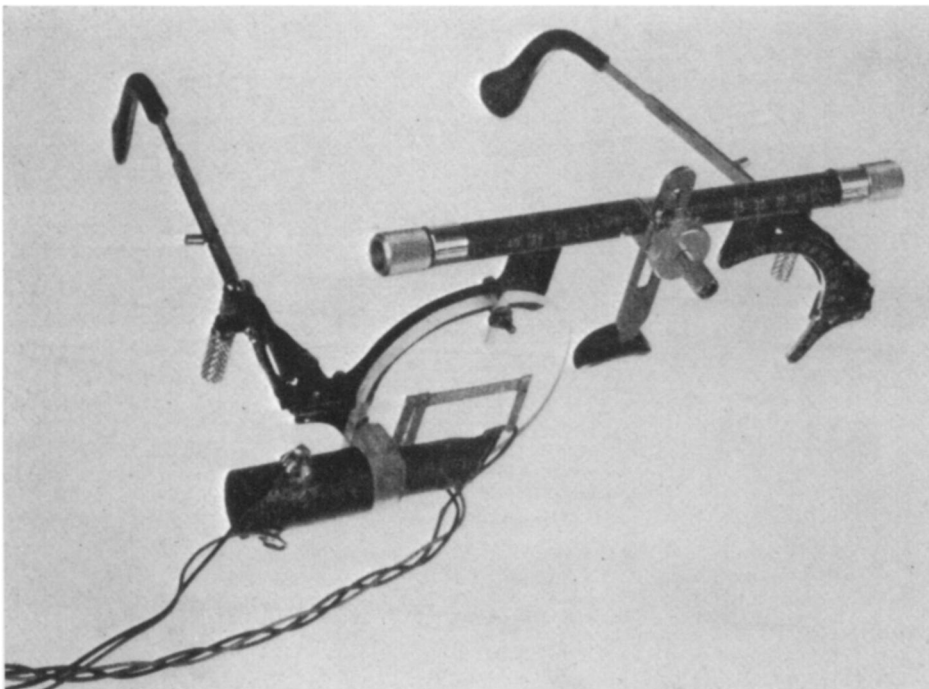
Studies show that the eyes are the most active of all human sense organs. Because detailed visual information can only be picked up by the fovea (a pinhead size area on the retina), the eyes constantly move to focus clearly. Thus they alternate between fixed positions when they are aimed at a single point in the visual field, or rapid and irregular jerky movements called saccades—usually occurring at the rate of two or three per second.

The regular pattern of eye movement (see illustration) when viewing a scene is called the “scan path.” Besides telling us how quickly and comprehensively individuals can absorb information, or even how the

brain functions, eye movement studies have practical application. They can help indicate the relative merit of stimulus characteristics (complexity, redundancy, color, reduction of detail, contour elements, etc.) in visual communications and can determine where the eyes dwell. As such, they have had useful applications for designers of films, charts, signage and other visual media.

Interesting articles on the subject have been published by David Noton and Lawrence Stark (“Eye Movement and Visual Perception,” *Scientific American*, June, 1971) and Malcolm Fleming (“Eye Movement Indices of Cognitive Behavior,” *AV Communication Review*, Winter, 1969):

B4 Mini-Eye Recorders

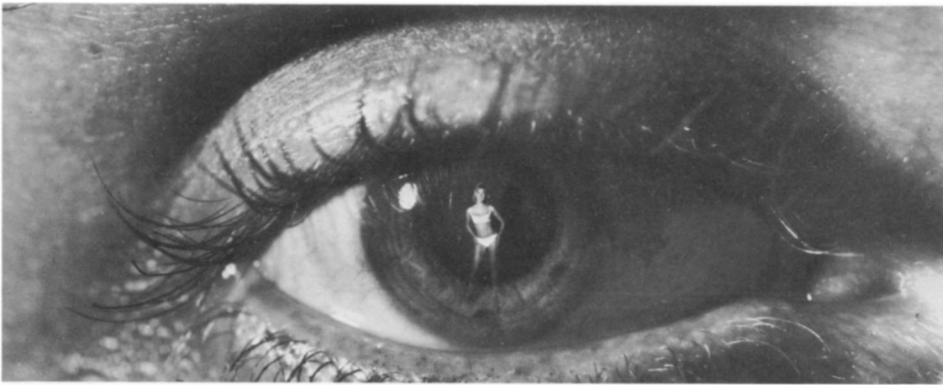


Because of the technology involved, most equipment for recording eye movement is fairly bulky and can't be used without restricting a subject's other movements or interfering with his normal vision—especially in photographic recording of eye movements when cameras must be worn on the head.

To test the perceptual abilities of drivers, the Road Research Laboratory in England (Ministry of Transport, Crowthorne, Berkshire) has developed a system that employs a special miniature position-sensitive photoelectric cell to detect light reflected from the cornea. Eye movements of approximately ± 15 degrees may be recorded. The recorder's main drawback is that it cannot easily be used except in conditions of relatively low general illumination.

B. Understanding the Senses

B5 Pupillometrics



Over a century ago Charles Darwin noted that widening and narrowing of the eyes were signs of human emotions. But the idea was not entirely novel, even then. Different cultures throughout the ages seem to have understood the principle. Medieval Middle Eastern rug dealers often wore crude colored spectacles to conceal the pupils of their eyes when examining unusually fine specimens, to prevent the seller from raising his prices.

More recently, the contraction and dilation of the pupils have been studied scientifically. In the 1960s Dr. Eckhard Hess at the University of Chicago developed the science of pupillometrics. According to him, pupillometrics is based on the principle that the pupil of the eye is a direct extension of the brain and cannot be consciously controlled. It grows larger or smaller in response to stimuli such as pictures, sounds, odors, tastes or even spoken questions.

Hess asked subjects to peer into one end of a two-foot-long black box called a Pupil Response Apparatus, to look at photographs projected on a screen at the other end. A movie camera recorded the

changing size of their pupils. The dilations and contractions of the enlarged pictures could then be measured.

Hess's assumption is that an increase in pupil diameter reflects varying degrees of pleasure or interest in the subject's reaction to the photographs; a constriction indicates distaste or rejection of whatever the subject is observing; no change in pupil size shows disinterest or boredom.

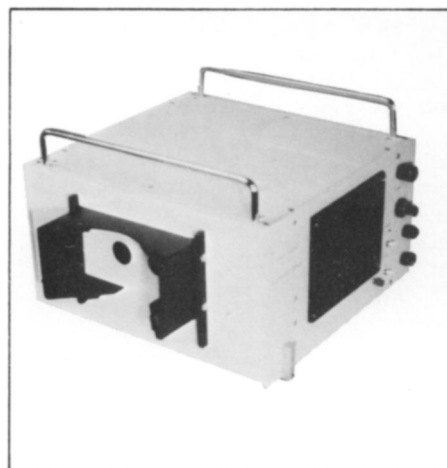
Dr. Hess used this method to determine the emotional reactions of subjects to whatever they were observing. It also enabled him to tell what they first saw in the field of view, and how much time they spent looking at it.

Pupillometrics has already been used in market research to determine the appeal of advertising layouts, package designs, and new products, such as silverware. It could be used, more appropriately, to study people's subjective and often subconscious emotional responses to objects, environments, graphics and typography, with a view toward discovering what elements, conditions, colors, shapes and sizes are pleasing or displeasing.

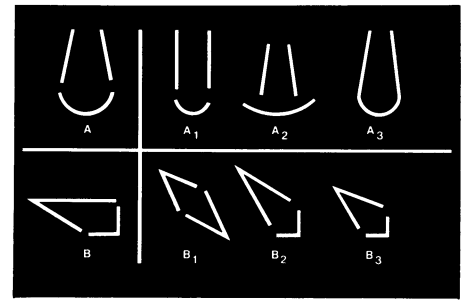
B6 Eye Power

Eye movement has always been one of the more expressive and subtle forms of non-verbal communication. Now it has new applications. Quadriplegics and those who lack arms or legs can trigger a new Sight Switch device (made by Hayes International Corporation), enabling them to control a motorized wheelchair by eye movement alone. The user can start, stop, reverse or turn his wheelchair by practiced movement of either eye. Eyeglass-mounted sensors transmit the eye movement to a computer programmed to ignore blinking and other accidental or involuntary movements which might activate the wheelchair.

B7 Tachistoscope

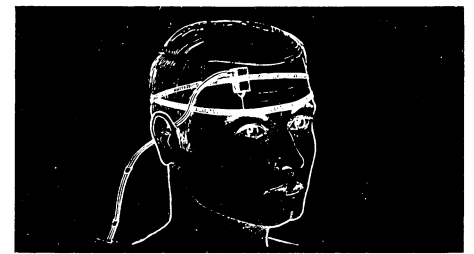


B8 Visual Recall



To measure visual recall, symbols like "A" and "B" are shown to people for a fraction of a second. They are then asked to draw the symbol from memory. Symbols "A₁," "A₂" and "A₃" were drawn by three different people, as were the corresponding "B" symbols. Visual recall has been used in designing symbols, logotypes and other graphic elements where high visual recall is considered vital.

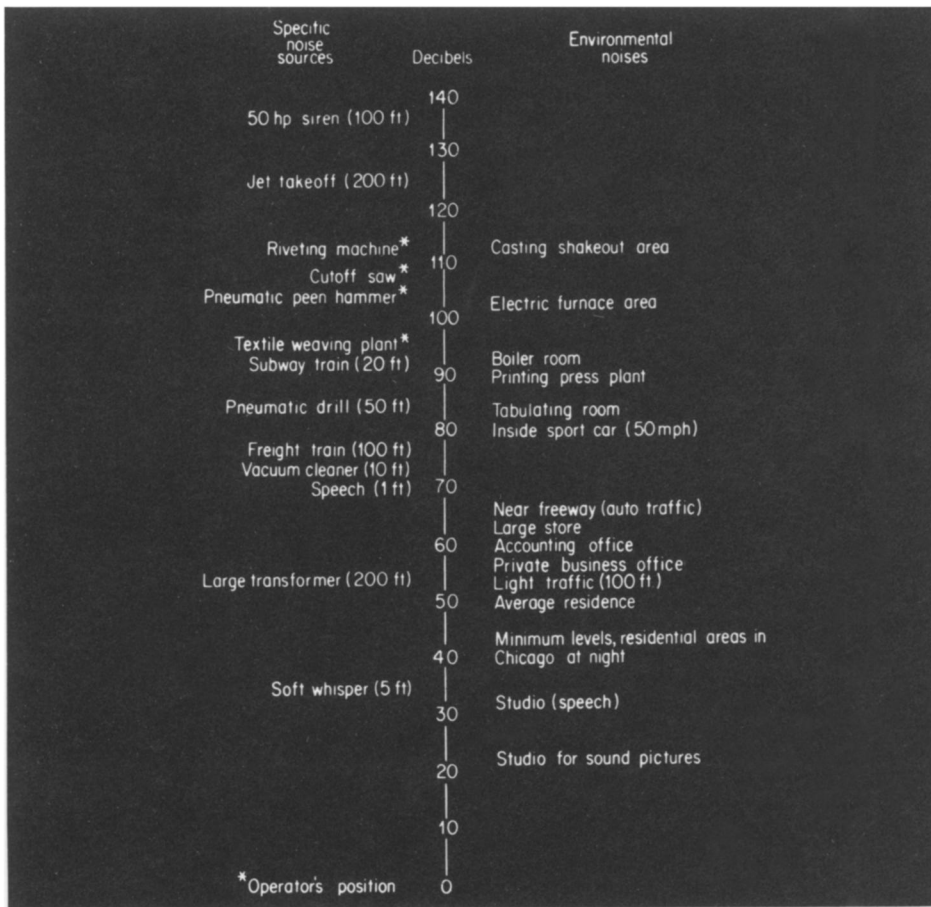
B9 Brow Metrics



The raising and lowering of eyebrows is a reliable indicator of emotional states and attitudinal preferences, according to Richard Coss. He has invented the brow meter to measure minute muscle movement. Brow movement technique has been employed to measure the responses of consumers to various design techniques.

Searching for a face in a crowd, a word in a list, a symbol or a picture from among similar items, involves certain cognitive operations. The length of time it takes to recognize an element, and the exact process of the scanning operation, can be studied. The device shown here, a tachistoscope, displays a series of similar elements and a single deviant. Tachistoscopes vary from the simple (like this one) to the very complex, and have already been used by market researchers for packaging evaluation and advertising layout.

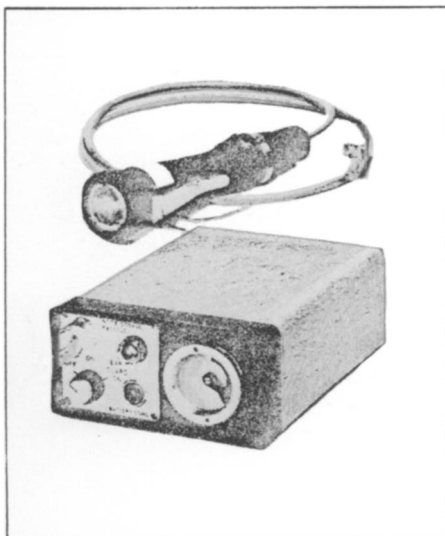
B10 How Loud is Loud?



An increase of one decibel of sound may seem insignificant, but it actually registers a doubling in volume. The chart shows the relative rank of various auditory experiences. The worst places to be, obviously, are on a city street with a siren blaring (approximately 137 db),

or near a jet runway during takeoff (125 db). Decibel measurements provide objective criteria for designing machinery, transportation vehicles (including the interior), as well as work and living environments.

B11 Personal Noise Meter



How can a drill operator, a rock dancer, a jet airplane mechanic or a harassed urban pedestrian know when he's reached his maximum auditory tolerance? Studies show that performance suffers and physical damage to the ears may result from overexposure to noise.

The Noise Abatement Society in London—England, incidentally, has much stricter noise control ordinances than the U. S.—markets a pocket-size solid state noise survey meter. It can be set at a preselected level which, when reached, triggers off a red light.

B12 What Price Noise

City noise is irritating, and though people may learn to adapt to it or become insensitive, they pay a high price. Children especially seem to suffer if exposed to it for prolonged periods.

These findings are reported in an article published in *Psychology Today* (“Urban Din Fogs the Brain,” May 1973). Typical experiments studying the effects of noise on behavior ask people to perform tasks while exposed to various kinds of noise. Though they may perform as well in noisy surroundings as in quiet ones, noise does produce stress, and it also appears to have adverse after effects.

In one study of elementary school children who lived four years or more in a particularly noisy highrise apartment building which straddled a New York City expressway, children on lower floors, where it was noisiest, experienced a loss in auditory discrimination. Their test scores in word knowledge, reading comprehension and reading total were lower than those of children living on higher floors.

The authors of the article suggest that four factors determine the effects of noise on behavior: intensity, duration, predictability and controllability.

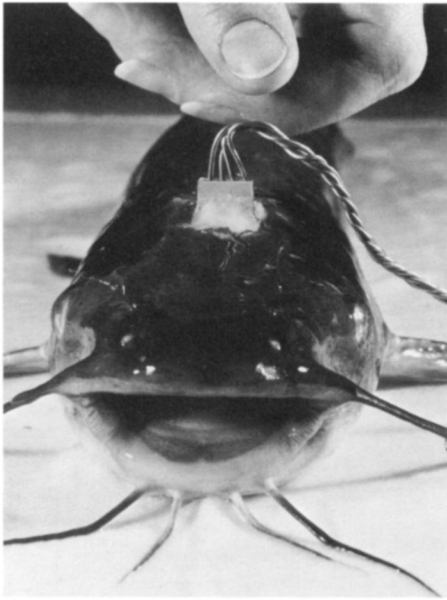
B13 Soundscape

In the last 200 years our acoustical environment has altered radically. The world of sound we inhabit is acoustically far more intense than was that of our pre-industrial revolution ancestors. In big cities the signal-to-noise ratio—how clearly a sound stands out in relation to ambient noise—is approaching 1 to 1, the ultimate lo-fi definition. Sounds of nature have been almost totally obliterated. The adverse psychophysiological effects, though unmeasured, are assumed to be serious.

A new journal (*The Music of the Environment*) published by Universal Editions and edited by R. Murray Schafer is devoted to “soundscape” studies. Among other things, it calls for the creation of a new discipline called “acoustic design.” According to Schafer, “musicians, acousticians, psychologists, sociologists and others would study the world soundscapes together in order to make intelligent recommendations for its improvement.” Issues will deal with the acoustic design of parks, playgrounds, communities, cities—all aspects of the sonic environment, primarily from an aesthetic point of view.

B. Understanding the Senses

B14 Smelling Sense



It's hardly news that man and beast react positively or negatively to a wide range of smells and odors, but the olfactory mechanisms have been little explored. Dr. Vernon A. Benignus has monitored a catfish's sense of smell by exposing it to various foul-smelling chemicals, then analyzing via computer the resulting changes in the animal's electrical brainwaves. The research, conducted at Trinity University in Texas, should help clarify suspected links between the sense of smell and general behavior.

B15 Touch Sensitivity



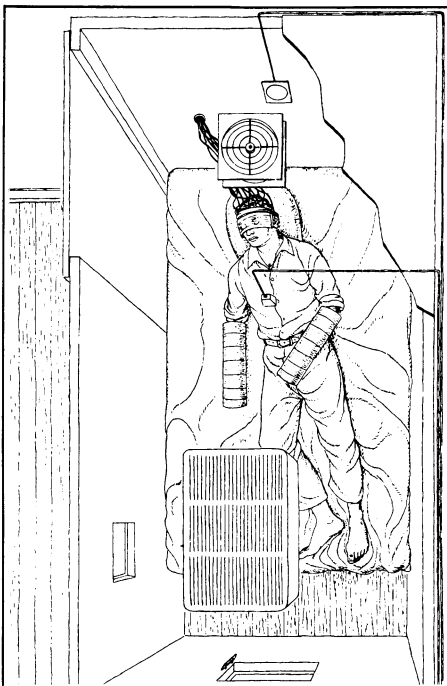
The degree of sensitivity of various regions of the body can be measured by an esthesiometer, a device that measures the distance on the surface of the skin at which the actual separation of compass points is just perceptible. At sensitive points of the body—shown as short vertical lines on the diagram—the two points are very close together. Measures of body sensitivity are useful in designing special gear like hard hats, backpacks and prosthetic devices such as artificial limbs, braces and dental bridges.

B16 Voice Printing

Each person's fingerprints, as everyone knows, are unique. "Voice prints"—graphed by a spectograph which translates the sound into lines and bars which may then be analyzed—are also unique to each individual.

Voice prints have been used in criminal law and in identifying enemy radio operators during wartime. They can also be used to measure various psychophysiological states on which it is otherwise difficult to obtain reliable data: for example, fatigue and other emotional states. The fundamental frequency of vibration—or pitch—of the vocal cords has proved a reliable measure of stress, more accurate than heart rate measurement and other indicators. Craig B. Grether has conducted studies of voice as an index of fatigue at North Carolina University. In the occupational environment, fatigue can be a precursor to changes in health, attitude, performance capacity and psychological adjustment. Grether recommends voice studies for monitoring emotional states and performance in plants and factories, hospitals and air-traffic control towers.

B17 Sensory Deprivation



Our over-technologized environment is often faulted by its critics (for example, Rene Dubos) for its monotony and lack of rich or adequate sensory stimuli. Sensory deprivation studies undertaken in recent decades show that a lack of sensory input affects physiological and mental processes.

People who work at monotonous tasks or in isolated conditions often report boredom and dissatisfaction with their jobs. During World War II, radar operators on anti-submarine patrols often failed to detect U-boats on radar screens. Long-distance truck drivers, railroad engineers, aviators have often performed abnormally—occasionally with fatal results—for no apparent reason.

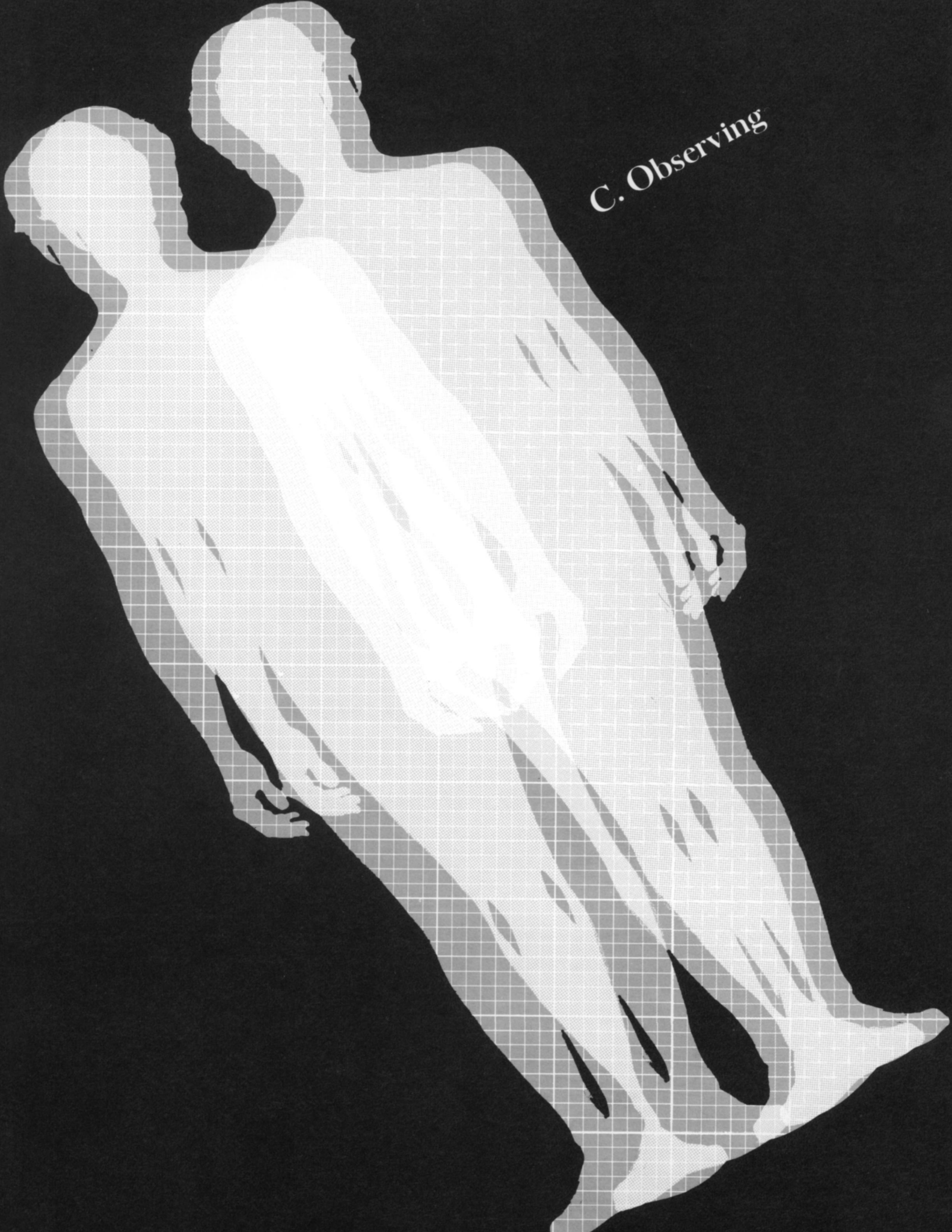
Experiments to test human behavior in situations where almost nothing is happening, place subjects in isolated environments called sensory deprivation chambers. They may be confined to a bed, or even to a respirator, and partially blindfolded,

gloved and cuffed to restrict sense of touch. Electroencephalographs may be used to trace brain wave patterns.

The results show that sensory deprivation leads to significant impairment (temporary, fortunately) of reasoning and perceptual ability, reversion to childish emotional behavior, changes in brain wave patterns and other deleterious effects. Subjects have reported powerful and disturbing hallucinations.

Woodburn Heron, writing in *Scientific American* ("The Pathology of Boredom," January, 1957), observed: "A changing sensory environment seems essential for human beings. Without it, the brain ceases to function in an adequate way . . ." He quotes Christopher Burney's remark about his experience in solitary confinement: "Variety is not the spice of life; it is the very stuff of it."

C. Observing



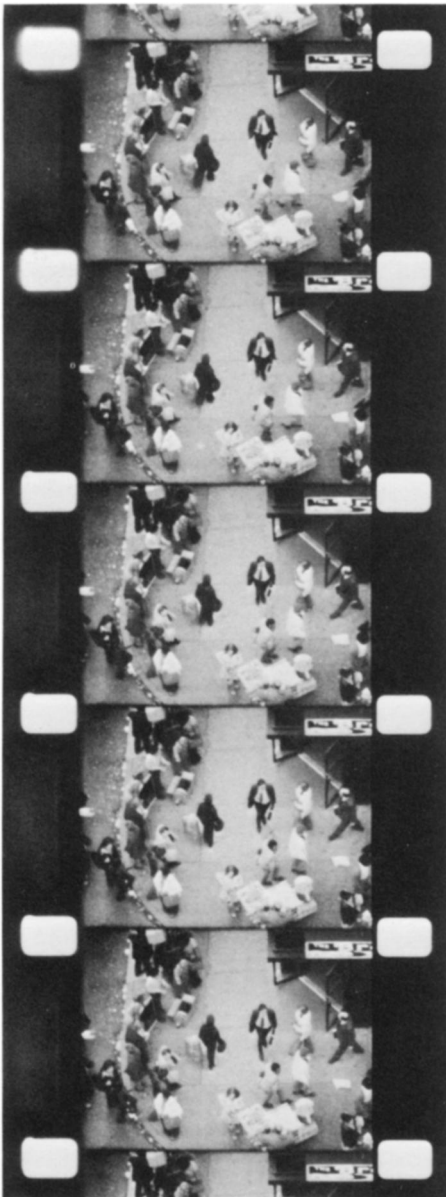
C. Observing

C1 Unobtrusive Measures

As every social scientist knows, *how* things are measured often affects the results. Some of the more interesting devices for observing human behavior are the so-called “unobtrusive measures,” that collect data while remaining unnoticed by the subjects. They require no interviewing or questioning of subjects.

Frequently, hidden cameras—motion picture and video—are used to obtain photographs which can be reviewed and studied again and again. Because the devices are unseen, unless told, subjects will not be aware they are being watched and they will act naturally, giving a true picture of their movements and expressions.

C2 People Watching No. 1: Plaza Study



C3 People Watching No. 2:

In a study of what planters and benches would do for Fifth Avenue—William Whyte again spent hours of time, pad and pencil in hand, observing how people responded to these amenities. (Simple observation is the best method for getting the feel of a place, he believes.) His second technique was to use time-lapse photography to help establish general patterns of use, and to serve as a record.

Several prototype bench and planter models were set up on different parts of Fifth Avenue, to see whether and how they would be used, and to evaluate which models and locations would be preferred.

William H. Whyte—author of *The Organization Man*, chief literary draftsman for the Master Plan for New York City published by the City Planning Commission, and a former editor of *Fortune*—has been people watching in public places in New York City for the past few years. Among his watching places are streets, plazas, playgrounds and parks. He writes well about his observations, in refreshingly jargon-free language. His work has been funded by major foundations. The New York City Planning Commission is interested in applying his observations on what makes plazas work to the design of new areas, by incorporating specifics into the zoning ordinance.

Whyte describes how he goes about watching people in public places: “With time-lapse and telephoto photography we charted such factors as sun angles and the flow of pedestrian movement; we did special close-up studies of the most heavily used spaces, including such places as the steps of the New York Public Library. We talked extensively with the people on the plazas, but mostly we sat and watched what they did.”

The new office building plazas are the worst, he found, with their emphasis on a predictable visual effect, and little provision for social use. Sit-ability is the key to successful plaza use and some of the best places to sit are the simplest: ledges and broad steps where people can sort themselves out in variable groups are better than short benches and fixed seats, which constrain choice. Sidewalk food vendors, though discouraged by city officials and some building management, are vital to plaza life.

C4 Lighting Studies

The invention of artificial light has undoubtedly changed human behavior in a social sense. But evidence now indicates that if artificial light deviates even slightly from natural sunlight, it may profoundly affect health and behavior.

A recent example—that of hyperactivity in children—proves the need for more research. An article in *Human Behavior*, January, 1975, describes experiments conducted by John Ott (President of Health and Light Research, Inc.) at a Sarasota County, Florida, school. The research combined observation with unobtrusive measures. In two windowless classrooms the lighting was changed, and time-lapse photos were taken, without the children’s knowledge. Two other similar rooms were also photographed by time-lapse, but the lighting remained the same.

In the classrooms where lights were changed (improved fluorescent lights were installed, containing all the waves of the visual light spectrum, and long ultraviolet rays), the behavior and learning of the hyperactive children improved. In the rooms illuminated with standard cool white fluorescent lamps (lacking the ultraviolet waves found in sunlight, and also the blue and red waves) the children remained hyper.

Similar experiments conducted by Ott, on the affect of light on animal behavior and plant growth, have shown that the quantity and quality of illumination has statistically significant results.

(For other observational studies using photo techniques, please refer to Section D.)



C5 Body Language



Kinesics is the study of body language, or what different gestures and movements mean. Body signs are believed to reveal something about a person's hidden feelings. But that, according to Albert E. Scheflen, M. D., is only a small part of what kinesics is about. In his book, *Body Language and Social Order*, he argues that, combined with spoken language, it serves to control human behavior and to maintain the social order.

In the photograph at left, the two ladies at right have convened for a transient conversation. They are standing face-to-face, though one is momentarily orienting her head to another place. Around them is a vacant area—a “buffer zone”—that allows them privacy. The people at left are observing the conversation. Clustering thus provides a nuclear space and an outer regional space. This is a fairly standard territorial encounter zone.

C8 Cut-Off Behavior

Modern urban environments constantly expose their occupants to stressful contacts with strangers. Encountering others in close quarters, they engage in “cut-off” behavior: they avert their gazes, scratch their heads, fidget with parcels or cigarettes.

Richard G. Coss proposes that design priority should go toward understanding how people make themselves comfortable in elevators, corridors, reception rooms, restaurants, small office areas, and other tight spaces. Careful analysis of behavior and use of space might lead to such design solutions as lowering ambient lighting levels to limit perception of other people's faces and gazes, studying traffic angles and doorways to reduce the sudden looming of people entering through doors, or strategically placing decorative objects at corridor intersections to force people to use a larger cornering radius.

C6 Communication Without Words



The Profile of Nonverbal Sensitivity (PONS) test measures a person's ability to understand two kinds of wordless communication—tones of voice and movements of the face and body. These two don't constitute a person's entire nonverbal repertory, but they're a good start. Certain intonations, together with certain facial expressions and bodily movements, are the clearest part of a person's message aside from the words themselves.

The test is based on a 45-minute film which presents the viewer with a series of scenes that involve facial expressions and a few spoken phrases, audible as sounds and tones but not as words. Some of the scenes are both seen and heard. After each scene, test takers try to describe what was going on in the scene.

Females score better on the PONS test than most males; people who score well report fewer but warmer friendships.

C7 The Media and Perception



“We shape our buildings, and then they shape us,” Winston Churchill once remarked in a classic truism that seems to hold for a lot of other things too. For example, man acts primarily in terms of symbol systems. Thus, in an age of mass communications (the new symbolic environment), the rise of communications technology has had a huge impact on human consciousness and social behavior.

At the Annenberg School of Communications of the University of Pennsylvania, the influence of the media on the perceptions that viewers form of individuals and society are being tested. Dramatic scenes from TV programs and motion pictures are shown without being identified to

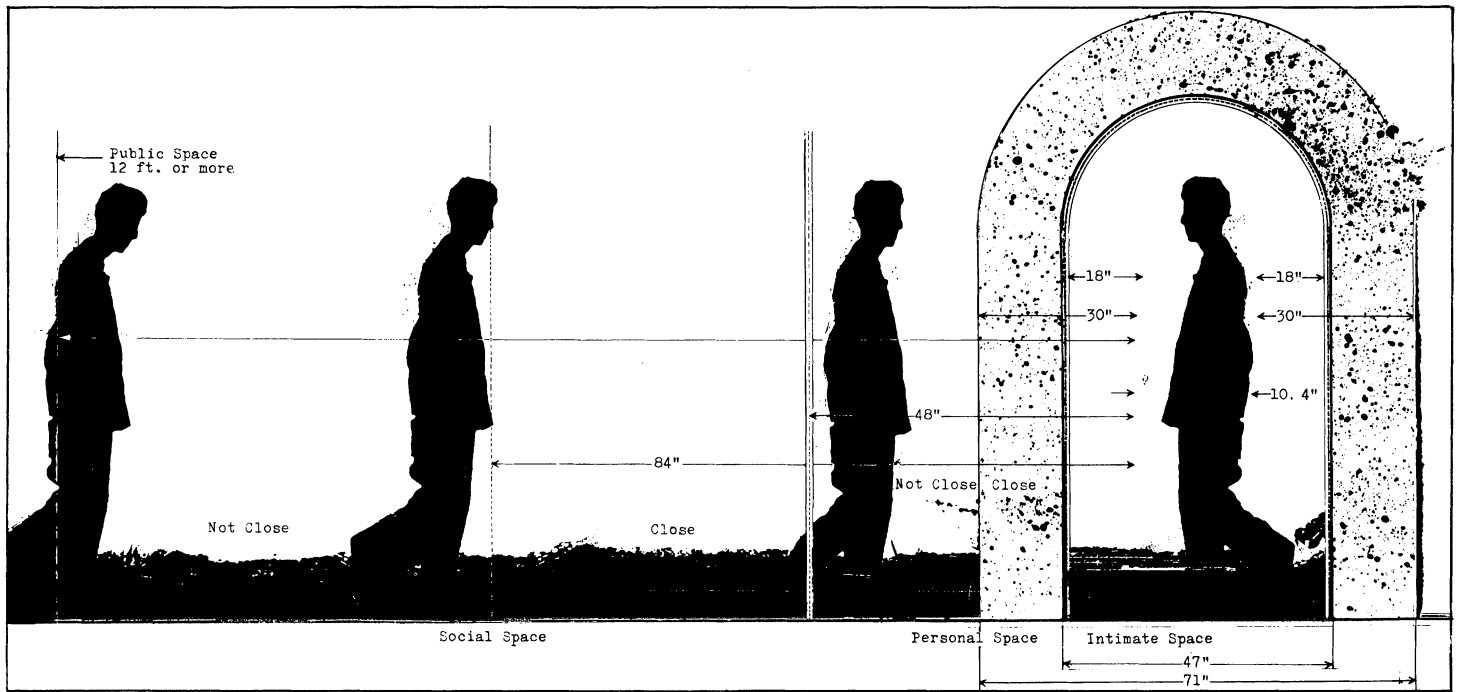
respondents, who are then asked questions like: What are the characters saying?

Standard photos of people may be shown, and respondents are asked such questions as: Who is most likely to be friendly? Or, which person is not an American? Viewer answers are then compared with one another and with those of nonviewers, to determine the effects of types of content on perceptions.

All of this is part of a program called Cultural Indicators, designed to study and report cultural transformations that are occurring. The program is intended to create the conditions of cultural self-consciousness in our new symbolic environment.

C. Observing

C9 Proxemics



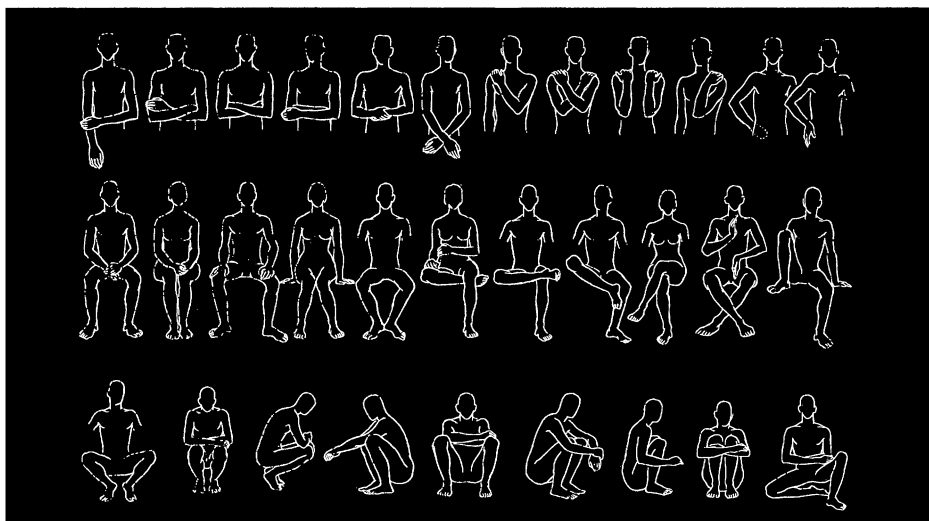
Edward T. Hall wrote two classic books in the 60s, *The Silent Language* and *The Hidden Dimension*, establishing the science of proxemics as part of environmental psychology. Hall, an anthropologist, took as his theme the world of social and personal space and man's perception of it. He also studied spatial behavior in animals. In his observations, he showed that human awareness of spatial relations was governed by several factors, many of them cultural. Arabs, Japanese, Jews, and American middle class Protestants, for example, relate to people or to personal living environments in varied, and sometimes singular ways.

Hall identifies four major social distances for man. The first, *intimate distance*, has a close phase (lovemaking, wrestling, comforting and protecting) and a far phase (6 to 18 inches, a comfortable distance for some cultures, but uncomfortable to Americans when shared with strangers). *Personal distance*, the small protective "bubble" that an organism maintains between itself and others, also has two phases. The close phase, 1½ to 2½ feet, allows physical contact (like handshaking) between people, and close scrutiny of features, without visual distortion. The far phase, from 2½ to 4 feet, is a kind of "arm's length" personal distance.

Social distance, ranging from 4 to 12 feet, tends to be used by people who work together. The near phase, 4 to 7 feet, indicates closer involvement than does the far phase, 7 to 12 feet, which is more formal.

Public distance is well outside the circle of involvement. It is the phase characteristically used in teaching, performance, and other public or semi-public activities. It also governs the distance automatically set around important public figures, like heads of states, in large group situations.

C10 Anthropology of Posture



Posture—relative positions of parts of the body—is of great importance to ergonomists and product designers. Most of our complex tools are designed for use by people accustomed to the postural traditions of Western cultures. The typology of posture shown here, based on work by anthropologist G. W. Hewes, shows that culture and posture are intimately linked to many aspects of our daily lives.

D. Using the Camera



D. Using the Camera

D1 Rapid Motion and Time-Lapse



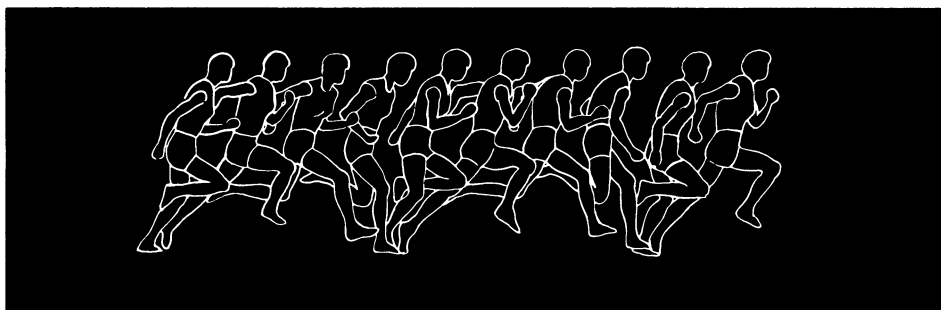
Over a century ago, railroad magnate Leland Stanford engaged Eadweard Muybridge to make photographs recording the postures of horses in motion. This led to the development of a method employing a battery of cameras with shutter controls activated by a series of electrical circuits. The device permitted the making of the first real photographic records of objects in rapid motion. Exposures as brief as 1/2000 second were made by this method, sometimes referred to as stop-motion photography.

Muybridge was a precursor of motion pictures, and also of a technique which is becoming familiar in design research: time-lapse studies. An authentic camera focused on a work situation or a public space is set to take photos every few seconds. The film can be replayed on a projector at fast speed—a whole day's activity may take no more than a couple of minutes; people look like jerking figures in a speeded-up Keystone Cops short—and allows the observer to note how much time the subject spends at each task, and in what posture. The photos can also be analyzed at leisure, and activities and motions can be tabulated and charted.

Besides fast replay of information gathered over a period of hours or days, time-lapse's other great advantage is the unobtrusive role of the camera. While it clicks away, the subject forgets about it, or ceases to care and simply ignores it, while he proceeds with his tasks unselfconsciously.

Time-lapse has been employed in design on several occasions. Patricia L. Musick of Skem Designs used time-lapse in renovating a kitchen complex. The film (at left) helped her to specify the performance requirements of food preparation and service areas, both in terms of spatial function and the cook's work style.

D2 Time-Lapse Tracing



D3 Seating Evaluations

An evaluation of seat designs, in an experimental British Railway train traveling between London and Edinburgh, was based upon records provided by two techniques. One was observation of sitting postures using a rapid coding method. The other was time-lapse films of a selected sample of subjects. Both served as unobtrusive measuring devices.

Two types of seats were studied. Type I seat was a traditional, spring and upholstered seat; Type II had a glass reinforced plastic shell and urethane foam cushions of high density. Type I was relatively soft, whereas Type II appeared to be firm, in these observations.

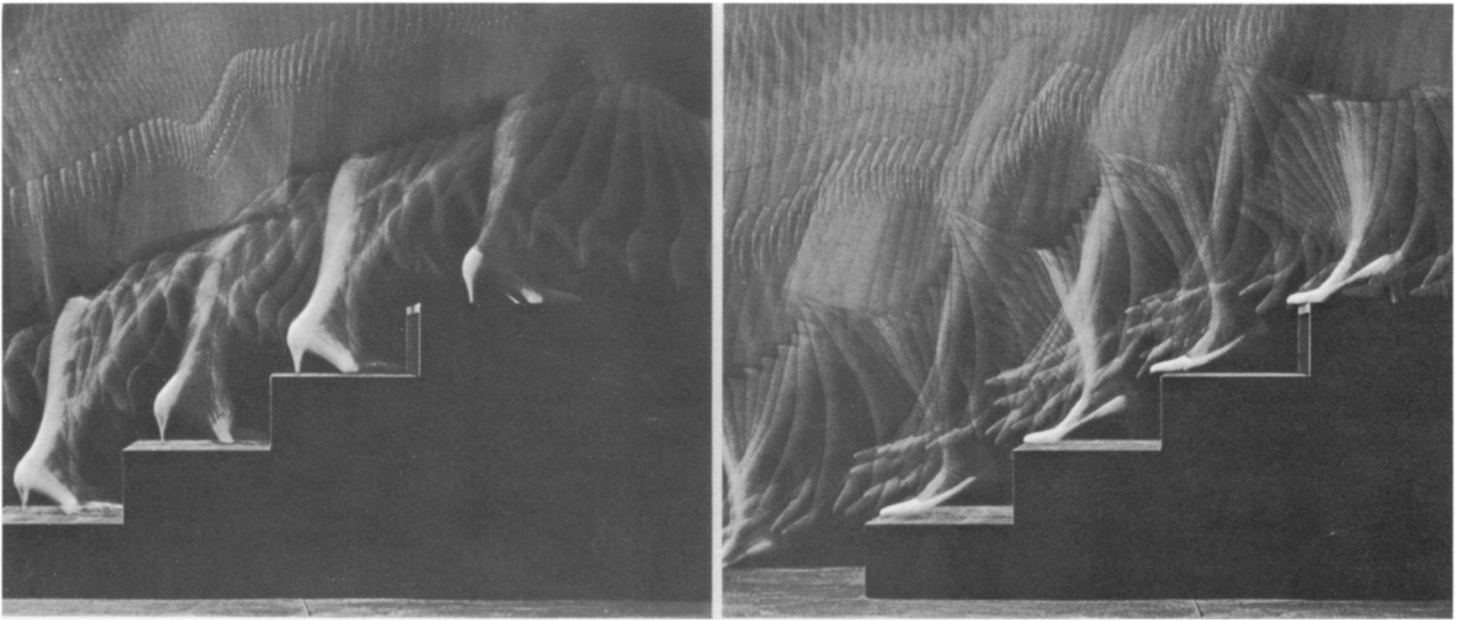
The study (reported by P. Branton and G. Grayson in *Ergonomics*, Vol. 10, No. 1, 1967) attempted to provide an "ecological" approach by regarding the seat as the sitter's immediate environment and posing the question: Can one seat "cause" people to sit more in one way than another?

People using the two seats exhibited significant differences in behavior. Those in Type II (a "mod" seat) held postures longer than those in Type I (a "trad" seat), a finding interpreted to mean that Type II was more comfortable. Further, passengers in II were less fidgety than in I. Type II also allowed more postures than Type I, and those postures were considered orthopedically healthier. The tendency of passengers to adopt better postures in Type II increased with sitting time.

Despite the positive results obtained from the techniques used in the study, the author cautions that extracting information from films and observation is not always a straightforward procedure. There were no useful answers to several questions. For example, did the lack of use of a headrest by most passengers indicate that they did not *wish* to use it, or that it was designed so that they *could not* comfortably use it?

Tracings made from individual frames of a time-lapse film show one complete right leg/left leg cycle during a fraction of a second while a man is running.

D4 Up Stairs, Down Stairs



More accidents occur while people are descending stairs, when they are more likely to slip, than when they are ascending.

The four steps between the Metropolitan Opera House and Lincoln Center Plaza, of unusual configuration because of their very shallow risers and deep treads, are among the most dangerous public stairways of recent times.

Stairs are almost the least studied devices in terms of safety or danger, comfort or strain.

These are just a few observations made by James Marston Fitch, John Templer and Paul Corcoran in their article, "The Dimensions of Stairs," *Scientific American*.

Their investigations included a number of observational and research methods, including stroboscopic flash-lamp photographs of people climbing and descending stairs. The purpose: to identify "riser and tread sizes and combinations that seemed to be most congruent with human feet and hence [that] felt safe and comfortable to users."

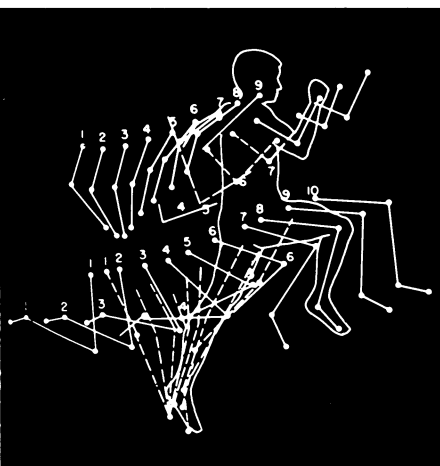
On the basis of hundreds of tests, they developed equations enabling them to predict the numbers of missteps that could be anticipated with various riser-tread combinations. They also experimented with different riser and tread combinations, pitches and speeds of ambulation for both their affect on the

human gait and the amount of energy required to climb under various conditions—using a mechanical stairway that could be set at different angles of pitch (see photo).

Among the findings: the safest stairs for descent are not the same as those safest for ascent.

Nevertheless, researchers were able to recommend some reasonably good minimum standard stairs, including a design that would accommodate 95 percent of the population by making the smallest allowable tread 11.1 inches deep and the largest no more than 14, with risers from 4 to 7 inches high.

D5 Multi-Image Patterns



Multiple-image photography, a technique used to record movement and permit detailed analysis, has many applications in measuring and studying human behavior. In one experimental study it was used to measure the relationship of fatigue to body movements ("The Movement Pattern as an Index of Fatigue," by Frank P. Jones and John H. Hanson, Institute for Psychological Research, Tufts University). The recording process involved using color-coded multiple image photography. High reflectance markers were attached to a subject's head, trunk and limbs. As he moved, a strobe light unit began operating and a single transparency photo was made to provide a time-space

pattern of movement. (The resulting picture is like a time exposure with bright light-spots showing the pattern of arm, leg and trunk movement). The color-coding device, synchronized with the strobe, aided in establishing the time relationships among the trajectories.

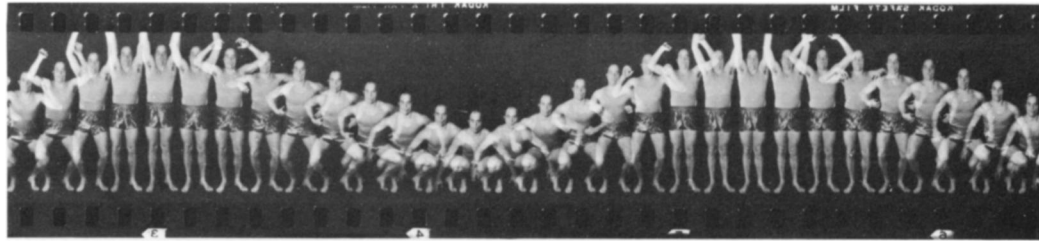
To analyze the patterns, the transparencies were projected and selected linear and angular measures were examined.

This basic method has been applied to the study of human movement functions such as walking up stairs, sitting down, getting up, working at a typewriter, rowing, swinging a golf club.

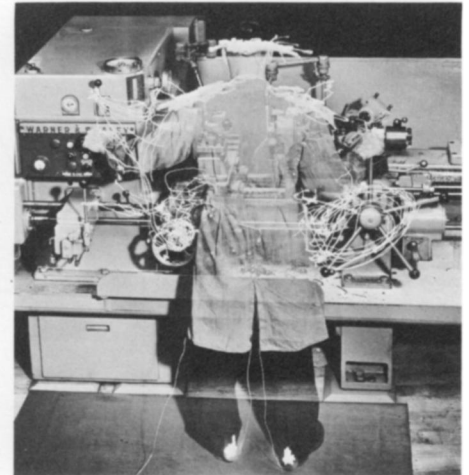
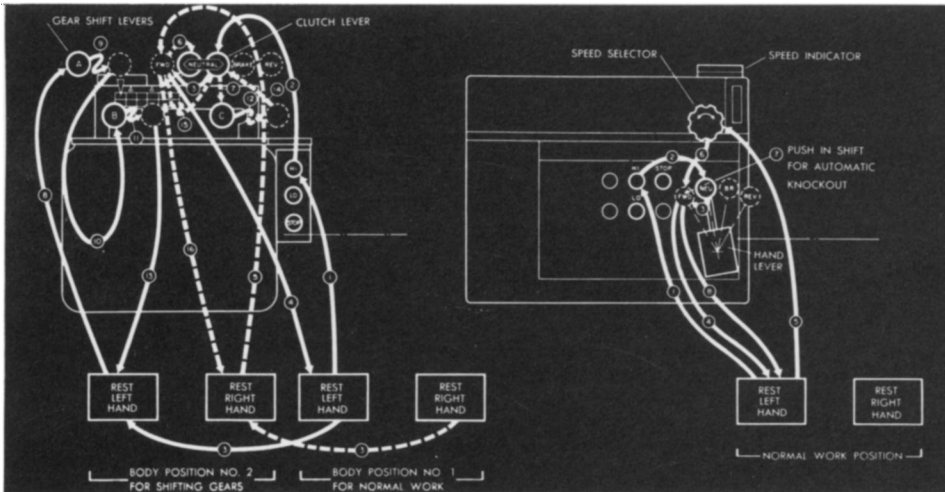
D. Using the Camera

D6 Multiple Image Optics

A Servo-Scan camera photographs continuous images in time. It is capable of viewing the same subject from all sides in a 360-degree panoramic exposure, or of showing movement progression. Images can be analyzed to provide precise information. This photo (right) taken by Media Factory, used multiple strobe lighting.



D7 Time-Motion Study



The camera has played an important role in ergonomics, the science of human factors in the work (especially the man-machine) environment. Ergonomics includes time and motion studies of human performers interacting with tools, machines, control panels. If waste motion, inconvenient features or fatigue-causing factors are uncovered in the studies, the

machines can be redesigned for more efficiency.

Multiple exposure photographs of man-machine relationships using human subjects rigged with lights on wrists, shoulders, head, etc., give a visual record in a single picture of the movement patterns involved in operating a machine.

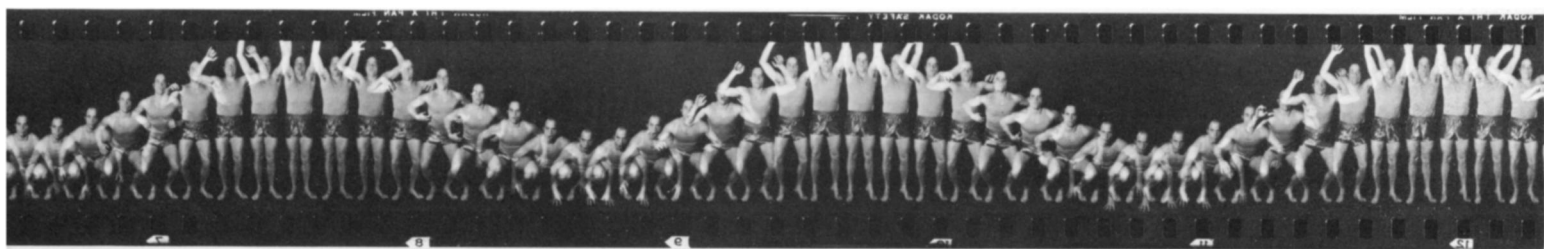
The link charts shown here illustrate motion studies of an old and a redesigned turret lathe, based on ergonomics. Solid lines represent left hand moves; dotted lines, right hand moves. The link charts show that hand moves on the newer lathe are short, effective, harmonious and smooth. The most frequently used controls are more accessible, too.

D8 Videotape



Videotape systems—which allow easy sight and sound recording on videotape, with instant playback through television receivers—promise great and as yet virtually untapped potential for designers. Uncomplicated equipment and lightweight cameras open up a whole realm of human experience to instant study and analysis.

Some systems permit playback of high speed activities in slow motion. So far, the major application of the slow motion feature has been to analyze and diagnose problems with production machinery in industrial plants. But there is no reason why the system can't be applied to people.



D9 X-Raying



X-rays, showing sitting positions of the body, are used to analyze the curvature of the spine in relation to a backrest. This technique permits designers to achieve a proper seating design. Though it may look like a single X-ray, the one shown here is actually a composite. Research is currently being done that will allow full X-rays to be taken without exposing subjects to harmful doses of radiation.

D10 Thermography

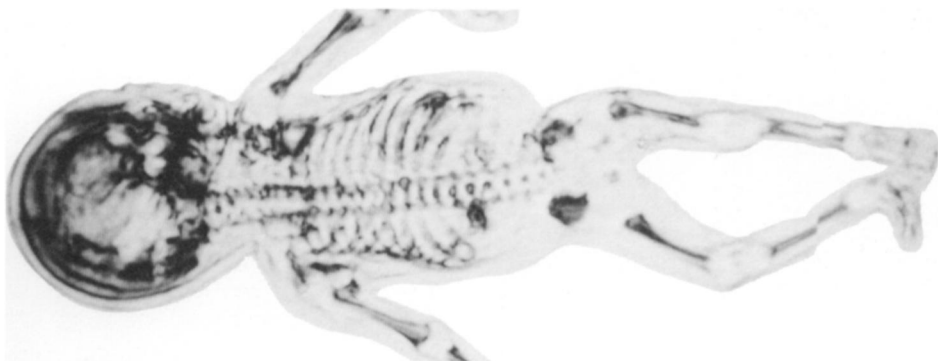


Thermography, which is defined by Webster's Third as "the conversion of a temperature pattern by contrast into an image for viewing or recording (as by photography)," is rapidly becoming a major tool in environmental and ecological observation and analysis. Primarily through the use of infrared cameras and scanning systems, it is now possible to take thermal pictures of objects and environments that provide precision temperature measurements of object details (showing, for example, a cold section of a room where wall and ceiling meet). In medical diagnosis, thermographs have been used to show blockage in a carotid artery leading into the head.

Thermography, or infrared photos, are used in hand tool evaluations by Dr. Erwin Tichauer. A darkening on infrared film will point up the reduction of blood flow to fingers where circulation is being cut off by an improperly designed hand tool.

Equally exciting are the possibilities of exploring large-scale phenomena via infrared cameras placed in satellites orbiting close to the earth. These permit study of urban growth patterns and analysis of the efficiency of transportation systems, among many other things.

D11 Ultrasonic Imaging



Ultrasonic visualization of internal structures produces more highly resolved, detailed images than those provided by conventional X-rays. Ultrasonic can be used to obtain precise information about the internal functioning and interrelationships of parts of objects, gadgets, machines, materials, and their internal malfunctionings or structural weaknesses. The technique is used in medical diagnosis. An ultrasonic image of a 17-week-old human fetus, reproduced left, is far sharper than a conventional X-ray.

D. Using the Camera

D12 Photogrammetry



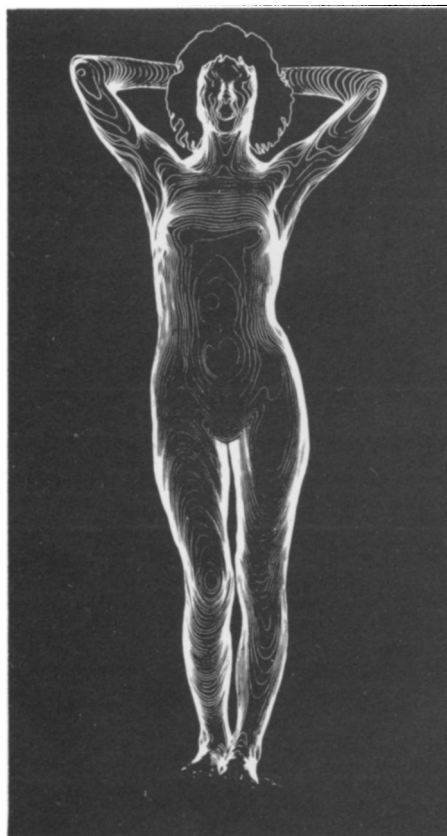
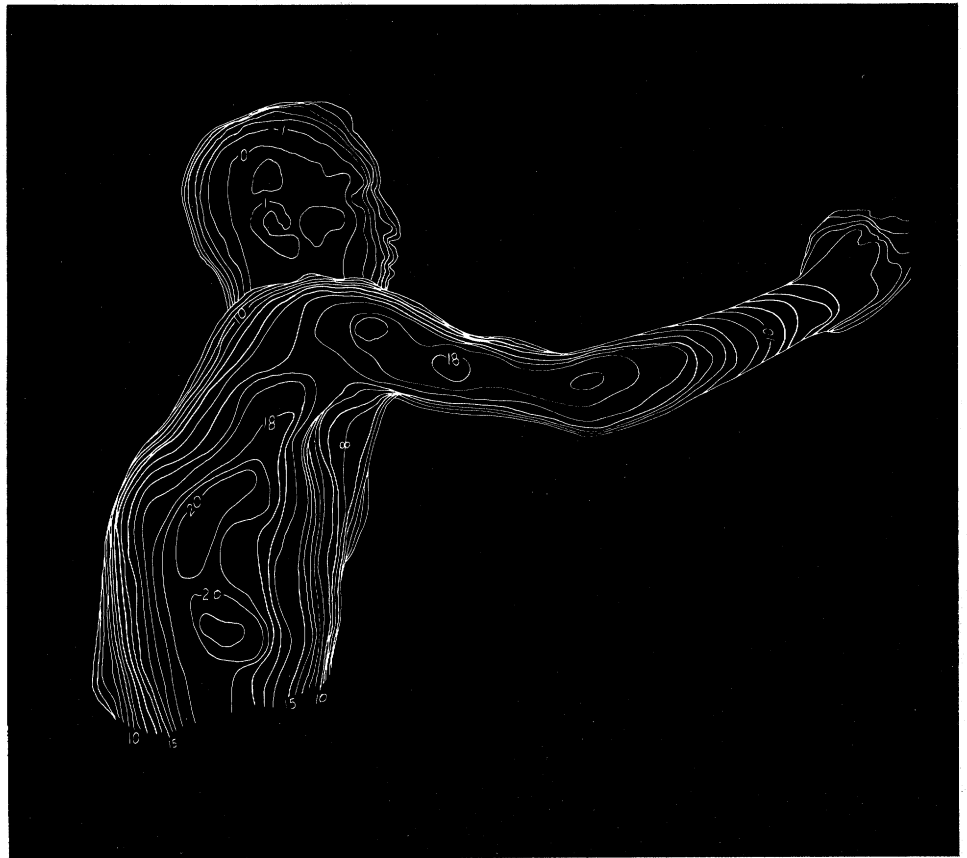
A camera and multiple mirror arrangement records four separate images (profile, front, rear and overhead) on a single exposure for use in static anthropometric studies. The technique is widely used for taking accurate body measurements. It can also be used to analyze movement and task performance.

D13 Closed-Circuit TV

Closed-circuit television to monitor remote behavior where on-line information for design purposes is being sought is still only in the realm of possibility. But its use in a pilot project to monitor highways and save police manpower suggests its feasibility for future applications.

A control room linked by closed-circuit TV to one or more cameras placed along a highway was used in a study (reported in *Ergonomics*, Vol. 11, No. 5, 1968). A single observer sat in a control room and in different versions of the experiment either monitored one screen while switching from one camera to another, or simultaneously scanned several screens positioned close together. The results showed that each technique lent itself to observing or detecting certain kinds of incidents, and that if the control room operator had radio links to police cars, the system could be made to work.

D14 Stereophotogrammetry

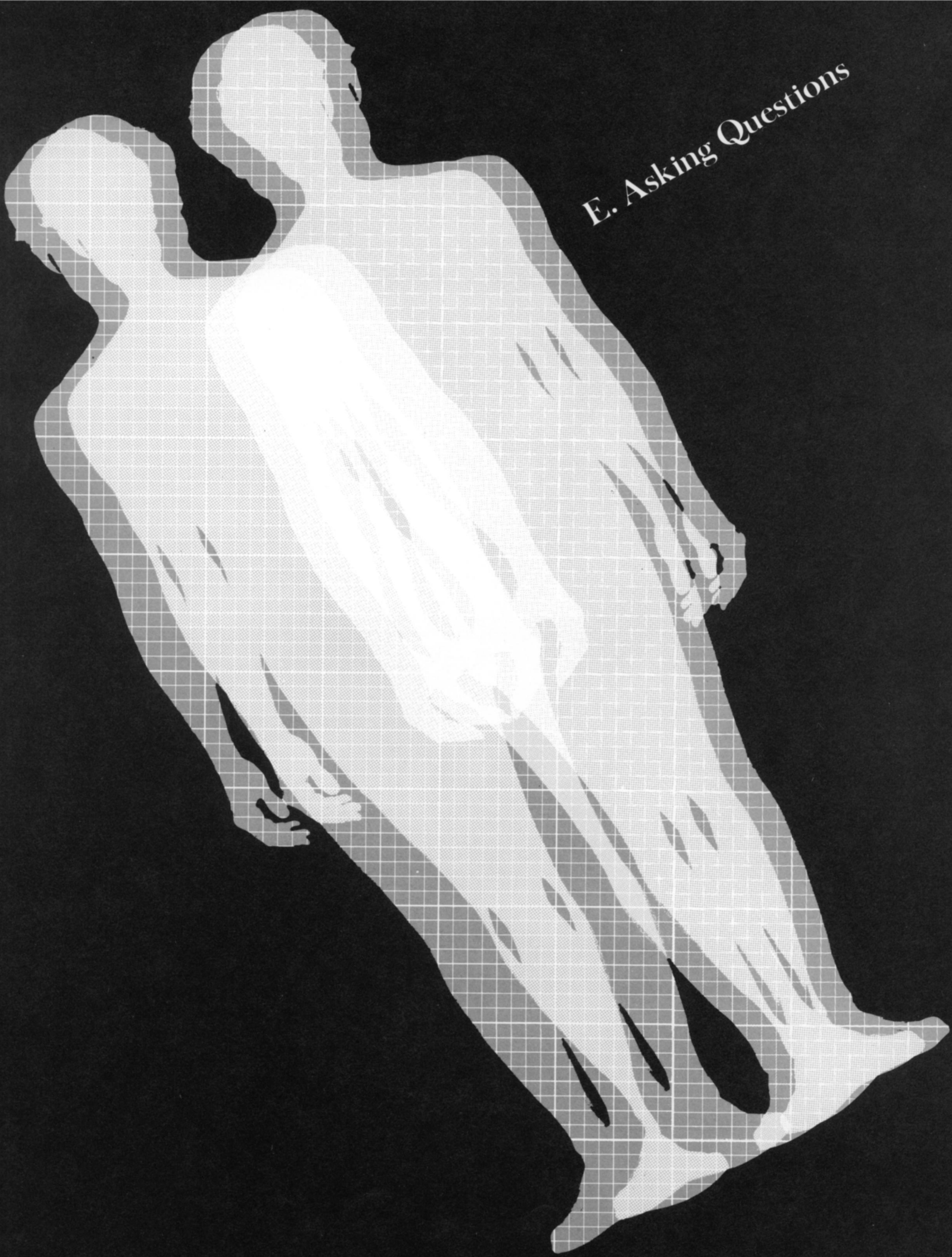


That eight syllable twenty letter tongue tripping word denotes the process by which civil engineers map terrain. Now it's being used to chart the human body. A special camera takes three-dimensional photographs, which are then inserted into a plotting machine and reproduced on a two-dimensional chart. The topological body map is produced much more quickly by this process than by the manual method of measuring with calipers and tape.

The technique spatially relates 3-D forms, providing a more "spatial" interface between the individual and his environment.

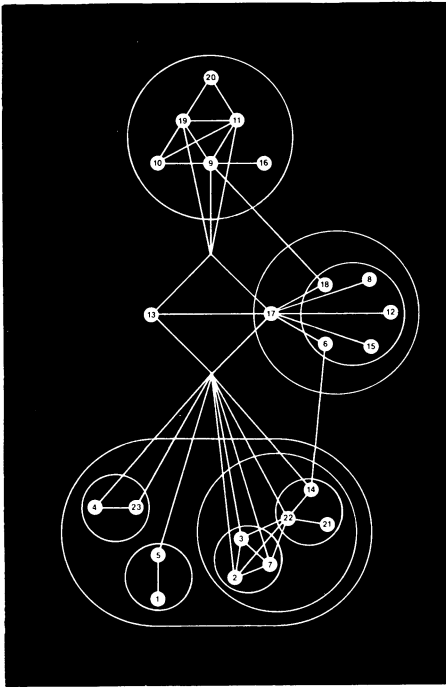
Body maps like the one shown here help measure and understand the physiological differences among people. They are often used in man-machine studies. Exposures taken during dynamic action show muscle displacement when compared to stereophotograms of the static body.

E. Asking Questions



E. Asking Questions

E1 "Task" Questionnaires



Designers and space planners of office environments often give individual "task" questionnaires to the users. The questionnaires develop information about how each person works and what equipment is needed to do the best job, so that the worker's area can be made to accommodate his needs and habits.

These questionnaires vary in complexity and detail. For large open plan environments, the questionnaires are sometimes quite elaborate in investigating the communication lines in an office.

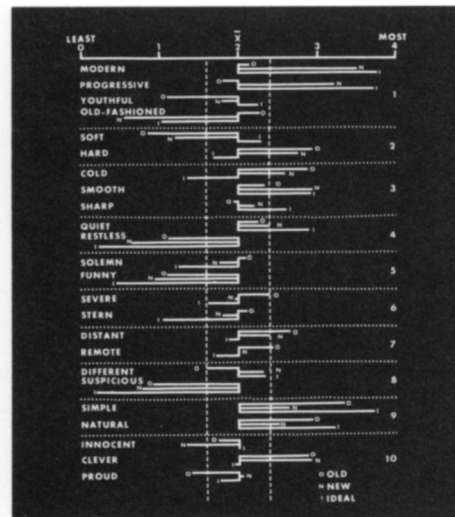
The graphic chart at left, used in the development of Herman Miller's Action Office, illustrates the optimum representation of a total organization, including its facilities and how people function and relate. It was drafted after intensive questionnaires and interviewing. The chart is directly translatable to real life situations.

E2 Polydiagnostic Study: Old vs. New Telephone



How people feel about the telephone was the subject of a polydiagnostic study completed in 1957. The study investigated people's subjective feelings toward three telephone designs. One was an ideal telephone existing only in the subject's mind. Another was a standard model telephone, and the third was a newer model of the time.

Three sets of 15 descriptive adjectives were used. Subjects were asked to choose three terms from each set that best described one of the models. Then they had to choose three more from the remaining 12 in the set, and so on, until there were no more words.



By comparing people's feelings about both the old and the new telephone with the ideal telephone, relatively successful or unsuccessful design changes could be evaluated. An improvement in design is evidenced where the new telephone is rated closer to the ideal than is the old. Design failure is evidenced where the old telephone is judged closer to the ideal than is the new. If people find little difference between the new and the old, then it's obvious that there was no need for the new one.

E3 Evaluating Office Landscape

Almost half the American working population is employed in offices. Billions are spent annually on rentals, equipment and design. Yet despite the revolutionary advent of open plan landscapes in the 60s, there is precious little hard data about whether it performs better than conventional office planning.

That's the argument advanced by Malcolm J. Brookes and Archie Kaplan ("The Office Environment: Space Planning and Affective Behavior," *Human Factors*, 1972, 14(5)), space planners who undertook a field study of the effects of design on office occupants.

The attitudes and perceptions of 120 people in three departments of a major U. S. retail firm were explored to determine whether new company headquarters should have landscaped or conventional offices. The test group was given questionnaires to fill out, and people were interviewed individually, both before they heard about the proposed company move, then again nine months after occupying a pilot landscaped office.

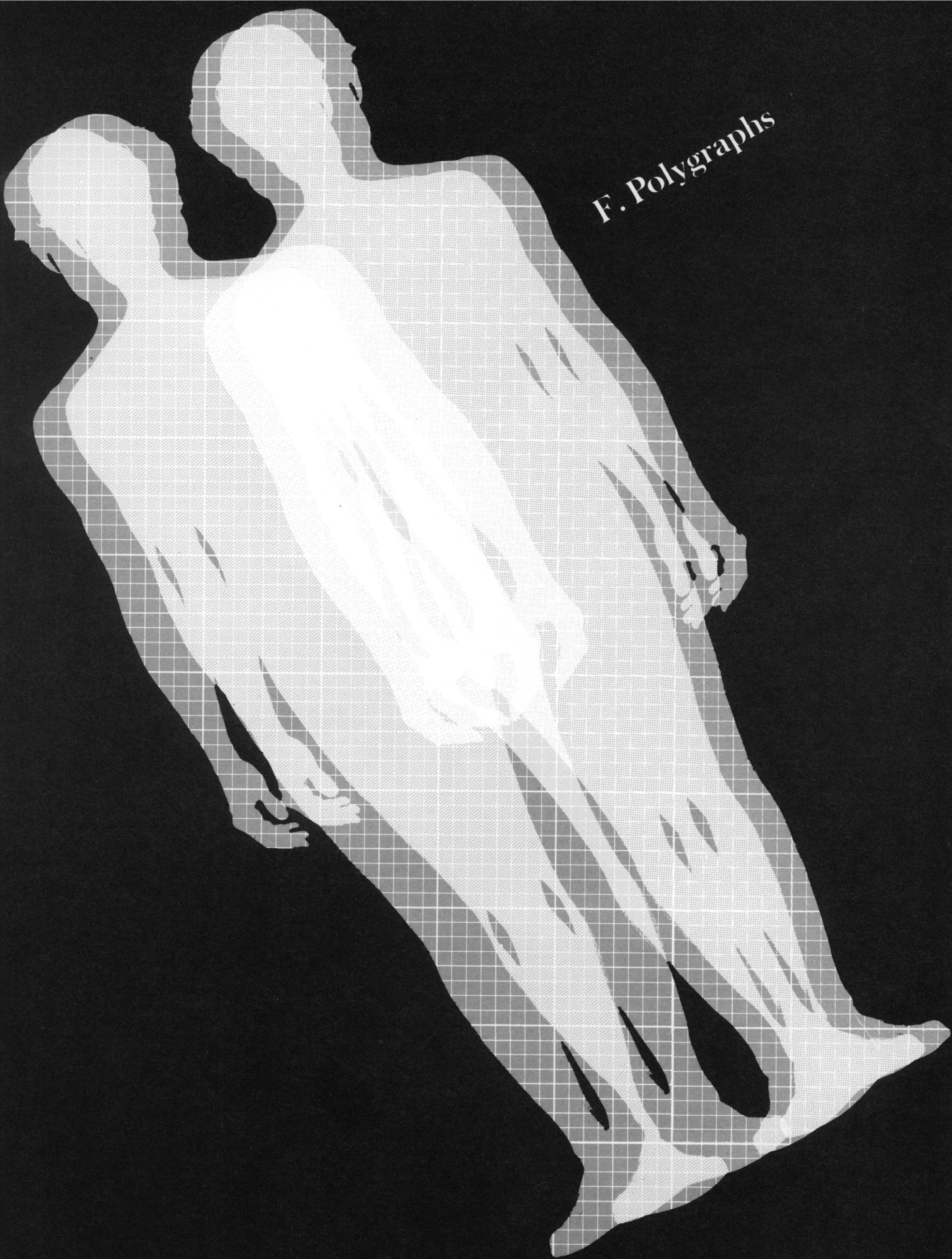
The questionnaire consisted of 45 rated scales asking respondents to describe the offices according to whether they were adaptable, efficient, orderly, noisy, quiet, private, cheerful, hostile, etc. There were a total of 45 semantic scales.

Subjects were also instructed to write down what they most liked and least liked about the office spaces. Afterwards they were interviewed.

Despite the goals and claims of landscape theorists, there appeared to be a small but significant decrease in efficiency. And despite objective measurements which showed that noise levels had decreased significantly (through the addition of acoustical controls like carpeting), most people found the new office noisier than ever.

The conclusion was that there was no strong body of evidence to support the claims of the landscapers, though the study did not pretend to be conclusive about all aspects of office function and design. Another study, organized and administered in a different way, might yield an entirely different set of responses.

F. Polygraphs



F. Polygraphs

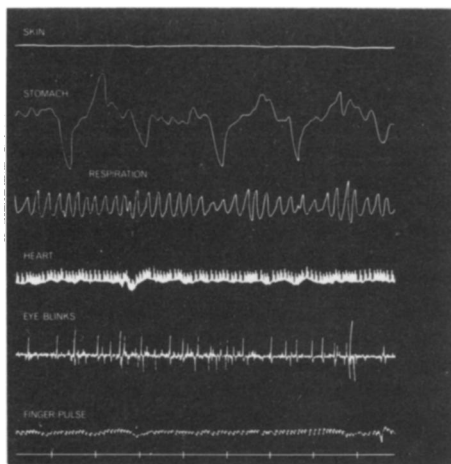
F1 What's a Polygraph?



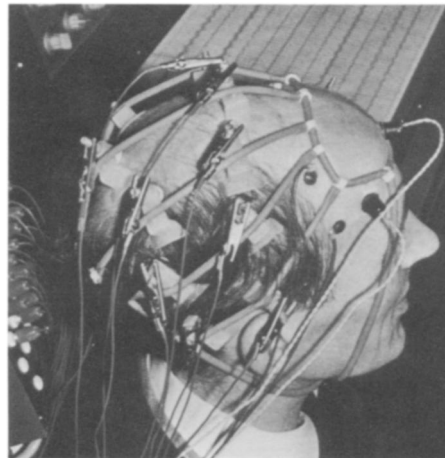
Everybody has heard of lie detector tests: they employ instruments that continuously record physiological processes like blood pressure, pulse rate, respiration, electrical changes in the skin during interrogation of a subject. Modifications in response will occur, it is assumed, if the person knowingly lies.

Any instrument that simultaneously records more than one event or process at a time is a polygraph. These devices monitor not only biological and physiological processes, but natural phenomena like barometric pressure, temperature and humidity. The lie detector is in fact a rather simple polygraph. More sophisticated multi-channel polygraphs relate the ephemeral things of the mind to the measurable reactions of the body. The newest polygraphs contain as many as 16 measurement channels, including those that monitor eye movement, pupil size, muscle tension, brain waves, skin temperature and blood volume in the finger.

Polygraphs are already being used to test the effect of environmental variables on office workers, school teachers, college students, and workers in hazardous conditions.



F2 Electroencephalograph



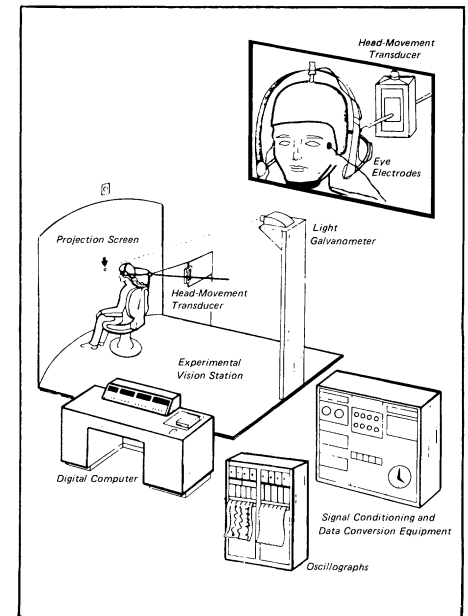
The electroencephalograph, or EEG, consists of electrodes taped to the scalp and attached to a recording device which graphs electrical brain activity. Analysis of brain wave patterns has been used traditionally for diagnostic and therapeutic purposes (as in head injuries or abnormalities in brain function), and also to find out more about the normal workings of the brain. More recently, EEGs have been used to provide information about people's reactions to environmental stimuli: sounds, odors, flashes of light, touch and so on, in which the effect can be traced in brain recordings. Computers have opened the way for new and fine-grained ways of analyzing the brain's electrical activity.

F4 Biofeedback

Biofeedback has been receiving wide notoriety in the popular press within the last few years. The term describes the use of special equipment to make people aware of their body processes (heartbeat, blood pressure, muscle tension, brain waves) and to teach them how to control them.

A person "tunes in" to his bodily processes by hooking up with special equipment that measures things like pulse or muscle tension or skin reaction and gives off a reading by flashing lights, the movement of a needle, the sound of a steady tone. The subject becomes aware of his response mechanisms and then learns how to control them. (No one knows quite how; it just happens.) After practice, the subject doesn't even need equipment to control the pace of his heartbeat or the tension in his body. Mental conditions like anxiety and depression can be controlled as well as physical functions. Subjects can even learn to produce relaxing Alpha brain waves.

F3 Electro-oculography

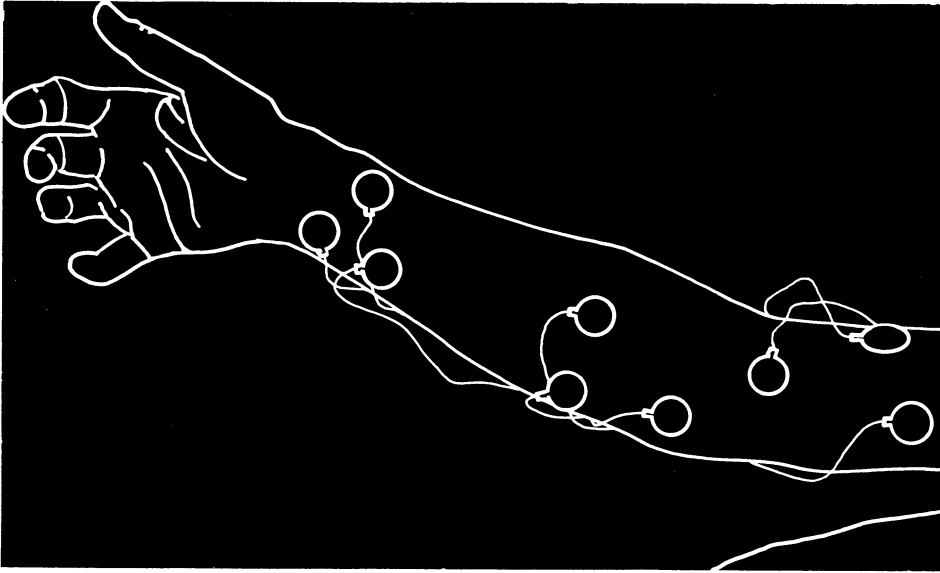


Electro-oculography is a technique of placing electrodes near the muscles of the eye to measure eye movement. Head movement devices can also be attached to monitor head movement. Information derived is applicable to one of the central questions of human factors in man-machine relationships: the way in which operators correct for and adapt to spatial noncompliances in feedback between eye, head and manual movements, and visual input.

For design, biofeedback offers the potential of putting a person in touch with himself and getting new insight into his deep-seated responses to his surroundings. Being in touch with oneself, and having control over one's responses and destiny, potentially may lead one to a new relationship with one's environment, to the demand for a more ordered and constructive relationship to the world.

Before plunging into biofeedbackism, people should note a *caveat emptor*. Do-it-yourself biofeedback machines are booming these days, if the ads in back pages of pop science and youth oriented magazines are reliable evidence. But experts warn laymen enthusiasts that such devices may be dangerous. They may not have been calibrated accurately during manufacture or after shipment, and they may lose their calibration after use. In addition, nobody yet knows what the effects of long-term or intensive conditioning of brain waves and other biological processes may be.

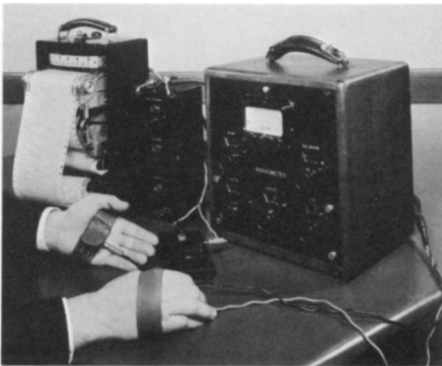
F5 Electromyography



Electromyograms—recording devices for measuring muscle contractions—operate by electrodes placed on the skin over muscles, and connected by wires to a meter, a chart recorder or oscilloscope. They pick up electrical changes accompanying contractions of the underlying muscles. EMGs are used to measure reactions of the human motor system to

such things as noise or other stress-producing agents in the environment. They can measure muscle action during work tasks or recreational activities—like the muscular action during a golf swing. As an aid to analyzing seating posture, they measure muscle tension in the back, shoulders and neck.

F6 GSR Tests



Galvanic Skin Response tests measure the electrical resistance of the skin. Electrodes are placed on the palms of the hands or other electrically conductive areas. If electrical impulses are easily carried by the skin, the subject is usually considered to be in a state of some emotional stress because the skin becomes moist and less resistant to electrical currents.

Changes in the skin's electrical resistance, particularly as a result of interrogation, are interpreted as indications of emotional response. GSR is part of polygraphy, as in lie detector tests.

F7 Behavior-Changing Machines

Today, more than 50 behavior-modification devices exist that deliver rewards or punishments to modify particular types of behavior. They may administer an approving thump to encourage good posture, or a slight shock to inhibit smoking or obsessive thoughts. Usually portable, the devices are attached to humans at one end and a monitor at the other. Besides providing tracking information about physical movement or delivering very mild signals to monitor behavior, these devices can establish two-way communication between sender and recipient. Thus, they can alert him to environmental conditions such as where it's too crowded to park, which freeway is relatively free of traffic, or when a polluted air zone is being entered. According to their supporters, "behavior electronics," "behavioral engineering," or "social instrumentation" may offer potential in guiding and raising people's aesthetic levels of experience.

F8 Sentic Science

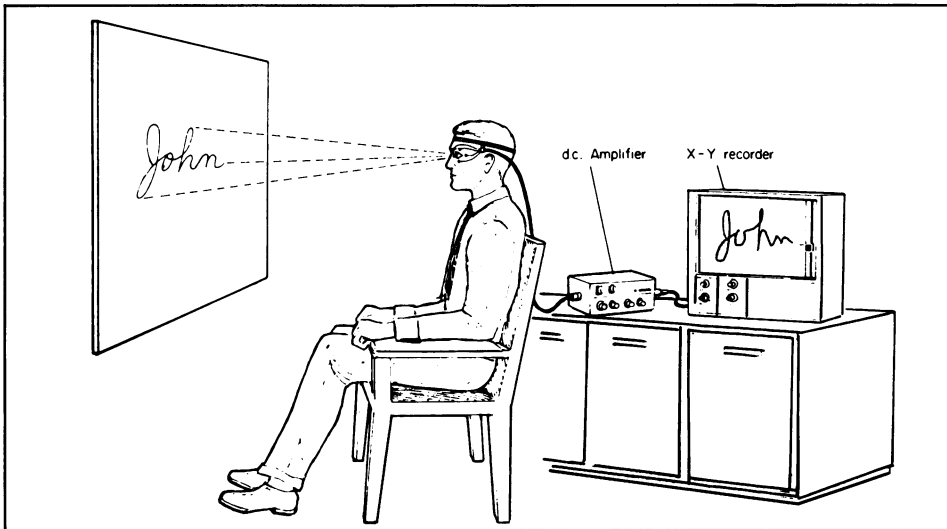


An ordinary pressure-transducer—a standard laboratory device that transforms variations in physical pressure into variations in electrical current by the touch of one fingertip on a button—has been used to graph such human emotional states as love, hate, anger, joy and grief. The device has played a central role in the development of a new science, called sentics, founded by Manfred Clynes. Clynes has attempted to show that each primary emotion or sentic state has its own "command shape" (charted as vertical and horizontal components of finger pressure) that remains fairly constant not only among different individuals but across ethnic and cultural boundaries as well. He argues that command shape is genetically programmed and not culturally based.

In experiments, the subject operates a pressure-transducer with his fingertips and provides a standardized basic measure of the expression of emotions which he is asked to fantasize about. Fantasy is used because it is difficult to study the effects of emotion in a real situation, and because generating and expressing fantasy emotions allows precise, repeated measurement. The emotions are recorded as two wavy lines of ink on a roll of graph paper. The shape resulting is assumed to be a "self-portrait" of the brain program for that emotion. At the same time, Clynes records the muscle potential needed to activate the pressure transducer and specific sentic states. Changes in respiration and heart rate are also monitored and have been found to correlate with change in the emotions.

F. Polygraphs

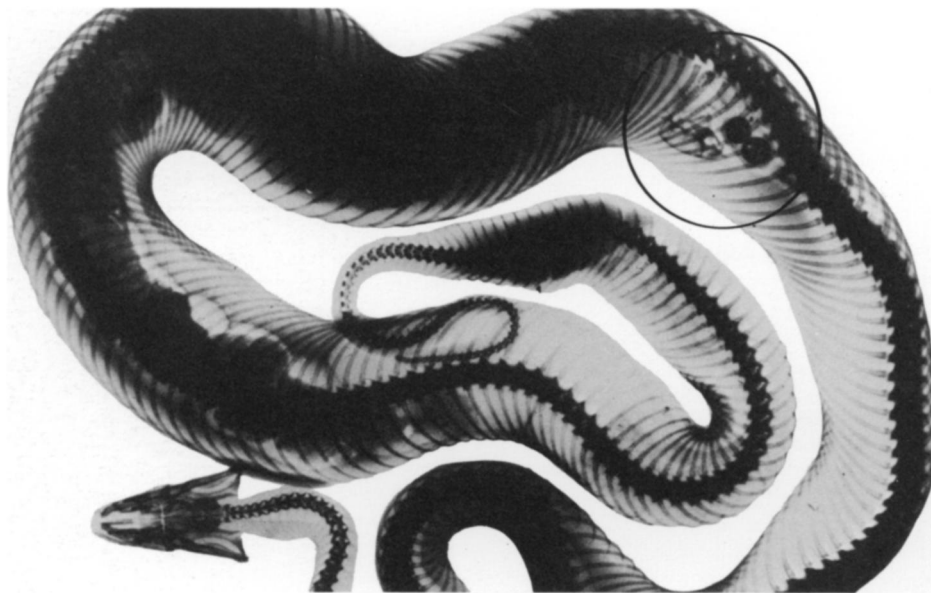
F9 Tracing Eye Movements



Not only can eye movements be measured on an electro-oculograph (EOG), but drawings of eye movements can be traced. A two-dimensional X-Y recorder traces the eye movement as a subject visually scans either the contour of an object or pattern in front of him, or a mental image. The result is a rather wiggly line drawing but it nevertheless defines the image.

The application to design is almost limitless. The designer might imagine outer boundaries of particular forms and record them almost as fast as they were imagined. Greater detail in the form could be imagined later and then superimposed on the first drawing.

F10 Bio-Medical Telemetry



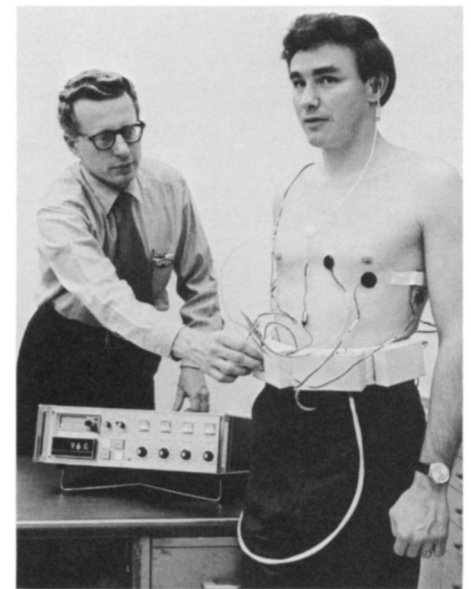
Bio-medical telemetry offers a potentially intriguing method of monitoring human behavior for design research. Already routine in studies of some kinds of human and animal behavior, bio-medical telemetry involves surgically implanting, or externally affixing, a tiny radio transmitter, no larger than a medium-size pill, onto a subject—he may even swallow it, and it will simply pass through the intestinal track without harm—and then recording information signals in a remote receiver. The technique allows the subject to continue his normal activities, free from the disturbance of gadgets or polygraphs attached to his body. (He doesn't even have to know he's transmitting information.)

Transmitters can be specified to transmit data on body processes (heart rate, respiration) movement patterns, internal temperatures and heat flow, chemical concentrations, radiation intensity and so on.

Though the medical applications are foremost, people have also been monitored for other purposes—while working in a hazardous environment, for example, divers and astronauts.

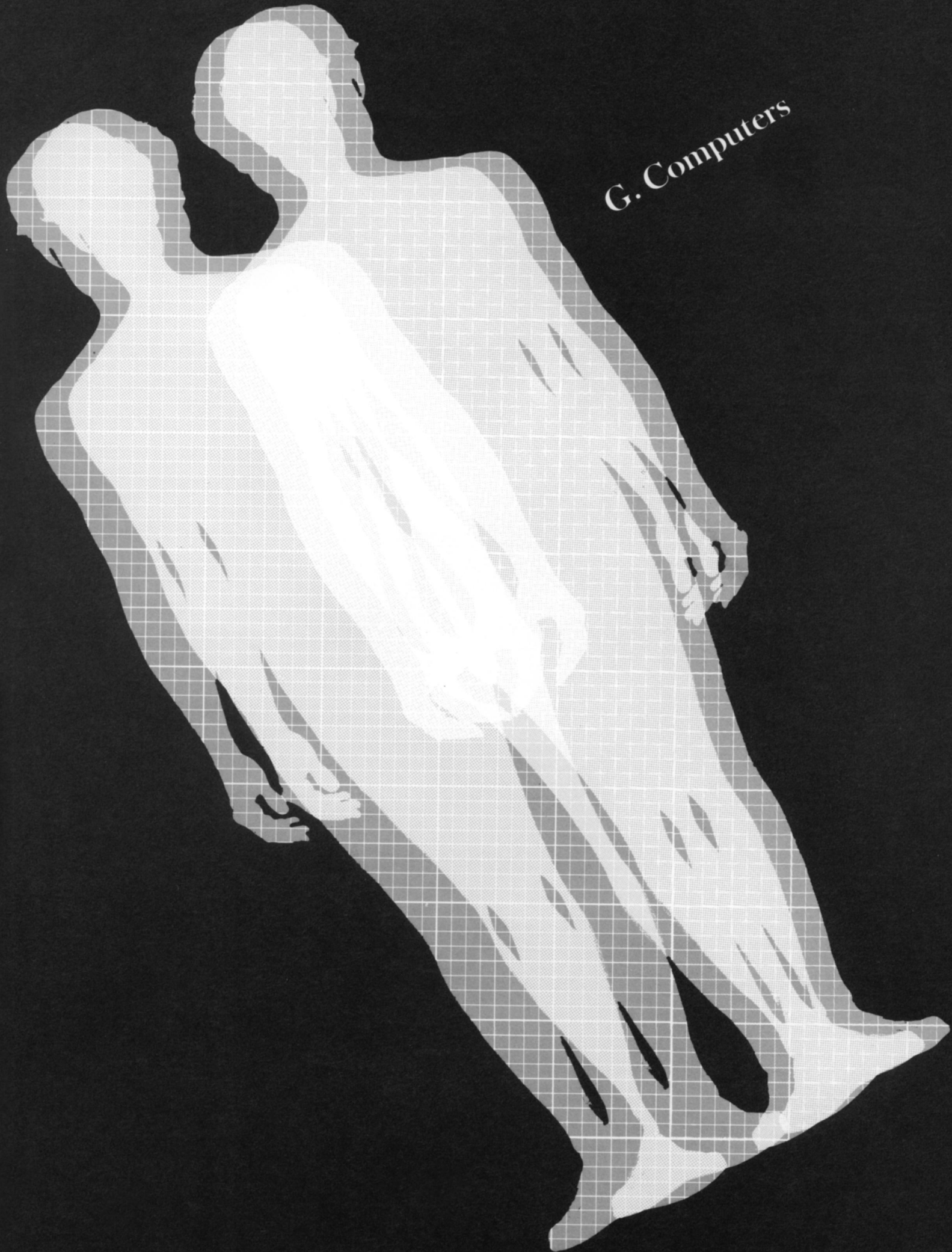
Telemetry can monitor active subjects like truck drivers, tractor operators, airplane crew and passengers, and scores of others about whom it may be useful to have environmental response or measurement data without intruding on their normal behavior.

F11 Biobelt



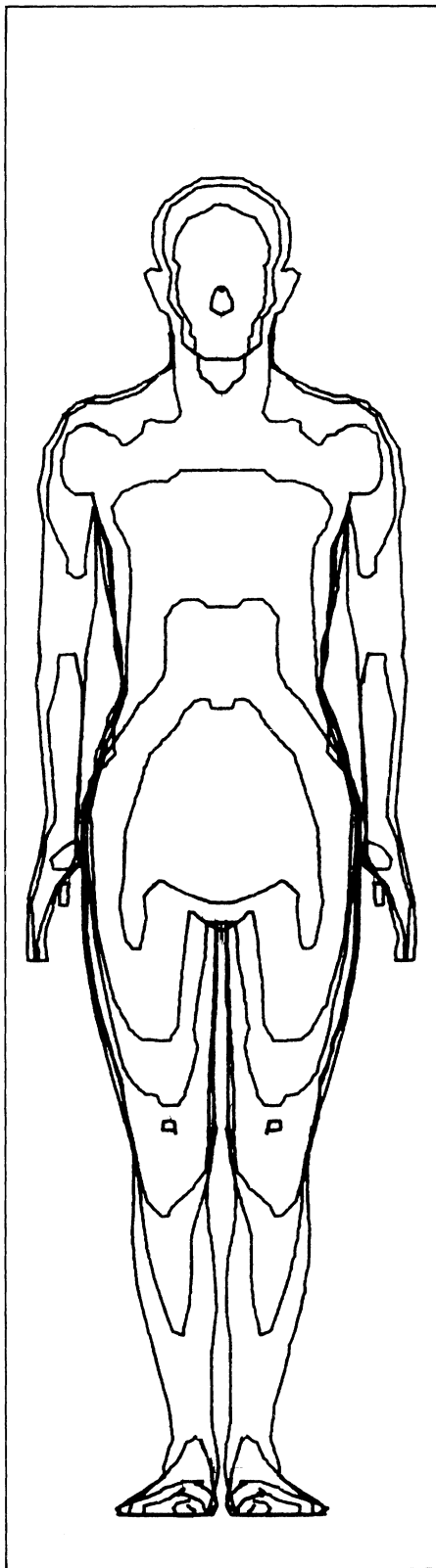
A compact device that can monitor a subject's heart rate and body temperature has been developed at Lockheed Missiles and Space Co. under contract from NASA. The Biobelt is a 2½-inch-wide, lightweight, battery-powered belt that feeds information from any location to a central command unit. Applications range from space astronauts to patients to subjects participating in strenuous work.

G. Computers



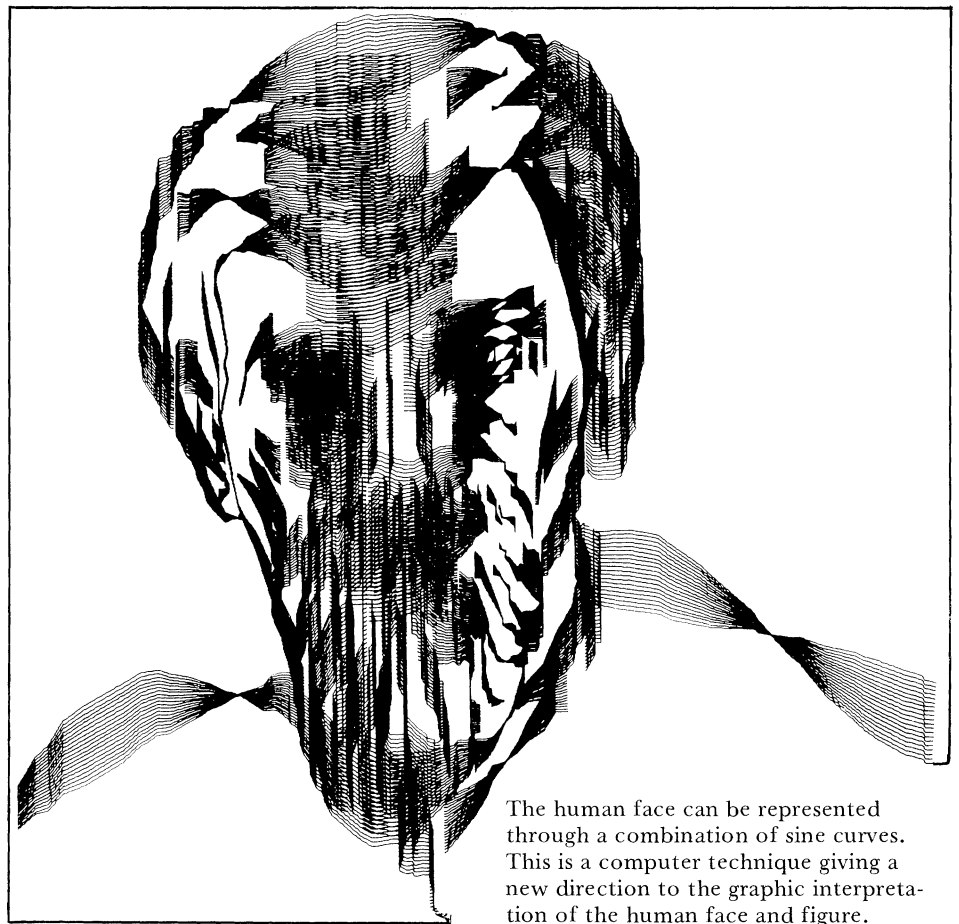
G. Computers

G1 New Forms



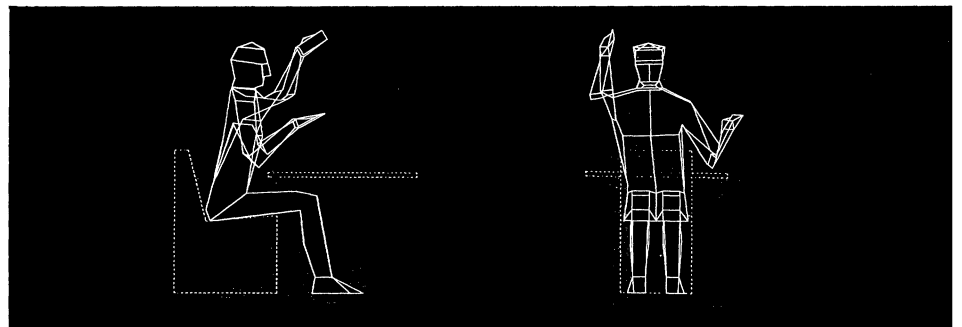
Computer drawing of body forms is now developing into a sort of topographical mapping. The figure can be shown straight on or at a specified angle, walking or doing tasks.

G2 Sine Curve Man



The human face can be represented through a combination of sine curves. This is a computer technique giving a new direction to the graphic interpretation of the human face and figure.

G3 Biokinematics



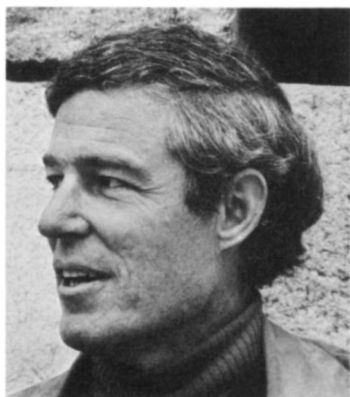
Man-machine systems are becoming increasingly complex. Their design must incorporate detailed anthropometric data. Close attention should be paid to spatial relationships between the operator and his working environment; devices like ergospheres and drawing-board manikins may be used. Even so, physical and visual interference problems may not be investigated until mock-ups or prototypes are built and field-tested. At that point the design may be too expensive to change.

To help evaluate spatial configuration early in the design process, Kerry E. Kilpatrick (*Human Factors*, 1972, 14) has proposed the use of a computerized biokinematic model of the operator to simulate the spatial relationships between the operator and the workplace for a given configuration and task sequence.

Computer graphics shown here represent a seated operator. The model can help predict the dynamic spatial configurations of an operator performing typical task sequences.

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Niels Diffrient is a partner in the industrial design firm of Henry Dreyfuss Associates in New York City. A principal interest of this organization has long been "designing for people" in all their products ranging from razors to skyscrapers and telephones to airplane interiors.

Several years ago, Diffrient started explorations in the sciences to enlarge on the traditional human engineering knowledge available to designers. A cross section of the information he has gathered is contained in this issue of *Design Quarterly*. Included are some examples of publications and work from the Dreyfuss office. Diffrient is co-author of *Humanscale 1/2/3* and many articles on design.

A graduate of Cranbrook Academy, Diffrient started his career in the office of Eero Saarinen and also worked with Marco Zanuso in Italy. He taught design for eight years at the University of California in Los Angeles. He is a Fellow and a board member of the Industrial Designers Society of America and is on the board of the American Institute of Graphic Arts and the International Design Conference in Aspen.

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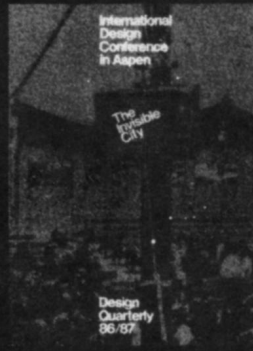
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