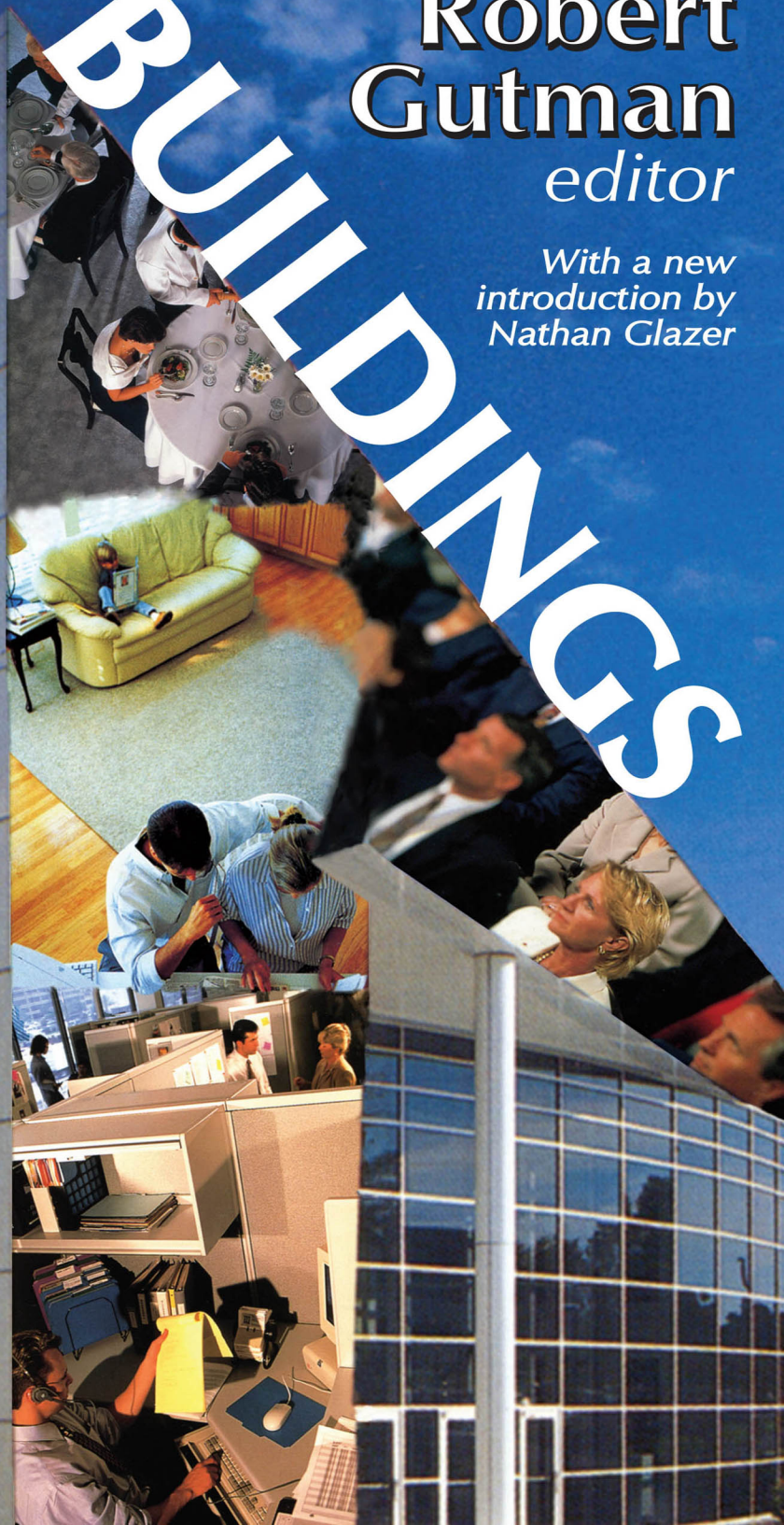


PEOPLE AND

BUILDINGS

Robert
Gutman
editor

*With a new
introduction by
Nathan Glazer*



**PEOPLE AND
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To the Memory
of
JOHN MADGE (1914-1968)



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Preface

There is at the present time an enormous interest in relating the behavioral sciences to the design disciplines. Most schools of architecture now require their students to take courses in the behavioral sciences, with particular attention being paid to urban sociology. Sociologists and social psychologists are being added to the faculties of architecture schools, where they offer lectures and seminars and participate as programming specialists and design critics in studio courses. For a number of years sociologists and other behavioral scientists in many European countries have collaborated with architects and planners in the design work undertaken by governmental ministries, and more recently have been participating in the work of private design firms. Similar developments are now occurring in the United States. Within the last few years, in both this country and abroad, several new magazines and journals have been published that are specifically devoted to reporting on the interaction between the behavioral sciences and the design professions.

The demand for collaboration was initiated by the design professions. The behavioral science disciplines have not always responded helpfully, but reciprocity is now beginning to occur. A few graduate departments in the behavioral sciences have begun to offer specialized doctoral training programs in what is coming to be called "environmental psychology" or "environmental sociology," and papers and monographs dealing with this subject have begun to appear in increasing numbers. The meetings of the American Sociological Association, the American Psychological Association, and the Society of Applied Anthropology now regularly include sessions in which the problems of environmental studies are discussed. Each of these organizations has developed liaison activities with the Interprofessional Council on Environmental Design, an organization representing six design groups, including the American Institute of Architects, the American Institute of Planners, and the American Society of Landscape Architects.

The interest in joining the resources of the social and design disciplines arises from several sources. Probably the major factor in this process is the realization by the design professions that the intellectual traditions of architecture and planning are simply not adequate for grasping the complexity of the building needs of urbanized and industrialized societies. Architects find themselves facing tasks and clients for which their training did not prepare them. Instead, for example, of designing villas and palaces for the wealthy, architects must now design projects to house the black and disad-

vantaged populations. Where once they were hired by a college to propose a scheme for one or two dormitories, a library, or an administration building, very often now designers are expected to take charge of the design of a complete campus. In these settings architects encounter questions that they are unable to answer through informal programming techniques—questions about the life styles of the poor, about the housing needs of different racial groups, about the ultimate purposes of a college or university—and they turn to the behavioral scientist in the hope that he can provide the answers.

The design professions are also setting higher standards of social responsibility for themselves. The modern movement in architecture has been characterized by a utopian thrust, but the aspiration to increase welfare and improve justice demands more than good intentions. Architects evidence an increasing desire to be sure ahead of time that the buildings they design will have a beneficial effect upon the ultimate users. Of course, the architect's greater interest in the users' requirements is also a response to the increasing articulateness of clients and users. With building resources becoming scarcer at the same time that unmet needs for shelters are apparently increasing, those who pay for and use buildings want clear evidence that the final product will satisfy their needs.

At the same time that designers have become more self-conscious, behavioral scientists have developed a new concern for the practical applications of their research. During the years immediately following World War II, sociologists and psychologists often argued that their main task was to describe and explain the principles that govern human behavior, whereas the application of that knowledge was the responsibility of the policy makers, administrators, and the public. It became evident, however, to many behavioral scientists that their reports were being used in pursuit of goals they did not support. Furthermore, they came to realize that much of their research, for all of its contribution to knowledge, was not really apposite to the problems of industrialized society. As a result, many more behavioral scientists now wish to focus their research efforts on contemporary social problems and to try to maintain control over the development and use of their investigations.

The social disciplines also exhibit a renewed awareness of the relevance of environmental factors to human behavior. A body of coherent theory and research is now emerging that examines those needs of the human organism and of group functioning that are best satisfied through the provision of specific conditions in the physical, as distinguished from the social, environment. Examples of such studies are those based on the need for personal space and for territory. Both of these needs, it is coming to be thought, must be met if organisms and groups are to function effectively, and both needs imply certain constraints on the form of buildings and urban settlements. Investigations are also being carried out, particularly within the field of anthropology, on the communication function of symbol systems. Some of these investigations take into account the role of architecture and urban form as "languages," through which men and groups define the boundaries of relevant social interaction and through which the social values and norms

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that produce social order and integration are reinforced. One can also point to the expansion of research in social biology, epidemiology, and social control. Studies in these fields consider the influence of the physical environment on physiological stress, mental illness, and symptoms of social pathology, such as family disorganization, urban violence, and delinquency.

It is important to emphasize that these developments are not taking place primarily because of demands from the design professions for useful behavioral knowledge. In large part they reflect the sense within the behavioral sciences that the tradition that assumed that human personality was formed by culture and that the causes of social distress could therefore be found in social and cultural conditions was an extreme overreaction against an earlier period of evolutionary and biological determinism in American social theory. As in many other fields concerned with human behavior, the idea has suddenly taken hold that many of our social problems may stem from a failure to be sensitive to the limits on human progress and perfectability. To put the same thought in a less negative light, civilization can advance further only by respecting the constraints that the nature of the organism and the nature of the environment impose on human adaptability.

Those of us who have tried to work in the middle ground between environmental design and sociology are aware of the many issues about which little is known and of how much about the interaction between men, society, and architecture remains to be understood. A tremendous investment in research must be forthcoming if the potential utility of the behavioral sciences to design is to be fully exploited. But the situation is not as impoverished as some critics and skeptics would have us believe. A good deal of empirical research has been undertaken on many problems, and many potentially productive ideas and concepts have been developed. This work, however, is not widely known or easily accessible. It is this fact that constitutes the rationale for this collection of articles, essays, and selections from books and research monographs.

I have tried to assemble some of the most illuminating material in five important areas of converging interest between the social and design disciplines. The first of these areas deals with current research and theory on human anatomy and physiology, on man's sensory apparatus and his behavior in space, and on the requirements that these characteristics generate for the design of buildings. The second area deals with the impact of spatial organization on social interaction and group relationships, as revealed through studies of friendship patterns, communication and privacy. Part Three of the book discusses environmental influences on physical and mental health, with particular attention to the role of housing conditions, noise, esthetic surroundings, urban relocation and overcrowding. A fourth area is concerned with the work that anthropologists, functional sociologists, and psychologists have done in demonstrating the significance of architecture as the expression of social values and the reinforcement for cultural patterns. Part Five includes a series of readings that illustrate the ways in which architects and behavioral scientists are applying a variety of these ideas and approaches to the practical problems of the design process.

The selections have been written primarily by behavioral scientists and designers working in the behavioral science mode. The selections within each part have been arranged to provide an ordered argument or exploration of the general topic with which the part as a whole deals. To facilitate the reader's appreciation of the argument, each selection is preceded by a short prefatory statement. In view of the fact that a single article or preface can hardly be representative of the depth of the literature that has developed around an argument, I have included an annotated bibliography, which is keyed to the selections through the use of subheadings.

The resulting collection is not intended as a manual or handbook to guide design decisions on specific projects, nor is it intended to be just an assemblage of interesting articles dealing with the intriguing issues that arise when the behavioral sciences confront architecture. It has a polemical aim as well: namely, by the selection, organization, and arrangement of the readings and introductory notes, to urge both architects and behavioral scientists to recognize certain features of the phenomena to which their work is addressed. These points can be summarized as follows:

1. Architecture is a legitimate topic of inquiry for the social sciences. It is an element in human culture and social organization to which all people are responding even when they are unaware of it.

2. Architectural phenomena involve a range of properties—from the subtle and elusive features of symbolism and sensual qualities at one end to the utilitarian qualities of measurable space and ambient conditions at the other—and *all* of these properties must be kept in view if one is to achieve a comprehensive understanding of the effect of the built environment on man and society.

3. Sensitivity to the totality of buildings and environments implies, in turn, recognition of the fact that architecture connects with the full range of human qualities, capacities, instincts, feelings, needs, and dispositions, including the measurable needs for light and air, the experimentally observable functions of seeing and hearing, and the experientially observable demands for communication and group membership, as well as the cultural need for strong integrative symbols and the individual need for a sense of place. The latter requirements probably cannot be directly observed or measured, but they can be inferentially determined from the study of human actions and the linguistic and symbolic products of society.

4. Designers and others who are anxious to apply the insights and findings of the behavioral sciences to the creation of built environments must be careful to recognize the variety of interconnections between buildings and men. They should not merely use the findings from a selected sample of studies to justify an approach to architecture that may in its concern for behavioral requirements be just as restrictive as the older design methodology was in its concern for symbolic and esthetic features.

5. Finally, behavioral scientists and architects who collaborate in joint efforts should realize that full appreciation of the behavioral science tradition demands using its critical apparatus not only to consider the spatial organization and building specifications that are appropriate for reinforcing existing behavior patterns and preferences but also to evaluate and, if necessary, to

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encourage the reform of the goals and purposes that the existing patterns imply.

This volume grows out of my experience in working with architects, in teaching sociology to architecture students, and in discussing architectural problems with sociologists. I am especially grateful to Peter Cowan, Peter Eisenman, Kenneth Frampton, Robert Geddes, and Robertson Ward Jr. for many valuable discussions about architecture, building, design, and society; to William L. Gum and Irving Kristol for encouraging me to put this volume together; and to Angela G. Irby for her guidance in making available the resources of Princeton University's Urban and Environmental Studies library. The editorial and bibliographical assistance of Barbara Westergaard has been invaluable. My wife, Sonya Rudikoff Gutman, has been a sympathetic critic and reader. I owe a special debt to the late John Madge for his help in getting me to appreciate the sociology of architecture and I would like to dedicate this book to his memory.

R. G.

Princeton, New Jersey
March, 1971



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Introduction to the Transaction Edition

NATHAN GLAZER

Robert Gutman was one of the few social scientists of his generation who spent most of his career teaching students of architecture in a school of architecture. This collection, with extended introductions to its various sections written by Gutman, appeared at a time when the contribution of the behavioral sciences to architecture and urban design had established itself with a series of major works that had outlined an important field for both the behavioral sciences and architecture and urban design. In 1972, we already had available to us some of the major work of Erving Goffman, Michael Young, Herbert Gans, Kevin Lynch, Jane Jacobs, Robert Sommer, Edward Hall, William H. Whyte, Jr., Amos Rapoport, Christopher Alexander, and many other sociologists, social psychologists, and anthropologists. Some of those I listed were not credentialed social scientists—in the sense of holding degrees in one of the social sciences—but all worked with some of the perspectives of social science disciplines. This was a tradition already established by Lewis Mumford with his monumental works on the city and his criticism of building in New York City; Mumford on occasion called himself a sociologist, though he was without degrees.

It seemed when *People and Buildings* was originally published that a new field was being established. From its first flourishing, as exhibited in this book, one expected that it would and must extend further, as behavioral scientists became an indispensable part of the teams engaged in the design of buildings and the building of cities. As Gutman wrote in his introduction: “There is at the present time an enormous interest in the relation of behavioral scientists to the design disciplines. Most schools of architecture now require their students to take courses in the behavioral sciences.... Sociologists and social psychologists are being added to schools of architecture....” And so on. But it turned out this was written at a high point in the relationship of the behavioral sciences to architecture and urban design, rather than at the beginning of a sustained relationship that would go further. That is why this collection of 1972 retains its value in 2009: little would have to be added to it to outline the possible contributions of the social sciences to architecture and urban design. To the classic figures who had already done much good work at the time this book was published, there are few who would have to be added to make this collection current today.

One evidence of this relative paucity of important new work since the 1970s can be found in the most recent edition of the valuable book

Inquiry by Design, by John Zeisel, which sums up the contribution of the behavioral sciences to architecture and urban design. Zeisel was one of the sociologists who were teaching in a school of architecture—the Harvard Graduate School of Design—in the 1970s. The first edition of *Inquiry by Design*, published in 1981, bore the subtitle, “Tools for Environment-Behavior Research.” Revised for a new and updated edition in 2006, it carries the subtitle, “Environment/Behavior/Neuroscience in Architecture, Interiors, Landscape, and Planning.” Despite the addition of a chapter on “The Brain’s Environment System,” drawing on the explosion of new research in the cognitive sciences, this most recent edition adds little to our knowledge and understanding beyond where they stood at the time when it was originally published. There are few major figures to be added to those who first explored the connection between the behavioral sciences and the art of building in the ’50s, ’60s and ’70s.

That first promise of a close and continuing relationship between the behavioral sciences and architecture and urban design was not sustained. As Gutman himself wrote some time after he edited *People and Buildings*, “We social and behavioral scientists must recognize that many of our intellectual orientations are not popular among architects now. Architects are less interested in designing buildings around user requirements and programmatic concerns. These orientations are seen as manifestations of a positivist and empiricist bias.” Gutman went on to characterize the theories that then (and now) most interested architects: theories that “investigated the role of symbolism in culture and society ... or that examined the impact of social change on culture (e.g., Marxist humanism and critical sociology).”

But of course, in describing this relative decline in interest among architects in the contribution of the behavioral sciences, Gutman had in mind the architecture students he was teaching, and the most admired and newsworthy architects of the day that were their models. There is no way, in architecture and urban design, in getting too far away from “user requirements,” from human concerns, and from the way people react to and make use of buildings and the urban built environment. It is true architecture is also a design discipline, and the role of aesthetics and new notions of what is beautiful or, on occasion, striking, must play a role in it. Architecture must also deal with practical needs, and symbolism and theory, less bounded by the needs of reality, must always, except in the rare cases of exceptional clients and architects, play a muted role. When symbolism and theory outweigh practical needs, the architect may enjoy the worldwide publicity that many star architects now enjoy. However, for most architects engaged in designing houses, office space, manufacturing and research space, schools, even ceremonial spaces of various kinds, the practical, and the contribution of those disciplines that examine how people react, what they expect, where they are comfortable, will have to play a major role. For this larger world of architecture—building the spaces in which we live, work, learn, and play—the perspectives developed and presented in *People and Buildings* are still invaluable, almost four decades after its initial publication.

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PART ONE

Behavioral Constraints on Building Design



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The Aesthetics of Function

JAMES MARSTON FITCH

It is common in design circles to claim that architectural phenomena are enormously complex. Usually what this assertion means is that a building is made up of so many different kinds of systems and is subject to such a wide variety of technological, esthetic, and social constraints that it is often exceedingly difficult to resolve a design problem. The notion of architectural complexity, however, also applies to the relations between the built environment and society. Many different aspects of architecture and a variety of human needs and group processes are interconnected. For example, the visual qualities of architecture, its geometrical forms, the environmental control systems of buildings, the sheer provision of two-dimensional surfaces and three-dimensional spaces—all these aspects of architecture may become meaningful to people and influence their behavior. In the other direction, there are a great number of biological, psychological, and cultural needs that architecture and the environment have the capacity to satisfy. At the least, many of these needs can be satisfied through social mechanisms and social forms that architecture can help to organize and regulate. These needs are related to specific characteristics of the human organism, including man's anatomical structure and physiology, his personality and unconscious mental life, his perceptual apparatus, his use of symbol systems for communication, and his dependence upon group interaction for civilized survival.

Fitch's selection is an attempt to provide a conceptual framework that will alert the student of architectural phenomena to the many different ways in which the built environment and man are related. His argument is particularly directed against the traditional emphasis in architectural training and criticism on the visual qualities of buildings. Fitch counters this view by describing the linkages between the human being's response to the environment and his full perceptual mechanism. The full perceptual mechanism includes not only the visual and auditory senses but the gustatory, olfactory, and haptic responses, and the sense of spatial orientation as well. This perspective leads Fitch to a definition of architecture as a "third environment" that mediates between the hazards of the natural world and of civilized society and the internal breathing, feeling, seeing, and hearing processes of man.

Two additional polemical thrusts underlie Fitch's argument. One is the

Reprinted from James Marston Fitch, "The Aesthetics of Function," *The Annals of the New York Academy of Sciences* 128, article 2 (September 27, 1965): 706-714.

view, repeated in several selections in this book, that until basic anatomical and physiological needs are better satisfied through building designs, human societies cannot really afford the luxury of an interest in the esthetic properties of architecture. The second is the demand for an experimental architecture that will also be experiential, that is to say, that will be responsive to the full range of human needs and will call upon the total sensory capacity of the human organism.



A fundamental weakness in most discussions of aesthetics is the failure to relate it to experiential reality. Most literature on aesthetics tends to isolate it from this matrix of experience, to discuss the aesthetics process as though it were an abstract problem in logic.

Art and architectural criticism suffers from this conceptual limitation. This finds expression in a persistent tendency to discuss art forms and buildings as though they were exclusively visual phenomena. This leads to serious misconceptions as to the actual relationship between the artifact and the human being. Our very terminology reveals this misapprehension: we speak of art as having "spectators," artists as having "audiences." This suggests that man exists in some dimension quite separate and apart from his artifacts; that the only contact between the two is this narrow channel of vision or hearing; and that this contact is unaffected by the environmental circumstances in which it occurs. The facts are quite otherwise and our modes of thought should be revised to correspond to them.

Art and architecture, like man himself, are totally submerged in an exterior environment. Thus they can never be felt, perceived, experienced in anything less than multi-dimensional totality. A change in one aspect or quality of the environment inevitably affects our response to, and perception of, all the rest. The primary significance of a painting may indeed be visual; or of a concert, sonic: but perception of these art forms occurs in a situation of experiential totality. Recognition of this is crucial for aesthetic theory, above all for architectural aesthetics. Far from being based narrowly upon any single sense of perception like vision, architectural aesthetics actually derives from the body's *total* response to, and perception of, its external physical environment. It is literally impossible to experience architecture in any "simpler" way. *In architecture, there are no spectators: there are only participants.* The body of architectural criticism which pretends otherwise is based upon photographs of buildings and not actual exposure to architecture at all.

Life is coexistent and coextensive with the external natural environ-

ment in which the body is submerged. The body's dependence upon this external environment is absolute—in the fullest sense of the word, *uterine*. And yet, unlike the womb, the external natural environment does not afford optimum conditions for the existence of the individual. The animal body, for its survival, maintains its own special internal environment. In man, this internal environment is so distinct in its nature and so constant in its properties that it has been given its own name, "homeostasis." Since the natural environment is anything but constant in either time or space, the contradictions between internal requirements and external conditions are normally stressful. The body has wonderful mechanisms for adjusting to external variations, e.g., the eye's capacity to adjust to enormous variations in the luminous environment or the adjustability of the heat-exchange mechanism of the skin. But the limits of adaptation are sharp and obdurate. Above or below them, an ameliorating element, a "third" environment, is required.

Before birth, the womb affords this to the foetus. But man, once born into the world, enters into a much more complex relationship with his external environment. Existence now is on two distinct levels, simultaneously and indissolubly connected, the metabolic and the perceptual. (Figure 1-1.) The metabolic process remains basic. It is at once a "preconscious" state and the material basis of consciousness. Many of life's fundamental processes transpire at this level: heart beat, respiration, digestion, hypothalamic heat exchange controls, etc. Metabolic disturbance occurs only when the external environment begins to drop below the minimal, or rise above the maximal, requirements of existence. And sensual perception of the external environment comes into play only *after* these minimal requirements are met. (As a matter of fact, loss of consciousness is one of the body's characteristic responses to environmental stress—drop in oxygen or pressure, extremes of heat and cold, etc.)

Metabolic process then is clearly the precondition to sensory perception, just as sensory perception is the material basis of the aesthetic process. But the aesthetic process only begins to operate maximally, i.e., as a uniquely human faculty, when the impact upon the body of all environmental forces are held within tolerable limits (limits which, as we have said, are established by the body itself). Thus, we can construct a kind of experimental spectrum of stress. The work of psychiatrists like Dr. George Ruff at the University of Pennsylvania establishes the lower end of this spectrum: sensory overloading is destructive, first of balanced judgments, then of rationality itself.¹ But

The Relationship between Man and His Environment

Organism

Environmental Factors

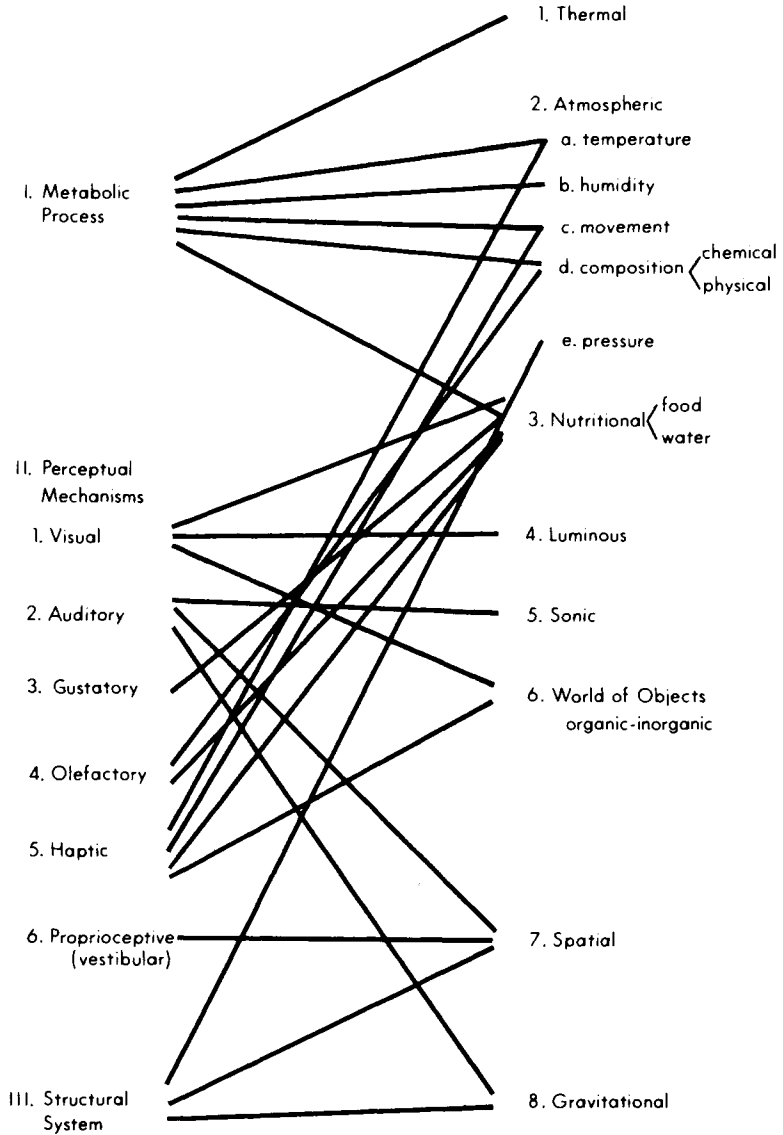


Figure 1-1 The relationship of the metabolic process to its environmental support is literally uterine. And since the process is the substructure of consciousness, sensory perception of changes in the environment in which the body finds itself is totally dependent upon satisfaction of the body's minimal metabolic requirements.

the other end of this spectrum proves equally destructive. Investigations of the effects of sensory deprivation, such as those carried on by Dr. Philip Solomon of the Harvard Medical School, indicate that too little environmental stress (and hence too little sensory stimulation) is as deleterious to the body as too much. Volunteer subjects for Dr. Solomon's experiments were reduced to gibbering incoherence in a matter of a few hours by being isolated from all visual, sonic, haptic and thermal stimulation.²

Psychic satisfaction with a given situation is thus directly related to physiologic well-being, just as dissatisfaction must be related to discomfort. A condition of neither too great nor too little sensory stimulation permits the fullest exercise of the critical faculties upon that situation or any aspect of it. But even this proposition will not be indefinitely extensible in time. As one investigator has observed in a recent paper (significantly entitled *The Pathology of Boredom*)³: "variety is not the spice of life; it is the very stuff of it." The psychosomatic equilibrium which the body always seeks is dynamic, a continual resolution of opposites. Every experience has built-in time limits. Perception itself has thresholds. One is purely quantitative; the ear cannot perceive sounds above 18,000 cycles per second; the eye does not perceive radiation below 3,200 Angstroms. But another set of thresholds are functions of time: constant exposure to steady stimulation at some fixed level will ultimately deaden perception. This is true of many odors, of "white" sounds and of some aspects of touch.

Of course, even more important facts prevent any mechanistic equating of physical comfort with aesthetic satisfaction. For while all human standards of beauty and ugliness stand ultimately upon a bedrock of material existence, the standards themselves vary astonishingly. All men have always been submerged in the environment. All men have always had the same sensory apparatus for perceiving changes in its qualities and dimensions. All men have always had the same central nervous system for analyzing and responding to the stimuli thus perceived. The physiological limits of this experience are absolute and intractable. Ultimately, it is physiology, and not culture, which establishes the levels at which sensory stimuli become traumatic. With such extremes—high temperatures, blinding lights, cutting edges and heavy blows, noise at blast level, intense concentrations of odor—experience goes beyond mere perception and becomes somatic stress. Moreover, excessive loading of any one of these senses can prevent a balanced assessment of the total experiential situation. (A temperature of 120 degrees F. or a sound level of 120 decibels can render the most beau-

tiful room uninhabitable.) But as long as these stimuli do not reach stressful levels of intensity, rational assessment and hence aesthetic judgments are possible. Then formal criteria, derived from personal idiosyncrasy and socially-conditioned value judgments, come into play.

The value judgments that men apply to these stimuli, the evaluation they make of the total experience as being either beautiful or ugly, will vary: measurably with the individual, enormously with his culture. This is so clearly the case in the history of art that it should not need repeating. Yet we constantly forget it. Today, anthropology, ethnology and archaeology alike show us the immense range of aesthetically satisfactory standards which the race has evolved in its history: from cannibalism to vegetarianism in food; from the pyramid to the curtain wall in architecture; from polygamy and polyandry to monogamy and celibacy in sex; from hoopskirt to bikini in dress. Yet we often act, even today, as if our own aesthetic criteria were absolutely valid instead of being, as is indeed the case, absolutely relative for all cultures except our own.

Our aesthetic judgments are substantially modified by non-sensual data derived from social experience. This again can be easily confirmed in daily life. It is ultimately our faith in antiseptic measures that make the immaculate white nurses, uniforms and spotless sheets of the hospitals so reassuring. It is our knowledge of their cost which exaggerates the visual difference between diamonds and crystal, or the gustatory difference between the flavor of pheasant and chicken. It is our knowledge of Hitler Germany which has converted the swastika from the good luck sign of the American Indians to the hated symbol of Nazi terror. All sensory perception is modified by consciousness. Consciousness applies to received stimuli, the criteria of digested experience, whether acquired by the individual or received by him from his culture. The aesthetic process cannot be isolated from this matrix of experiential reality. It constitutes, rather, a quintessential evaluation of and judgment on it.

Once in the world, man is submerged in his natural external environment as completely as the fish in water. Unlike the fish in his aqueous abode, however, he has developed the capacity to modify it in his favor. Simply as an animal, he might have survived without this capacity. Theoretically, at least, he might have migrated like the bird or hibernated like the bear. There are even a few favored spots on earth, like Hawaii, in which biological survival might have been possible without any modification. But, on the base of sheer biological existence, man builds a vast superstructure of institutions, processes

and activities: and these could not survive exposure to the natural environment even in those climates in which, biologically, man could.

Thus man was compelled to invent architecture in order to become man. By means of it he surrounded himself with a new environment, tailored to his specifications; a "third" environment interposed between himself and the world. Architecture, is thus *an instrument whose central function is to intervene in man's favor*. The building—and, by extension, the city—has the function of lightening the stress of life; of taking the raw environmental load off man's shoulders; of permitting *homo fabricans* to focus his energies upon productive work.

The building, even in its simplest forms, invests man, surrounds and encapsulates him at every level of his existence, metabolically and perceptually. For this reason, it must be regarded as a very special kind of container. (Figure 1-2.) Far from offering solid, impermeable barriers to the natural environment, its outer surfaces come more and more closely to resemble permeable membranes which can accept or reject any environmental force. Again, the uterine analogy; and not accidentally, for with such convertibility in the container's walls, man can modulate the play of environmental forces upon himself and his processes, to guarantee their uninterrupted development, in very much the same way as the mother's body protects the embryo. Good architecture must thus meet criteria much more complex than those applied to other forms of art. And this confronts the architect, especially the contemporary architect, with a formidable range of subtle problems.

All architects aspire to give their clients beautiful buildings. But "beauty" is not a discrete property of the building: it describes, rather, the client's response to the building's impact upon him. This response is extremely complex. Psychic in nature, it is based upon somatic stimulation. Architecture, even more than agriculture, is the most environmental of man's activities. Unlike the other forms of art—painting, music, dance—its impact upon man is total. Thus the aesthetic enjoyment of an actual building cannot be merely a matter of vision (as most criticism tacitly assumes). It can only be a matter of total sensory perception. And that perceptual process must in turn have adequate biological support. To be truly satisfactory, the building must meet *all* the body's requirements, for it is not just upon the eye but upon the whole man that its impact falls.

From this it follows also that the architect has no direct access to his client's subjective existence: the only channels of communication open to him are objective, somatic. Only by manipulating the physical properties of his environment—heat, air, light, color, odor, sound, sur-

face and space—can the architect communicate with his client at all. And only by *doing it well*, i.e., meeting all man's requirements, objective and subjective, can he create buildings which men may find beautiful.

The matter by no means ends here, however. The architect builds not merely for man at rest, man in the abstract. Typically, he builds for man at work. And this confronts him with another set of contradictions. For work is not a "natural" activity, as Hannah Arendt has brilliantly reminded us.⁴ Labor, according to her definition, is "natural"—that is, the use of the whole body to meet its biological needs, to feed it, bathe it, dress it, protect it from attack. Work, on the other hand, is "unnatural"—the use of the hand and the brain to produce the artificial, non-biological world of human artifice (skyscrapers, textbooks, paintings, space ships, highways, symphonies and pharmaceuticals). Both levels of human activity are, of course, fundamental to civilization, and the world of work can only exist as a superstructure on the world of labor. But insofar as we share the world of labor with the beasts, it can fairly be described as both natural and subhuman. Only the world of work, of human thought and artifice, is truly human.

This distinction is not so fine as it might at first appear: it has important consequences for architectural design. For if the architect ever builds for the wholly "natural" man, it will be only in his house, at his biological activities of resting, eating, lovemaking and play. Most other modern building types involve man at work, engaged in a wide spectrum of "unnatural" processes. Each of these involves stress. Stress, as we have seen, comes either from too much or too little stimulation, from sensory "overloading" and "underloading" alike. Biological man requires a dynamic balance, a golden mean between extremes. But modern work knows no such requirements: on the contrary, for maximum output and optimum quality, it sometimes implies environments of absolute constancy (e.g., pharmaceuticals, printing) and often requires extreme conditions never met in nature (e.g., high-temperature metallurgy, cobalt radiation therapy, etc.).

When plotted, these two sets of requirements will seldom lie along the same curve. From this it follows that architecture must meet two distinctly different sets of environmental criteria—those of man at some "unnatural" task, and those of the "unnatural" process itself.

Variety may indeed be the very stuff of man's natural life. But most of our human activities are, to a greater or lesser extent, "unnatural." From the moment we place the young child in kindergarten, we are imposing "unnatural" tasks upon him—placing his eyesight, his pos-

ture, his capacity for attention under quite abnormal stress. And this situation grows more acute throughout his education and his normal working life. As an adult, his biological existence is linked to processes which are never completely congruent with his own. Often they involve work which is fractionalized, repetitive and hence often unintelligible to the individual; often, the processes are actually dangerous to him. Only in agriculture does he confront work whose "natural" environment, rhythms and wholeness correspond to his own; but only six out of one hundred American workers are involved nowadays in this work.

The child at school faces a situation not qualitatively different from his father on the job: namely, to accomplish a given amount of work in a given time. Ideally, his physical growth and intellectual development should be steady and parallel. His rate of development should be as high at the end of his school day as at its beginning. In reality, of course, this is impossible. His energies flag as the day advances and nothing but play, food and rest will restore them. The question for architects is how should the classroom intervene in his favor? How to manipulate his external environment so that his learning advances with optimum speed and minimum stress?

It should be immediately apparent that the child's requirements are dynamic and imply a dynamic relationship with his classroom. No classroom should confront the child with a fixed set of day-long environmental norms, e.g., 72°F. air, 50 per cent humidity, 60 foot lamberts at desk top, 45 decibels of sound. Far from being held at some fixed level, the probability is that environmental conditions should be continually changing. *But this change cannot be casual or statistically indeterminate* (if change alone were all that was required, the class could be held in a nearby meadow). It must be a *designed* response to the child's changing requirements. The child may well need less heat at 2 p.m. than at 9 a.m. At day's end he may need less humidity and more oxygen; he may require more light and a different color; he may need a chair that gives a different posture or sound levels higher or lower than the morning. Whatever the requirements are, they could only derive from the child himself, in the experiential circumstances of study. They cannot be met by mechanistic engineers (windowless classrooms, "steady state" controls) nor by formalistic architects who design as though visual perception is the whole of experience.

But the symbiotic relationship between the architectural container and the men and processes contained is nowhere clearer than in the modern hospital. Here we find every degree of biological stress, in-

cluding that of birth and of death. Here we find a wide range of highly specialized technologies, each with its own environmental requirements. And here we find the narrowest margins for error of any building type: here success or failure are literally matters of life or death. Here, if anywhere, we can observe the integral connections of metabolic function and aesthetic response as shown in Figure 1-1.

The seriously ill patient—above all, the major surgery case—will traverse the full experiential spectrum during his stay at the hospital. Stress will be greatest under surgery. His relationship with his environment can be almost wholly defined in somatic terms. Since he is under total anesthesia, there is no aesthetic aspect to his experience. (It is interesting, in this connection, to note that the two words anesthesia and aesthetic have a common origin in the Greek word meaning “to feel” or “to perceive.”)

His gradual process of convalescence—through the recovery room, intensive nursing, regular nursing and ambulatory state, on up to discharge—traverses the full spectrum of experience. Precisely as the metabolic crisis diminishes so will his aesthetic response rise to the front of consciousness. Colors, lights, noises and odors which he was too ill to notice can now become major factors of experience. And their satisfactory manipulation becomes matters of active therapy.

The surgeon and his staff too will meet their greatest period of stress during surgery. At this juncture their requirements will be opposed to those of the patient. Where the latter requires warm moist air (and anti-explosive measures demand even higher humidities), the staff under nervous tension should ideally be submerged in dry, cool air. But since stress for them is of limited duration while any added load might be disastrous for the patient, the room's thermo-atmospheric environment is usually designed in the latter's favor. The staff sweats and suffers and recovers later. On the other hand, the luminous environment of the operating room must be wholly designed in the surgeon's favor (and no contradiction is raised because of the patient's lack of consciousness). The color of the walls, of the uniforms, even of the towels is quite as important to visual acuity of the surgeon as the lighting fixture themselves.

Thus, every decision made in design of the operating room will be based upon functional considerations, objectively evaluated. The very nature of the intervention prohibits any abstractly “aesthetic” considerations. The margin of safety is too narrow to allow the architect the luxury of any formalistic decisions based upon subjective prefer-

ences. In varying degrees, this situation will obtain in other specialized areas of the hospital. And it will increase as the hospital comes to be regarded not merely as a container for men and processes but as being itself an actual instrument of therapy. There are many evidences of this tendency already: the hyperbaric chamber where barometric pressure and oxygen content are manipulated in the treatment of both circulatory disorders and gas gangrene; the metabolic surgery suites where body temperatures are reduced to slow the metabolic rate before difficult surgery; the use of saturated atmospheres for serious cases of burn; artificially-cooled, dry air to lighten the thermal stress on cardiac cases; the use of electrostatic precipitation and ultraviolet radiation to produce completely sterile atmospheres for difficult respiratory ailments or to prevent cross-infection from contagious diseases. Here the building is not merely manipulating the natural environment in the patient's favor but actually creating totally new environments with no precedent in nature as specific instruments of therapy.

The exact point in hospitalization at which these environmental manipulations cease to be purely therapeutic and become merely questions of comfort or satisfaction, i.e., the point at which they cease to be functional and become aesthetic problems, is not easy to isolate. Objectionable odors, disturbing noises and lights; uncomfortable beds; lack of privacy; hot, humid atmosphere—all these will work against "beauty" in the hospital room. They may also delay convalescence. We cannot hope to make modern medical procedures "pretty" and the well-adjusted patient will probably want to leave the hospital as soon as possible under any circumstances. All the more reason, then, that every external factor be analyzed as objectively as possible, with a view to removing all unnecessary stress.

All of this suggests the possibility of establishing, much more precisely than ever before, an objective basis for aesthetic decision. It would be mistaken to attach too much importance to aesthetics in hospital design; but it would be equally foolish to minimize it. It cannot, in any case, be avoided. Everything the architect does, every form he adopts or material he specifies, has aesthetic repercussions. His problem is thus not Hamlet's: to act or not to act. It is rather to act wisely, understanding the total consequences of his decision.

If the architect's aesthetic standards are to be placed on a firmer factual basis than the one on which they now stand, he will need the help of physiologists and psychologists to do it. Architecture needs a much more systematic and detailed investigation of man's actual

psychosomatic relationship with his environment than has yet been attempted, at least in architecture. It is not at all accidental that we can find the broad lines of such research appearing in the field of aerospace medicine. For man can only penetrate space by encapsulating himself in a container of terrestrial environment. And to accomplish this he must ask fundamental questions: what, actually, *is* this environment? What specifically is its effect upon us? What *is* its relation to human pleasure and delight?

In the design of the space vehicle, for example, it is no longer possible to say where problems of simple biological survival leave off and more complex questions of human satisfaction begin. Clearly, they constitute different ends of one uninterrupted spectrum of human experience. It is very probable that the upper end of this spectrum, involving as it does man's innermost subjective existence, can never be fully explored or understood. But it could certainly be far better understood than it is today, even among architects and doctors.

American society today employs some 270 distinct building types to provide the specialized environments required by its multiform activities. Most of them embody contradictions which must be resolved at two different levels: first between the persons and processes contained and then between their container and the natural environment. Respect for these two conditions is mandatory if the building is to be operationally successful. And yet, respect for these two conditions will often leave the architect with little room in which he can manipulate the building for purely formal, i.e., aesthetic, ends.

Most contemporary failures in architecture (and they are very many) stem either from a failure to understand this situation or else from a refusal to come to terms with it. Of course, no building can grow like an organism. Architects do not work with living tissue, with its powers of cellular division and genetic memory. In this sense, buildings must always be designed by men and these men will always bring to the task preconceived ideas of what forms they ought to assume. As Ernst Fischer, the Austrian philosopher has said, a good honey bee will often put a bad architect to shame. "But what from the very first distinguishes the most incompetent of architects from the best of bees is that the architect has built a cell in his head before he constructs it in wax."⁵ Good or bad, beautiful or ugly, the building is always the expression of somebody's creative ambitions. Today, more than ever in history, these ambitions must be contained, structured and disciplined by objectively verifiable terms of reference.

NOTES

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Physiology and Anatomy of Urination

ALEXANDER KIRA

Although Fitch is probably correct in claiming that discussions of architecture have often proceeded as if the only important human or social dimension of architecture was how a building looked to the educated eye, the fact is that buildings, if they are to meet even the minimal requirements of functional adequacy, must necessarily respect the anatomical and physiological characteristics of the organism. Indeed, the importance of human biology as a constraint on design is an ancient architectural notion, having been discussed by Vitruvius, who in the first century A.D. advised practitioners of architectural design to acquire a basic knowledge of medicine. Some architects, for example Leonardo and Alberti in Renaissance Italy and Le Corbusier in our own time, have worked with the idea of basing a formal geometry of design on the dimensions of the human figure.

However, it is possible to conclude that respect for the constraining power of man's biological nature has declined since the Industrial Revolution, and that contemporary architecture, partly because of its technical prowess, has tended to overlook the role of biological factors. As a result, for several decades now, there has been a growing sentiment in architectural and environmental design circles, particularly in schools of design, to reintroduce a deliberate concern for anatomical and biological studies.

This new emphasis on the role of biology in the practice of architecture has taken form in the development of specialized fields of scientific inquiry, such as ergonomics, or human factors engineering, and anthropometrics. Ergonomics is concerned primarily with developing work environments that are compatible with human physiological processes. Anthropometrics compiles anatomical measurements for different age groups and populations, thus providing an objective basis for determining the size of spaces and equipment. Both specialties examine in minute detail the characteristics of the human organism at rest and in movement, often in laboratory environments. These data are then used to design equipment and spaces that will fit the human body, not only in static terms but also when performing the move-

Reprinted from Alexander Kira, "Physiology and Anatomy of Urination," and "Design Considerations for Urination," in *The Bathroom, Criteria for Design* (New York: Bantam Books, 1967), pp. 138-151. © 1966 by Cornell University. Reprinted by permission of Bantam Books, Inc.

ments necessary to the task at hand. These studies have been applied with greatest effect to the design of industrial and military equipment and to the design of highly specialized environments that impose unusual stress on the organism, such as space capsules and submarines.

The significance of Kira's research is that he has applied to a domestic facility, the bathroom, the same careful method of investigating the requirements for comfortable and efficient operation ordinarily used in the study of industrial and military equipment. The selection reprinted deals with the design of equipment for urination within the home. In the book from which it is taken, Kira also analyzes facilities for washing, bathing, and defecation. The study was based on a thorough review of the previous anthropometric and ergonomic literature; a field survey of user attitudes, practices, and preferences; and detailed observations of personal hygiene activities in a laboratory specially constructed for the research.



The Process of Urination

Urination, or micturition, is the process of excreting from the body the waste fluids produced by the kidneys. The kidney is a highly discriminating organ which processes the body's supply of blood. It eliminates varying amounts of waste substances according to the body's needs. The urine, which is the final excretory product, is a composite not only of waste products which may have been in the blood but also of foreign substances and the excess products of the metabolic processes. Because the kidneys function to maintain the constancy of the body's internal environment, the composition of urine may vary considerably from one discharge to another. The quantity of urine which is produced over a 24-hour period varies directly with the amount of fluid intake but generally averages between 1,000 and 1,400 cc. Normal urine has an amber color and a very faint odor unless allowed to stand at room temperature for any length of time. As the urine is produced, it is carried through the ureters, or ducts, to the bladder where it accumulates until discharged from the body through the urethral openings.

Inasmuch as body posture has an effect on blood circulation, it can also affect urine composition and volume. The effect, however, is not significant unless there is considerable change or considerable stress from one posture and there is no evidence to suggest that posture has any appreciable bearing on the act of urination itself, either in terms of comfort or facilitating or hindering the process as is the case for defecation.¹

Although the process of toilet training with respect to urination does not appear to be as complex and fraught with psychological overtones as defecation, it does, nevertheless, demand a similar period of training and requires a similar degree of neuromuscular differentiation and control. The development of voluntary bladder control is generally not achieved until from 18 to 30 months. Usually nighttime control takes longer. Full control and the ability to void without any assistance is usually not achieved until well into the third or fourth year. Because of the differences in the positioning of the bladder, males generally have greater difficulty in developing proper control since the anal and urethral sphincters are so close together as to require a particularly fine neuromuscular differentiation.² In the female the two sphincters are separated by the vagina. While this simplifies the problem of learning to control each of the sphincters separately, the relation of the vagina to the bladder and the urethral sphincter often results in a sympathetic stimulation leading to urination. This is particularly true during the later months of pregnancy when the ever increasing pressure on the bladder results in more and more frequent urges to urinate. It may also be caused by vaginal stimulation prior to, or during, intercourse, especially if the bladder is at all full.

In this connection it may also be noted that the urge to urinate frequently is also very common among the aged. Largely this is due to an atrophying of the kidneys and bladder and a weakening of the sphincter muscles. Another fairly common problem among the aged is incontinence, particularly among prostate patients. This gradual degeneration of body functions may be regarded in some respects as a reversal of the initial developmental processes as, for example, in the loss of neuromuscular controls, which in some instances causes aged men to be as inept at urinating as small boys.

Anatomy

Anatomical differences between the male and female result in certain aspects of the urination process being different for each of the sexes. Aside from the problem of developing controls, the most significant and obvious difference is in the location and nature of the actual urethral openings from which the urine is discharged. In the female, the urethra is located just in front of the vagina, within the labial folds, and well inside the body envelope. As a consequence, for all practical purposes, she has no control over the direction of the urine stream. As we shall see later, this has certain consequences which restrict the

PHYSIOLOGY AND ANATOMY OF URINATION

posture assumed and the kind of facilities which might be provided. In the male, on the other hand, the urethral opening is located in the penis, thus lying outside the body envelope and permitting control of the urine stream within the entire volume circumscribed by its possible trajectory.

Design Considerations for Urination

DESCRIPTION OF ACTIVITY

Female Urination. The nearly universal custom in Western societies is for females to urinate in a sitting position (or squatting, if no support is available). From a purely physiological viewpoint, females could perform in a standing position as well. Urinating in such a position, however, inevitably results in soiling oneself, both directly and from splash, since the female's urine stream cannot be directed away from its essentially vertical axis. In addition, the complications of present-day clothing present varying degrees of handicap to comfortable, or possible, urinating in any position other than sitting, without virtually disrobing, because of the present tendency for some form of girdle, or otherwise restrictive and elasticized undergarment, to be worn virtually universally and constantly—even by teenagers. In this connection, it may be noted that attempts have been made over the years to provide a "stand-up" urinal for females similar to the standard men's wall-hung urinal, except for a longer projecting basin, primarily with the aim of improving the traffic capacity and particularly the sanitation of public facilities. In using these fixtures, a woman would have to partially disrobe and then straddle the projecting lip of the fixture in more or less a standing position. The practical difficulties of using the fixture in terms of clothing, combined with the psychological resistances to being publicly uncovered, have resulted in relatively little acceptance of it. The problem of exposure has been resolved by placing the fixture in a stall, but this has negated the potential advantages of economy and rapid turnover in use.

It seems obvious, however, that under present circumstances, particularly in the home where the problem of sanitation, compared with public facilities, can be considered for practical purposes to be non-existent, the most convenient and comfortable position for a woman to assume for urination is a sitting one. If we accept this premise, the problem then is largely one of making appropriate minor modifications

in whatever fixtures might evolve for defecation since the basic requirements are very similar. Accordingly, the rest of this discussion, since we are concerned primarily with facilities in the home, focuses on the particular problems posed by male urination which is almost overwhelmingly accomplished from a standing position and which poses major sanitary problems.

Male Urination. Males can urinate equally conveniently and comfortably from either a sitting/squatting, or standing, position. However, the restrictive effects of clothing, the sexual considerations which are involved, and the extreme convenience have caused men to favor the standing position almost universally. In general, men will urinate in a sitting/squatting position only when this activity takes place in conjunction with defecation and they have already assumed a sitting position. Insofar as urination, per se, is concerned, we must regard it as primarily a standing activity.

Because of the male's anatomy and his early learned ability to control the trajectory of the urine stream, there is, in some respects, relatively little problem of any substantial self-soiling in a standing position.³ The qualification depends upon the nature of the facilities available. That there are serious soiling problems associated with the use of current home facilities may be attested to by any housewife or cleaning woman. The soiled fixtures and the soiled, discolored, and rotted floors and walls, which everyone is familiar with, stem from the use of the water closet, which is completely inadequate for this purpose, instead of a separate "urinal." The key to these problems lies in understanding the particular characteristics of the male urine stream.

Urine passing through the slit-like urethral opening is emitted in the form of a thin sheet which twists and spirals for several inches and then disintegrates into a centrifugal spray. (See Figure 2-1.) Both the point of disintegration and the maximum diameter of the spray are directly proportional to the velocity of the stream, which is a function of the bladder pressure. A low velocity produces an increment (each twist in the integrated phase of the stream) of approximately $\frac{3}{8}$ of an inch; extreme velocity an increment of almost 2 inches. Normal velocity produces an increment of approximately 1 inch. In every instance, however, the centrifugal action causes the stream to disintegrate and assume a roughly conical shape. It is this dispersion which is responsible for a substantial share of the soiling both of the self and of the surroundings which can occur when urinating from a standing position, and when the receiving container is not as close as, for example,



Figure 2-1 Typical Dispersion and Splash Pattern of a Simulated Male Urine Stream.

a wall-hung urinal which intercepts the stream before the point of dispersion.

Another aspect which must be considered is the inability of the male to predict, or accurately position, the *initial* point of impact of the urine stream. Although the degree of accuracy is reasonable in most instances, there are a sufficient number of “accidents,” or gross distortions, attributable generally to temporary and unnoticed dermal adhesions of the urethral opening. Once the activity has begun, however, most adult males can, by a process of successive corrective maneuvers, exercise fairly accurate control thereafter. The notable exceptions are the ill and intoxicated, the very young, or the very old and infirm.

The normal water closet, however, presents a relatively poor target, particularly because of the psychological resistances involved in its use. Because of the general taboos on the elimination processes, and the particular aversions to being directly and actively aware of elimination taking place, most men will try to avoid urinating into the standing pan water—the easiest and most natural target—in order to avoid the embarrassment of being heard, since the noise, particularly with a full bladder, can be quite considerable and easily identified. Once this decision is made, the choice of target areas is limited to the sides and front and back walls of the bowl. In the majority of water closets the bowl configurations are such that these areas are quite small and difficult to hit with any degree of accuracy. Because of the necessity to stand up close to the front of the bowl to catch the dribble at the end of the action, the possibilities are further limited to the sides and the back. However, since the back wall in most cases is vertical or nearly so, the target area presented is quite small and is useful for only a brief period since the length of the stream trajectory continuously

varies. This leaves only the side walls which present a feasible elongated target. Since this area rarely exceeds 2 inches by 7 or 8 inches it becomes obvious that not only is the proper trial and error maneuvering difficult to accomplish successfully, but also half of the stream spray inevitably falls outside the bowl.

Still another problem which arises in the use of the water closet is the back splash which results when the urine stream hits a hard surface. (See Figure 2-1.) This problem will, of course, arise and have to be dealt with in any container. However, it poses a particular problem with respect to use of the water closet since this fixture has obviously been primarily designed to accommodate defecation, and urination has been left to be accomplished as best it can.

Any stream of relatively nonviscous liquid hitting a hard surface (including a body of liquid) will result in a considerable splash. The direction and extent of this rebound, or splash, is determined not only by the force with which the stream strikes the surface, but also, and more importantly, by the configuration of the surface and the angle at which the stream hits the surface. Proper manipulation of this latter factor can appreciably reduce the quantity of splash and can control its direction.

DESIGN CONSIDERATIONS

For a fixture to adequately accommodate male urination from a standing position, the following criteria should be observed. The receiving container must be so positioned, relative to the point of origin, as to intercept the urine stream before the point of appreciable disintegration. The container must be of a size and shape which will present an adequate "target" under a variety of circumstances. Use of the fixture should be relatively noiseless. The internal configuration of the container should be such as to avoid or minimize back splash, and the production of aerosols. The resulting fixture should not be obvious in appearance, and should probably look as little like the urinal found in "men's rooms" as possible.

In order to adequately provide for male urination in the home there are several possible approaches which may be taken. The first, and most obvious, is to provide a standard wall-hung urinal since this satisfies all the necessary functional criteria. It is unlikely, however, to meet with general acceptance, chiefly because of various psychological reasons. In addition, it may be argued on practical grounds that such a fixture would entail too much extra space and expense even if the

standard urinal were to be adapted for household tank-type operation. In view of all the evidence, this solution might as well be dismissed for the moment, even though it represents the simplest and most direct one.

A second approach is to try to make appropriate modifications to the water closet. This would offer the advantage of being relatively unobvious and at the same time relatively inexpensive. Extensive investigation, however, indicates that this is a next to impossible task. This is particularly true with respect to the low water closet since, as will shortly be made clear, the farther the container is from the point of origin, the greater the problem of containment of the stream. As is so often the case, in trying to accomplish several functions, each is compromised. The more the fixture is modified to accommodate urination the poorer it becomes for its primary function of defecation.

A third possibility, which might be mentioned in passing, is that, instead of accommodating the standing male, perhaps things should somehow be so arranged so that he would have to sit. From all practical and psychological viewpoints, this would seem, however, to be totally unworkable. Aside from changing a natural and age-old habit, it is likely to meet with strong resistance, from the aspect of convenience, particularly since in recent years the male has become ever more accustomed to the speed and effortlessness of the urinal, which is now almost universal. The idea of having to substantially undress for an operation which is presently so simple would certainly meet with considerable opposition. There is also not much question but that it would encounter a great deal of psychological resistance since it would, in effect, deny the male the free use of his greatest glory and would condemn him to assume the position of a woman.

The final and most logical possibility is to attempt to evolve a totally new fixture which will satisfy all of the criteria described.

Stream Characteristics and Positioning of Container. As pointed out earlier, the major problem posed by the standing male urinating in a water closet is the centrifugal breakup and dispersion of the urine stream which results in considerable soiling of the self and the surrounding area.

The behavior of a simulated stream was studied, assuming a point of origin of 29 inches above the floor, relative first, to an intercepting plane at a height of 16 inches (standard water closet), and then to an intercepting plane at a height of 9 inches (point of assumed interception of a floor mounted urinal and of the proposed squat closet). In

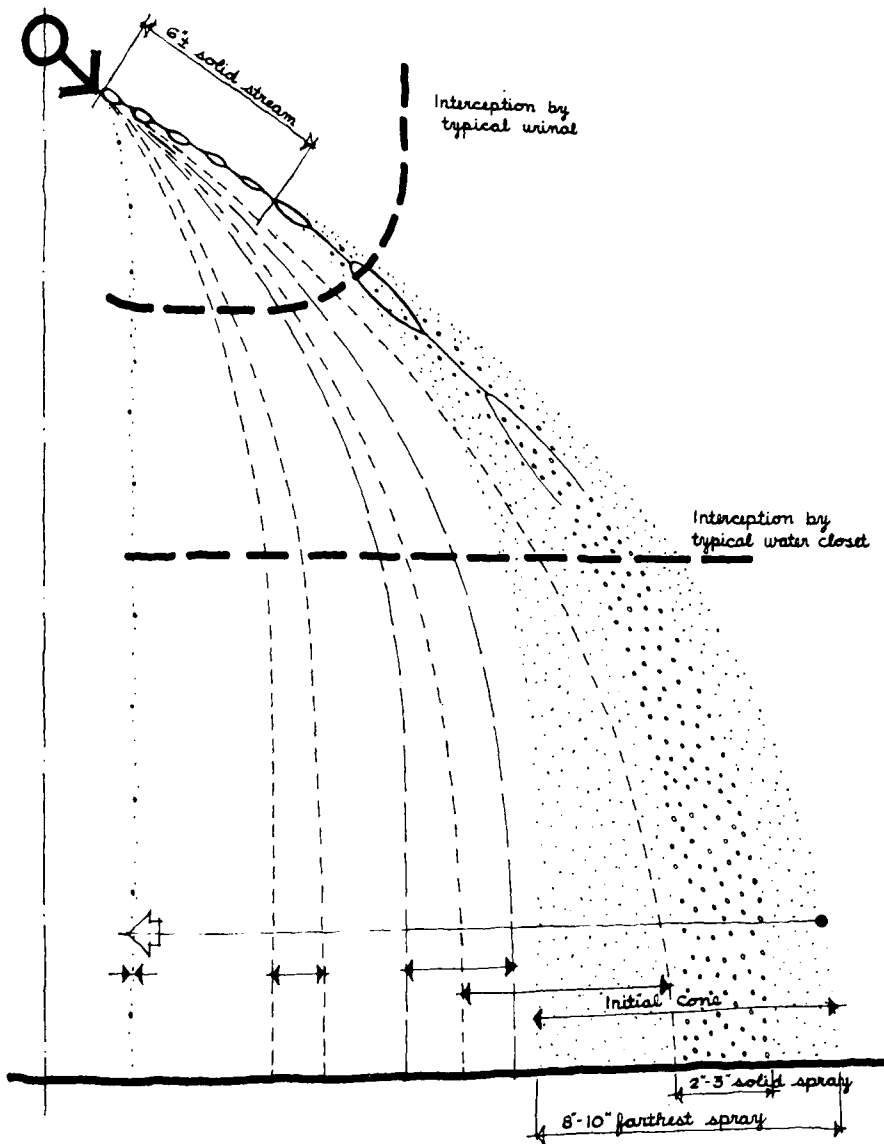


Figure 2-2 Dispersion and Containment Characteristics of Simulated Male Urine Stream. The stream at any given moment assumes the form of a warped conical solid which shrinks and shifts its base over a period of time. The size of the receiving container is also directly related to its distance from the point of origin.

every instance, the full extent of the spray indicated in Figure 2-2 could be measured within a 30-second period, the assumed average time of urination. Graus cites 45 seconds as the average time in military situations.⁴ This higher figure is undoubtedly due to the oppor-

tunities for urination or rather, the lack of them. The actual range, however, is quite considerable and can vary from 10 or 15 seconds up to a minute and a half, or longer, depending on how full the bladder is. It should be noted that these dispersion figures for a simulated stream represent minimums which are rarely achieved in actuality. Depending upon the particular angle of the stream trajectory, there is likely to be a greater dispersion the flatter the trajectory and the greater the pressure. In addition, incidental dermal adhesions can result in an immediate and erratic dispersion of the stream.

When we consider that the stream assumes the form of a warped conical solid with a shifting base, it is obvious, as indicated in Figure 2-2, that the size and shape of the necessary container or enclosure is directly related to its distance from the point of origin in order to completely contain the stream. The closer the container is to the point of origin, the more compact it can be and the less the danger of accidental soiling. In view of the range of heights of adult males, the front lip of the container should be set at a minimum height of 24 inches from the floor, the height at which regular wall-hung urinals are commonly set. At this height, the container needs to have a minimum opening dimension approximately 10 inches by 10 inches.

The container must also be so shaped and positioned that it can be more or less straddled in order to catch the dribble and drip at the conclusion of urination, again, in a fashion similar to existing wall-hung urinals.

Size and Shape of Container. The particular combination of size and shape may vary over a considerable range, so long as the container meets the criteria of presenting an adequate target area and of minimizing and containing back splash as well as dispersion.

In terms of shape, the most crucial point is that the contouring be such as to keep back splash to a minimum. To allow for variable bladder pressures and/or variable stream trajectories, the cross section should be continuously variable so that the surface maintains a constant relationship to the stream. (See Figure 2-3.) The effect of this angular relationship between the stream and the impact surface is shown in Figure 2-3, which reports the results of a series of tests with a simulated vertical stream at maximum pressure (twist length of 2 inches). As indicated, the smaller the angle between the stream and the impact surface the less the resulting splash. In general, it would be desirable to keep this relationship within a 30-degree limit in both a lateral and a longitudinal direction. While a properly designed single warped planar surface can keep splash within reasonable limits, it