MOVEMENT AND THREE-DIMENSIONAL ART:

AN EXPLORATION

by

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CHAPTER I

INTRODUCTION AND STATEMENT OF PURPOSE

The very essence of human behavior is activity, for action is inherent in all of life--it is a vibrant expression of energy. That man, as a part of society, is the central point of reference in all human activity is self-evident. His activities represent his efforts to interpret life as he attempts to understand himself and the world in which he lives. Human life is interpreted in many ways--through words, music, pictures, art, and movement patterns. These are man's media for expression and communication with other man. Man's mode of expression and communication is individual and social, for the individual and society insist upon reciprocal patterns of behavior.

Perhaps man's most familiar and common medium of expression and communication is through words. This is generally accepted as man's best discursive facility. But a basic and biological fact is that movement, the essential property of life, is the supreme and final medium of expression and communication. Whatever else the individual's activities are emerges from this central fact. Another medium of expression and communication which, traditionally, is as old as man, and which is ultimately directed to and through man's creative instincts and desires, is art. Whatever the age, whatever the time, the contributions that art has made to the develop-

ment and understanding of man, have been timeless and profound in influence. Art has drawn for its source of inspiration all that is characteristic of the living experiences of man--a dynamic image of life. Hence, in this sense, art, too, is expression and communication.

The purpose of this study is to explore through three-dimensional abstract art some of the aspects in which man seeks to interpret life--human movement. Specifically, the author chose to interpret three selected movement patterns--running, spinning, and the roll--in three-dimensional abstract art forms.

While this is not an experimental study in the usual sense, it is the author's belief that the attempt to interrelate expressive media has experimental aspects; aspects, which it is hoped, will be interesting and enriching in nature.

CHAPTER II

THREE-DIMENSIONAL ART AND MEANING

I. INTRODUCTION

Man interprets and responds to life in many ways. Whatever his medium of interpretation and ultimate response, life is lived, it seems, in the continuous attempt of man to express himself in an effort to relate to the world around him, and ultimately to self.

Art is a response to life. The basic desire to create is universal; thus, art becomes one of the common languages of expression and communication between all people, just as surely as music and movement become common symbols of communication. With this in mind, three dimensional art as a specific medium is related to at least two considerations: first, certain philosophical concepts of art perception and their meaning; and, secondly, the technical processes involved in creating and molding the physical materials into the concrete art form. This area of art, often referred to as "plastic art", includes both stabile (static) sculpture, and a more contemporary form of sculpture called "mobiles", characterized by the kinetic nature of its parts.

II. PHILOSOPHICAL CONCEPTS OF THREE-DIMENSIONAL ART

Man is, by nature, a searching, curious individual, inevitably

influenced by his times. Consciously or not, his search for the meaning of human life and his universe as an intelligent, cultivated individual, is reflected in a critical, examined view of life in all its proportions. He searches for wholeness. Indeed, as Socrates suggested in "The Apology", "The unexamined life is not worth living."

The simple words of Confucious[16:75] give pause for thought in this day of increasingly complex living:

> Is it not pleasant to learn with a constant perseverance and application . . . ? I do not open up the truth to one who is not eager to get knowledge, nor help out anyone who is not anxious to explain himself. When I have presented one corner of a subject to anyone, and he cannot from it learn the other three, I do not repeat my lesson . . . .

The beauty of man's search for the meaning of life is reflected and projected in many ways. One way is through his creative imagination. The world of the imagination is simple and wonderful. Small wonder, then, that each person shares a special affinity to Alice in Wonderland, for all wish to know what goes on behind the looking glass. Perhaps herein lies the origin of all our needs to know and understand and experience the third dimension. The painter can only hope to suggest it to us convincingly by his two-dimensional design. But this need for depth, which satisfies some basic desire of the mind, may very well have been that unseen force that influenced the birth of sculpture--something we cannot only see, but touch and feel all around.[16]

Life outside the self is not the whole of reality, for the world of the imagination is also a reality, an extension of the lived reality--the

consciousness of a new reality for that individual.[30] It is within the creative imagination that the vital and formal values of art lie. It is this imagination that ultimately gives impetus to the creative spark and sets it burning for the artist.

> Whether he [the sculptor] can set the world aglow by his work or not, is beside the point. He knows that his daily lot will be a search for form, it may be in stone, marble, or bronze; it will be a constant analyzing of life itself in terms of three-dimensional silence. But it is certain that if he accepts this yoke of labor he will plow deep under the surface of life and he will experience miracles and give thanks that he is alive and awake and aware.[16:19]

The artist, through his work, speaks of life, and what life feels like. He attempts to concentrate into visible form the essence of truth--it is a parable in three dimensions, a symbol of spiritual existence, a reflection of the artist who creates it, and of the era in which he lives. Herein lies the timelessness of art.

The intentions of the artist, generally speaking, are twofold. First, he wishes to create a symbol which represents and materializes a particular intuition or feeling of the artist--a symbol which is acceptable to other people because this same feeling or intuition is materialized vaguely in their consciousness. However, it is the artist who is first prompted to create such a symbol, because he wishes to share and communicate this feeling in an objective symbol of his inner state, embodied in a material pattern of some kind. A second intention is of a social or pragmatic purpose. The symbol which the artist embodies in a material form is produced through his artistic skill to record some common ex-

perience. In so doing, he must make certain that he uses the visual conventions of his time, and the materials which lend the best interpretation, so that his symbol will be acceptable.[31] In short, whatever the origin of the artist's conceptual considerations, he must always be concerned with the interplay of the physical and the spirit, of the form and his intention--the quality of the very process of living.

Sculpture has many physical properties peculiar to it, the most obvious of which is that it creates a three-dimensional object in space. Because of this property, it is basically concerned with its interaction among mass and volume and space. Thus, space perception permits one to respond not only to the stimulus of visual sensation, but also to the stimulus of tactile sensation.

William James suggested that there are two kinds of space perception, as he discussed it in relation to sculpture, touch-space, and sight-space. He suggested that sculpture is primarily an object of touch-space, while painting is primarily visual, or sight-space.[31] "The two . . . have no essential or intrinsic congruence, and only through the 'association of ideas' do we know what a seen object signifies in terms of touch."[31:47] This is true, because in merely "looking at" a three-dimensional object in space, we still get only a two-dimensional impression, and we must rely on our previous experience of that object to conceptualize this knowledge.[31] It is only as one moves around in space and in relation to an object that one can experience the third dimension.

Sculpture, then, is man's expression to man through a three-dimensional language--a bridge between his personal outlook and his environment. Man's idea world becomes conceptualized in visible form. It is an expression of ideas apart from any utilitarian function, and thus is first the product of the creative imagination.

III. THE TECHNICAL ASPECTS OF THREE-DIMENSIONAL ART

Since three-dimensional art is classified as a plastic art, as distinguished from the graphic arts, the following definitions for purposes of clarification are given.

Plastic art is any art which is sculptural in form or effect, the materials of which are capable of being molded or modeled, such as clay or plaster; hence, are pliable or impressionable. Therefore, three-dimensional forms may be said to be of a "plastic" nature.

Graphic art pertains to any of those arts which are primarily two-dimensional in nature, such as painting, drawing, engraving, and any other arts in which ideas are expressed by lines, marks or characters, impressed on a surface.

Basic Elements and Principles of Order of Three-Dimensional Design

One of the distinctive processes in the evolution of the plastic arts deals with an understanding of the technical and physical aspects of the elements of design and form. The purpose of three-dimensional design is twofold: 1) to present to the mind a three-dimensional form

through a series of relatively two-dimensional views; 2) to express certain feelings or truths through arrangements of the parts of the form. What we see and conceptualize, then, should result in a unity of expression. That is, the form must speak of the same thing from all views.[36]

Basic Elements

Planes. Sculpturally, planes are areas of surface defined by a more or less abrupt change in direction, and may be either flat or curved; that is, two-dimensional or three-dimensional. For example, a cube has six flat areas of equal size defined by right angle turns. A sphere has one continuous convex area which constitutes its one plane. It is a shape whose dimensions are very clearly defined. Planes which are partially defined and partially imagined are sometimes called "virtual planes", which very often suggest subtle changes in direction in a mass.[36]

Lines. Lines as such do not exist in the third dimension. What lines there are consist of three basic kinds: 1) outlines, or two-dimensional extensions of planes in space from a fixed point of view; 2) the axes of three-dimensional shapes, in which the length is apparent rather than the width, as in wire or rods; and 3) junctions of planes.[36]

Textures. Textures are the surface qualities of a substance, and are important to the artist in expressing the structural characteristics of the material, in interpreting the subject or idea correctly, and in pro-

viding light-reflecting capacities.[36]

Color. Usually, color is less important in sculpture than in painting due to lack of control over light. Even the colors inherent in the materials are often modified by this lack of control over light. For this reason, most sculpture is done in a uniform local color, thus simplifying the problem of tonal relationships of light and shadow. Sculpture, then, is more concerned with plane organization.[36]

Masses and Volumes. Masses or solids are three-dimensional, space-displacing shapes defined by planes, while volumes are virtually negative areas of space inclosed by the planes of the masses or solids.[36]

Thus, with the elements of planes, lines, textures and color, it is possible to organize masses and volumes into a final design. If these elements are properly understood, the final form should result in a unified design, in which each part is an essential contribution to the whole. This unity provides a sense of oneness, while variations within the parts add variety without sacrificing the total unity.

Principles of Order

Unity and variety in a design are created through various principles of order. These are not necessarily criteria for designs, for designs must be judged as total visual expressions, whether good or bad. However, an understanding of these principles of order help to find the right solution in a good design.

Balance. Balance has two aspects--the relationship of the mass to its support (law of gravitation), and the distribution of interest, or the balance of attraction within the elements previously discussed. In both cases, an individual sense of physical balance is involved, and the effect is felt just as surely as the effect of gravity is felt in the human body in various positions.(36)

Proportion. Proportion pertains to size relationships of the total form, height to width to depth; and to size relationships within the design, that is, the relative sizes of the parts to the whole. Whether the proportions are natural or exaggerated, they must be within the sculptural concept. This is a part of the expressive language of form. However, the sculptor must make certain that the materials used can truthfully contain these proportions.(36)

Movement, or the feeling of movement, in a form is a visual stimulation in association with conceptualization of the idea. This feeling of movement serves two functions. It activates space in such a way that the viewer can "see" what the eyes do not really see--that is, he is made aware of a life force that is not actually there. Finally, this feeling of movement creates a greater awareness of existence in space by enabling the eyes to see more of the third dimension than is ordinarily seen. Many of the most expressive qualities of a design are established by the qualities of its dominant movement patterns.(36)

Repetition, or Similarity. Repetition and similarity of parts to

the whole help to provide a strong unifying factor, as long as it doesn't become monotonous from overuse. Repetition is used, sometimes, to obtain rhythm or emphasis, with variations only in size. This helps to form a more integrated and meaningful image of the whole form.(36)

Contrast. Emphasis may also be achieved by either repeating or contrasting, and this helps to create variety and interest within unity. Contrast may be obtained through variations in size, linear direction, proportion, and texture; but according to the original idea, any contrast should be in keeping with the overall tone or concept.(36)

Whatever the design of the final art form, its unity and variety should represent a balance between visual clarity and interest.

At best, in his attempts to describe and analyze art, the artist can only hope to lead the way to a fuller understanding and appreciation of that which he has created. To attempt to verbalize about his work may be frustrating, and finally the artist may say simply, "Look!" For, as Moholy-Nagy said, "One can never experience art through descriptions. Explanations and analyses are at best an intellectual preparation. They may, however, encourage one to make a direct contact with works of art."(26:9)

CHAPTER III

MOVEMENT: A DIMENSION OF LIFE

Movement is life, a never-ending panorama of kaleidoscopic patterns of nature and of people--of growing things, animal life, soft eddies of water, the violence of waterfalls crashing against rocks, the transition from Winter to Spring; of people moving en masse, or as individuals, old, middle-aged, and young; meeting, parting, walking, running, playing or working. Some are happy, some sad, some bored, some enthusiastic, some angry, but all share in common that inexorable truth which is the essence of life--movement. Man's movement is the ebb and flow of his existence. Havelock Ellis[9] meant much the same thing when he referred to life as being the dance of man--a vivid description, for indeed, the beat and movement of things is forever upon and a part of us.

Movement is a dimension through which an individual can identify himself to self, and, ultimately, to his universe--in more than terms of space and time. His movement becomes an extension of his personality and thinking--a non-verbal language of communication and expression which is universal. By moving, man attempts to find the significance and meaning of his own human identity; and in his symbolical interpretation of the experiences of life, movement is one facet of man's ability to understand himself and the world in which he lives.

As an acting animal, man's body structure is composed of many parts, which, in cooperation with their supporting framework of bones, are moved by the contraction of innervated muscles which have been stimulated. It is this muscle contraction in association with the lever which gives the whole structure its mobility.

It is quite clear, then, that the special mechanism of muscular contraction which gives mobility to man, also gives character to our entire active world. This mode of movement is so universal and so much a part of our discursive activities, however simple or complex, that one tends to forget how very special is its technique and how limited are its activities. Man is a muscular animal with specifically muscular activities. He is able to understand and know much about his outer activities, and to a much lesser degree, what the inner structure of his functional activities may be. He knows that the body is nervously controlled in various ways, and that this control is continuous. Brownell(3:14) described the essence of this when he said,

> Muscular life, indeed, is a continuous state of tension, in which changes take place with more movement or less, but the basic tension never disappears. Muscular activity is not, in other words, spasmodic action with quiescence in-between. It is a continuous tonus with relative extremes of rigidity and relaxation. This variability in tonus results in variable action. The come and go of active life resides here. The action and repose of the day's work, in contrast to this continuous movement of such systems as the coursing blood, find their key in this roughly rhythmic variability of muscular contraction. But underlying these ups and downs of muscular activity is a continuous possibility of movement inherent in the living tonus of the muscular system.

Man lives in a world that is variable and highly diversified, and which imposes on him uneven demands for action. In turn, his type of activity often reflects such an environment, and the apparatus that expresses its energy must be able to meet these variable requirements. Man is able to do this with the wondrous machinery of the human body, and this ability is further increased and expanded by man's ability to think and coordinate his muscular patterns.[3] Thus, one might say that thinking is largely an extension of the forms and functions of muscular activity.

Certainly, muscular activity in movement is not all of physiology, nor do the activities of the muscles provide the complete structure of the active world. Perhaps more than anything else, the senses, with their limitations and ranges of contact with the inner and outer activities of the human body, identify, define, and limit the world in which man lives. Man's active responses can take place only within the limits established by his senses. Therefore, they, too, help provide the form and content of man's movements and actions.[3]

Because of man's senses, his response to vibratory activities extends the periphery of his life far beyond the immediacy of his own body. As far as the larger, outer world is concerned, man's more important senses are sight, sound, and smell, for, as Brownell[3:16] stated,

> . . . without eyes, ears, or nose, man's periphery would contract down to his skin, or near it, and like an angleworm's, his world would be only what he is immediately burrowing in. His muscular system with its discursive facility and variable power would be next to useless. His thinking activity in such a world would be alien in its pattern and almost entirely meaningless. A worm

> could not use a good brain if he had one. A man so limited in sense apparatus would need little more than his spinal cord and not all of that. These senses of the body and these bodily muscles establish the world in which man lives.

Our outer range of experience and activity is limited and defined by our sensory perception--that is, we are limited greatly in our activities by our capacities to observe and to perform. The senses and the muscles are a single pattern of action, functionally and dynamically one, and are meaningless without each other. Though often treated separately and in fragments and specialities, it is only in the whole living pattern that these fragments and specialities have significance. Thus, no aspect of man's actions should be segregated from any other aspects of his actions, for if the individual is fundamentally his behavior, then all that he may be is always involved in this physiological texture of life.[3]

The whole scope of human movement is integrated with and dependent upon man's capacity for kinesthetic perception and response, that is, his sensory perception of movement, and, ultimately, his ability to conceptualize the meaning of his somatic-sensory movement experiences with the human mind. This is a primordial property of the totality of man. The Greeks early recognized this truth of the synthesis of body and mind and its activity, resulting in human movement as it pervades the unity and totality of life, and as it gives character to man's behavior. The fact that man is able to conceptualize about his movement lends a new dimension of thought to the concept of movement-kinesthesia; that is, man's perception of movement in space and time.

The complexities of the mind and its processes are innumerable, and often unfathomable, and the mind's relationship to body functioning and man's activities are equally so. Anatomists, physiologists, and specialists in kinesiology have done much to define and explain the physiological and somatic structure of man, and his movements in terms of the mechanics and dynamics of motion. However, little work has been done regarding the significance of the human ability to conceptualize the sensory or perceptual aspects of movement, and human meanings and values therein. Washburn(39:xiii), in her development of a motor theory of mental processes, said:

> If, then, one persists in being curious about the 'inner aspect' of behavior and believing that a man's thoughts are as legitimate objects for scientific study as his movements; if on the other hand, one realizes that it is through his movements that man takes his place in the rest of the order of nature, then the proper outcome of this twofold interest is an attempt to show that the whole of the inner life is correlated with and dependent upon bodily movement. . . . While the facts of attention, perception, and emotion have had their relation to bodily movement fully discussed, there still remain many phenomena connected with the complexer life of the mind, the revival of past experiences and the construction of new thoughts and ideas, whose connection with motor processes has not been satisfactorily traced.

That movement is an essential element in all organic life is an established fact. Man exists, three-dimensionally, in space, and as he moves, in the fourth dimension of time. This feeling of moving in space and time "accompanies and guides every reaction an animal makes to the stimuli that constitutes its sensory perception of its internal and external environment."(41:265) While this is equally true for both man and

animal, there is an essential difference which distinguishes human movement from animal movement; for in the case of animal reactions a direct and immediate answer is given to an outward or inward stimulus; whereas, in the case of human response, it is interrupted, retarded, or accelerated by a slow and sometimes complicated process of thought.[6] That is, according to Ellfeldt and Metheny[41:264],

> . . . human movement differs from animal movement because man is able to think about his own movement. He can conceptualize his kinesthetic perception of his own movements. And he can try to 'make sense' out of these conceptualizations by philosophizing about them within the context of his own structure of human meanings and values.

It may be said, then, that man's patterns of movement and behavior are outward expressions of inward impressions, involving the whole syndrome of his psycho-sensori-somatic experiences, and the meanings and values inherent in these human movement experiences, which govern his total response to life.

The brain has often been described as a "transmitter system", similar to a telephone exchange in which sensory messages are received and motor messages sent out. This analogy provided a fairly simple explanation for reflex action. This idea was expanded by Pavlov and others when they demonstrated through experimentation with animals that reflexes could be conditioned through a substitute stimulus, which became a "sign" or "symbol" for the original stimulus to elicit a given response. While this theory accounted for many facets of animal behavior, it provided no adequate answer or explanation of man's ability to comprehend his own stimulus-responses and think about them in terms of ideas or abstractions.[41] Read[30] referred to man's ability to con-

ceptualize about his sensory perceptions in terms of ideas or abstractions as the "vital image". It is a symbolical transformation which is a transition from the perceptual image to the conceptual image. Further, said Read[30:54],

> . . . But how was this transition made? To pass from the perception of discrete phenomena to the conception of invisible agents manipulating these objects according to some cosmic plan, is an advance in human intelligence, in sheer mental capability, for which we must have some convincing explanation.

Therefore, it appears that this unique ability described above, is the distinctive mark of the human mind as opposed to the animal brain.

Langer[21] has suggested that symbolic thought and behavior are among the most characteristic features of man, and it is within the framework of his ability to assign symbols to certain analogues in experience that we find the basis of all interpretation and thought. "These are essentially the relationships we use in weaving the intricate web of meaning which is the real fabric of human life."[21:63]

Man's ability to deal with human experiences in terms of abstractions and ideas was further expanded by Cassirer[6:43]:

> The functional circle of man is not only quantitatively enlarged; it has also undergone a qualitative change. Man has, as it were, discovered a new method of adapting himself to his environment. . . . As compared with other animals, man lives not merely in a broader reality; he lives, so to speak, in a new dimension of reality.

It was within this concept of "a new dimension" of the human mind and man's ability to conceptualize about his movement experiences through symbolic transformation, that Ellfeldt and Metheny[41] developed

a general theory of movement and meaning. Specifically, it was their purpose to explore

> . . . the meaning of human movement-kinesthesia as a somatic-sensory experience which can be conceptualized by the human mind [and] which was developed within the context of the basic assumptions of the philosophy of symbolic transformation as they relate to the nature of the process which enables human beings to find meaning in their sensory perceptions.[41:264]

This philosophy of symbolic transformation, in which is incorporated the transforming power of the human mind, has been developed by a number of writers, among whom are Cassirer[6], Ittelson and Cantril[18], Langer[20,21], and touched on by Brownell[3].

Brownell[3] suggested that life is characterized by three kinds of human activity: the nutritive, the external, and the symbolic. He was referring to the inner, automatic processes of nutrition, growth, reproduction, and metabolism; externally, to the dynamic activities of man as a discursive animal; and finally, to those mental processes which involve the using and manipulating of symbols for the totality of his experiences. These three kinds of activity are, of course, inextricably related to each other, and the relative equilibrium of these processes is life.

Langer[21:33-34] described the transition from the perceptual (sensory) to the conceptual (symbolic) as follows:

> Ideas are undoubtedly made out of impressions--out of sense messages from the special organs of perception, and vague visceral reports of feeling. . . . The material furnished by our senses is constantly wrought into <u>symbols</u>, which are our elementary ideas. . . . For the brain is not merely a great transmitter, a

> super switchboard; it is better likened to a great transformer. The current of experience which passes through it undergoes a change of character, not through the agency of the sense by which the perception entered, but by virtue of a primary use which is made of it immediately: it is sucked into the stream of symbols which constitute a human mind. . . . It is only when we penetrate into the varieties of symbolific activity. . . that we begin to see why human beings do not act as superintelligent cats, dogs, or apes would act.

Ittelson and Cantril[18] also emphasized the ability of man to receive symbolic messages as one of the most important functions of perception; and, further, that it is impossible to have any perception that is devoid of symbolic content--an inseparable and integral part of perception.

Whether man's symbolic transformation occurs in a discursive form, such as through words, as in the language arts, or in a non-discursive form, such as in the graphic or plastic arts, or as in movement, he is able to abstract meanings about them. In fact, the importance of man's ability to do this, for example, in the art of dance movement, "implies a fundamental human capacity to also transform the more general movement-kinesthesia experiences of life into <u>meaningful</u> non-discursive conceptual symbols."[41:267] Such reasoning, then, may lead to a newer insight into whatever meaning is inherent in movement-kinesthetic experiences as man's most persistent sensory experience; and, hence, to a discovery of the meaningful aspects of his thoughtful understanding of himself and his universe.[41]

CHAPTER IV

SOME FUNCTIONAL AND MECHANICAL ASPECTS OF MOVEMENT

Movement is used, in some way, in every task attempted by human beings. The basic tool for the performance of such activity is the human body. Therefore, to accomplish and execute such movement in the most effective and meaningful way precludes some understanding of the human body and its function in relation to its movement patterns. Such an understanding would involve an integration of certain knowledge in terms of physiology, neurology, as well as the mechanics of movement. The applied science of kinesiology attempts to apply to human motion certain composite facts from the above-mentioned sciences. To explore each of these components fully is beyond the scope and purpose of this study. However, the basic physiological and mechanical principles which affect and govern human movement, are significant to understanding the complexity of any action and should be noted.

I. ANATOMICAL AND PHYSIOLOGICAL BASES OF HUMAN MOVEMENT

The skeletal system of bones serve several important functions in human movement activities. The skeleton provides the basic supporting framework of the body, and the various surfaces and projections provide for the attachments of muscles, tendons, and ligaments. The bones are

attached to each other at joints, thereby forming a system of levers. It is this structure of joints and levers which makes movement possible. This is characteristic of all freely movable (diarthrodial) joints. There are five main types of freely movable joints: hinge, ball-and-socket, pivot, saddle, and condyloid. The directional movements which are possible in various ones of the above type joints are: flexion, extension, abduction, adduction, hyperextension, circumduction, rotation, elevation, depression, plantarflexion, and dorsalflexion.

Muscle Structure and Function

The body has three types of muscles: smooth, cardiac, and skeletal (striated). Each is distinguished by certain characteristics of innervation, structure, and function. The skeletal muscles are the ones directly responsible for motor activity and this group is the largest of the three groups of muscles, forming almost half the total body weight. This group includes all of the muscles that are attached to the skeleton, and receives its nerve supply from the central nervous system. Each muscle has a body (the main muscle mass), and the two extremities. The extremity which attaches to the bone is called the origin of the muscle; and the part which attaches to the more movable or distal bone is called the insertion.[34]

The microscopic structure of the striated muscle tissue shows that it is composed of cells, and small fibrils which run lengthwise

through the plasma, and it is these transverse bands which give the skeletal muscles their striated appearance. These innervated muscle fibrils have the characteristic properties of elasticity, irritability and contractility, conductivity, and metabolism. The total functioning of muscular action is dependent upon the physiological properties. The property of contraction is specialized in muscle, and because of this, in addition to the above-mentioned properties, there are also other properties related to its function. These include tonus, the refractory and recovery period, treppe, extensibility, and fatigue.[5,15,27,34,40]

Neuromuscular Mechanism

The cerebrospinal, or central, nervous system is an integral part of the neuromuscular mechanism which is responsible for movement. That is, only when the nerve fiber endings are stimulated, and the stimulus is conducted along an appropriate pathway of neurons and synapses back to the motor end plate, can a muscle respond by contracting. The basic structure in the neuromuscular mechanism is the reflex arc. The length of reaction time depends on whether the action required is a complex or simple one, demanding more or less use of the cerebral centers in identifying the stimulus and choosing a response.[1,5,34]

Stimuli for movement may enter the central nervous system by any of the external organs of reception, such as seeing, touching, smelling, or hearing; or, by certain internal organs known as the proprioceptors,

and semicircular canals of the inner ear. The proprioceptors are located in the muscles, tendons, and joints, and are stimulated by tension and pressure--that is, by muscle contraction and movement itself. This feeling of movement and body position in space is often called the kinesthetic sense. The semicircular canals and their end organs also contribute to the individual's awareness of his orientation in space, and play an important part in relation to direction of movement, and stability. Together, the proprioceptors and semicircular canals serve to guide the individual's total reaction to the outside world in terms of motion and space. These sensations make it possible for the human body to react to gravity, inertia, and momentum--essential in maintaining balance.[1,5,34]

An important neurological concept in muscular action is the concept of reciprocal innervation. This is the process of maintaining a relationship between two sets of stimuli, in which one set of muscles contract while other muscles relax. This becomes particularly important in any skill or task requiring coordination, or even in more subtle, less conscious movements such as in simply maintaining one's balance in standing.[1,5,34]

Other Physiological Components Affecting Muscular Activity

Contraction of the muscle involves not only a nervous stimulation, but an associated chemical action. The energy required for the production of muscular activity is provided through the chemical breakdown of the

food taken into the body, through the metabolic process. These chemical substances are brought to the muscles by a continuous blood circulation. In addition, the blood circulation is responsible for bringing to the muscles the oxygen supply so necessary in muscular activity. The amount of these substances present, and the degree to which they are used, is dependent upon the work load of the muscle, the energy required, and resulting fatigue. The by-products of muscular contraction are various. Some are useful, and some become waste products. The most common waste products are lactic acid and carbon dioxide. In the early stages of contraction, lactic acid bathes the muscle fibers and contributes to their irritability and contraction. However, as muscular activity becomes more severe, an accumulation of lactic acid and carbon dioxide, accompanied by a decrease in oxygen intake, results in a state of fatigue. Carbon dioxide is carried back to the lungs where it is expelled. Part of the lactic acid is reabsorbed by the blood in the form of glycogen and stored in the liver. As these chemical actions occur, the muscle is allowed to recover its former irritability.[1,5,34]

II. THE MECHANICAL BASES OF MOVEMENT

All movement is governed by certain mechanical principles and laws, and these principles and laws determine what the body can or cannot do. Regardless of the type of activity, these principles and laws do not change. While the purposes and motivation of various activities

may differ, the same tool (the body), the same medium (movement), and the same basic physical laws govern human activity.

The basic mechanical principles important in human movement are gravity, equilibrium (balance), motion, leverage, and force. The basic physical laws governing all principles related to movement are those discovered and set forth by Sir Isaac Newton.[2,34,40]

The Law of Inertia states that a body at rest remains at rest, or in uniform motion in a straight line or direction unless operated on by some external force. The Law of Acceleration states that the velocity of a moving object (that is, the distance traveled in a given unit of time) will remain constant unless acted upon by an outside force. The Law of Action and Reaction states that to every action there is an equal and opposite reaction. That is, when a body moves, or develops momentum, the supporting surface or other object receiving the force of that momentum develops an equal and opposite momentum.[2,34,40]

Gravity

The force of gravity is constantly acting on the human body in a vertical pull towards the earth's center. The weight center, or center of gravity, receives the greatest concentration of this pull. This is the point around which a body is balanced in a given position. A body is balanced when the center of gravity is over the base of support. If it is not directly over the base of support, or falls outside the margin of

the base of support, the force of gravity will pull the body over.[2,34,40]

Equilibrium

Balance, or stability of the body, is dependent upon the center of gravity being over its supporting base. When the center of gravity is displaced, causing the line of gravity to pass outside the base of support, then a new base of support must be established directly below the changed center of gravity. Therefore, according to Broer[2:25], it follows that

> the nearer to the center of the base the line of gravity falls, the more stable the body. Conversely, the nearer the line of gravity falls to the edge of the base, the more precarious is the equilibrium.

The range of movement of the center of gravity without falling outside the base of support is dependent upon the size of the base of support. Therefore, the larger the base is, the more stable the body remains, and the greater the range of movement of the center of gravity. Successful execution of all human motor skills and activities which involve movement is predicated on an understanding of this principle. An individual makes many adjustments, then, in his movement patterns to provide for this stability, as demonstrated, for example, in a simple walking or running movement, or in a diagonal or sideward movement. Any displacement or shift in the center of gravity must be compensated by either one of two ways: by moving another body part in the opposite direction to bring the center of gravity back over the supporting base, or by establishing a new,

and often larger, base which is under the shifting center of gravity. This is done quite automatically in many movements such as walking and running. In all situations, the base should be enlarged in the direction of the intended movement.[2,34,40]

Since many activities require a constant shifting of body parts, the center of gravity also changes in relation to the shifts. Many of the adjustments the individual makes to maintain his balance are unconscious and automatic. According to Hellebrandt[42], the center of gravity in the human body is in constant motion to some degree. Upon this basis, she concluded that in reality, even standing erectly is movement upon a stationary base. The ability of the body to maintain the line of gravity over its base of support is fairly constant. Hellebrandt attributed this ability to such controlling factors as the kinesthetic sense, the stretch reflex, and vision.

Finally, the maintenance of balance is dependent upon the sensory organs of the body, particularly the semicircular canals of the inner ear, and the proprioceptor end organs. These are responsible for the kinesthetic sense.

Motion

As previously stated, all motion operates under certain basic physical laws, as stated by Newton; and further, the behavior of movement is governed by certain principles.

Magnitude of force relative to the magnitude of resistance is the

determining factor which causes a body or object to move. Motion occurs in terms of direction and speed, and implies a change in the position of a body, if the magnitude of the force is sufficient to overcome the inertia of that body. Initially, some force is required to set a body in motion. A resistance of a body to change in motion is dependent upon the size and weight of the body, and the speed at which it is moving. However, once a movement is started, it is easier to maintain a given speed than to change speed, and, hence, less energy is required to maintain that momentum. If a change in speed occurs, then that change is always proportional to the force which acted upon it.[2,34,40]

In spite of the endless variety of movements which man uses, they generally fall into two classifications. Broer[2:34] stated that

> . . . when the basic characteristics of all these movements are studied, it is found that there are actually two types of motion--linear and rotatory--and all movements can be classified as being essentially one or the other, or a combination of these two.

Linear, or translatory, motion occurs when a body progresses or moves as a whole, with all parts moving in the same direction, the same distance, and at a uniform rate of speed. Angular, or rotatory, motion is movement of all parts of the object moving in an arc around its axis, similar to the spokes of a wheel. The arms and the legs are examples of this type of motion in the human body. Most human movements are a combination of translatory and angular movements. Curvilinear motion may occur when certain forces such as gravity, air resistance, centripetal and centrifugal force act upon a body.[2,34,40]

Two factors determine the type of motion that will result when a force is applied: the point at which the force is applied, and the pathway available to the object or body. Linear motion will result if the force is applied through the center of gravity, or uniformly over an entire side. Rotatory, or angular, motion will result if the force is applied away from the center of gravity. (However, when a force is applied against a lever part, one end of which is fixed, even though it is through the center of gravity, only rotatory motion can result.)[2,34,40]

Such factors as gravity, air and water resistance, and friction may modify motion, depending on the situation, and often, the direction of the movement. Wind, for example, would be a hindrance, if the direction of the movement is against it. Sufficient friction resistance is necessary in such movements as running or walking, to prevent slipping. Otherwise, much of the force of motion may be dissipated, such as walking in sand.[2,34,40]

Principle of Leverage

All levers turn about a fixed point, or axis, and are able to overcome a resistance or weight. The longer the lever, the greater the range of motion (at the expense of force).[40] Speed and range of motion are linked together, and are related to the length of the lever. That is, when a lever moves about its axis, the distance that any point on it moves is proportional to its distance from the axis.[2]

Most movements of the body are the result of the functioning of several levers, either together, or in sequence. This sequential action of the levers is particularly important in achieving maximum speed and range of motion.

Force

The application of force is the energy which is necessary to move a body or change its motion, either in direction or speed. This force may be internally produced by the body itself, or that which is produced by another body or object externally. Internal force produced by the body to move itself or resist or react to an external force, is supplied by muscular contraction. The amount of force necessary for a given movement must be considered in terms of the magnitude of the force, the direction of application, the point of application, the distance over which it is applied.[2] Thus, according to Broer[2:50],

> The greater the distance, and therefore the time over which the momentum is developed, the greater the momentum possible; the longer the force is applied to the object, the greater the force imparted, all other things being equal.

The greatest total force may be attained when several muscle groups cooperate in a given task. That is, the total effective force may be increased when a sequence of forces in the same direction is applied. Each force is applied at the peak of the previous one, until maximum force is exerted in the last phase, such as in throwing.

Finally, it must be said that while the normal patterns of every-

day activities do not require that the individual take time to pause and analyze his movements in terms of the laws and principles just discussed, his general understanding of them is necessary to ensure not only his greatest efficiency, but also a better understanding of himself and his limitations.

III. AN ANALYSIS OF THREE MOVEMENT PATTERNS: RUNNING, SPINNING, AND THE ROLL

Running

In general, the mechanics of running are quite similar to those of walking. The main differences are evident in the increased speed, a non-support phase (as opposed to the double-support phase in walking), and a more forward angle or lean of the body, resulting in a greater horizontal component. The non-support phase occurs between the time the back foot pushes off and is lifted from the ground, and the front foot strikes the ground. In running, the foot striking the ground is almost directly under the center of gravity, making the supportive phase almost entirely propulsive.[2]

The foot contacts the ground with the ball of the foot rather than the heel, and this helps to cushion the force, along with the flexion of the knee, ankle, and hip. In addition, the flexion of these parts puts the body in position for a greater push-off for each phase of the running action.

The forward lean of the body helps to reduce air resistance, and also keeps the trunk of the body in line with the driving leg. Speed tends to increase this forward angle, along with a faster swinging of the arms and legs, moving in opposition. The knees are bent more as speed increases, since shortening of the lever increases both speed and range of motion, with less effort. Similarly, the arms are also bent at the elbows for increased efficiency.[2]

As in any other movement, the greatest force exerted must be at take-off to overcome inertia, but once a speed is established, it takes less energy to maintain it. Speed in running may be increased by lengthening the stride, and/or increasing the push-off force of the supportive phase. Additional flexion of the knees aid in a more powerful extension and push-off and longer stride.[2,34]

Finally, although the proper application of levers and forces in the mechanics of running is essential, even this application is dependent upon the coordination of the working muscles with their antagonists, and the timing of the action of the various body segments in sequence. In addition, endurance, speed of reaction, pace, and motivation are important factors.[2,27,34]

The Roll

The simple starting position of the roll begins with the body in a squat sitting position, toes turned out at a slight angle. The arms

are dropped in front of the body between the legs, with the palms of the hands flat and the fingers pointing inward. The trunk and head are bent forward. Thus, the body is in a completely flexed position in the beginning position. The weight is shifted forward over the hands. The elbows are flexed enough to keep the body weight low. The individual then rolls over, keeping the spine and legs fully flexed until the feet are on the floor again. Just before the feet are on the floor, the head is brought back. When the weight of the body is on the feet, the body moves upward and into full extension as it attains the standing position.[34]

Mechanically, the squat position makes easier the complete flexion of the body which is necessary for a successful forward roll. Positioning of the arms and hands inside the knees and close to the toes also helps in maximum flexion.[34]

The hands, with palms down, help support the weight of the body thrust as it moves forward. The hands are turned inward and help decrease resistance, since the body will rotate more easily off the side of the hands than when they are pointed forward. This positioning of the hands, with the elbows flexed and out from the body provide the most relaxation for the back and shoulder muscles, thus aiding in the necessary flexion of those parts. As the head is pulled under, and the weight of the hips and body is carried beyond the base of support, the pull of gravity, plus the forward momentum from the arm lift, provide

the force necessary to complete the roll.[34]

In the recovery from the roll to the standing position, the angular momentum of the roll is offset by the movement of the head and arms opposite to the direction of rotation. The timing of the extension of the body to the standing position also helps in controlling forward momentum of the body weight over the feet.

Spinning

A spinning movement, in its purest form, is perhaps best demonstrated by the ice skater or the ballerina dancer. It is a skill requiring the greatest sense of coordination and timing in order to maintain balance, smoothness, and precision of movement, thus assuring a graceful, flowing movement. This, coupled with the tremendous speed possible for such movement, almost defies accurate description and analysis. While most of the individual's activities and skills do not involve a spinning movement in the purest form as mentioned above, there are many movement skills that are a modification of spinning, such as the pivot in tennis or basketball, or a series of turns, as in the discus throw.

Basically, a spinning movement must occur around an alternating pivotal base (the feet) until enough momentum is established to maintain the speed of the spinning body. Momentum is established through the sequential action of the various body parts. For example, it begins

with the head leading to the side, followed by the action of the arms in the same direction, the rotation of the trunk, hips, and finally the legs. Once the momentum is established, the arms are brought into a tucked position, crossed at the chest; this decreases resistance to motion. In addition, one leg is slightly rotated outward, and flexed somewhat at the knee. Therefore, the base of support, provided by the toes of the other foot, is quite small. The axis of the body, around which the movement occurs, must be maintained at all times directly over this narrow base of support, thus requiring the utmost precision in timing and coordination. Since this type of movement is confined over a very small surface, it is primarily rotatory. It may, however, become translatory, in a curvilinear path, if the individual continues to alternate the pivotal base of support.

Almost all the major muscle groups of the body are involved in spinning, each group contributing to the sequential action at a particular point. Speed and acceleration is greatest in the final turn when maximum momentum is established, and just before the arms are tucked close to the body.

CHAPTER V

THE THREE-DIMENSIONAL ABSTRACT ART FORMS: THEIR DEVELOPMENT AND RELATION TO THE MOVEMENT CONCEPTS

To move from the "real", or immediacy of experience, to abstraction is an intriguing and challenging transition. Abstraction has become, literally, the intellectual foundation of all thought, in the sense that almost all of man's activities are referred to in terms of symbols. All languages utilize symbols, science utilizes symbols, the arts utilize symbols--and in each instance, some symbol is used within a particular context. This is the way in which man expresses and communicates his ideas in an understandable way. Abstraction is the product of perception.

This chapter deals specifically with certain procedures involved in the actual creative process of interpreting the three selected movement patterns, running, spinning, and the roll, in three-dimensional abstract art forms. Included is the reasoning with regard to the development of the art forms in relation to each abstract movement concept, the choice of materials, and the technical processes in the physical construction of the final forms.

It is to be re-emphasized that all good sculpture is basically a fusion of three elements: idea, form, and technical means (materials).

The idea must be a concept which has an affinity for three-dimensional expression--that is, a visually expressive idea, the meaning of which is implicit in the form itself. Visually expressive sculpture, in this sense, needs no verbal explanation.

The artist arrives at an abstraction through the media of the creative process. Generally, sculptural ideas are abstracted from time, and these ideas are the essence of a time sequence, rather than any isolated part of it. For example, only an abstraction of the movement can establish the idea of running in a static form.

Very often the artist, as he conceives an idea, also conceives the shape of the form and the materials which best express it. At this point, it may be a somewhat vague and flexible synthesis of the three elements of idea, form, and technical means, and becomes clearer as he progresses. In light of the artist's knowledge, experience, and understanding, he is able to begin the actual construction or molding of the form with the materials chosen. His technique of construction, while important, should never smother creativeness, to the point that it becomes the end rather than the means, in the creative process. The mastery of technique, then, is only a part of that total synthesis in the process of creating.

The characteristics of the materials must be exploited in such a way as to facilitate the unity of the idea, form, and materials. In the final product, what is perceived is a visual abstraction, or symbolic

transformation of the total idea--a simplification of the complex, distilled from experiences involving the senses. It is for the artist, through his understanding of the materials, and the basic principles and elements of art in relation to space and form, to finally represent and present to the viewer's visual and kinesthetic perception, the idea which he wishes to convey. The perception and interpretation of the viewer is dependent upon all his associated ideas and experiences, observed or felt. Thus, the latent state of the form carries with it the impress of action. It carries reality in the imagination of the viewer, within his frame of reference and experience. There is a natural unity of idea and perception through the form.

I. PROCEDURE

In the beginning stages of arriving at ideas for the abstract art forms, the author, through her own experience, had very definite ideas about the three movement patterns and how they should be interpreted. From this knowledge, she began by making a series of sketches of each movement, progressing from simple gesture drawings of the real movement to simple abstract lines representing the concept of the movement. From these came the idea for the final working sketch. Examples of these sketches appear in Figures I, II, and III. In the technical process of creating the forms, certain variations or minor changes were made when felt necessary for a more expressive visual perception of the idea.

The final art forms were photographed with a Polaroid camera, and these photographs appear in Figures IV, V, and VI.

II. CHOICE OF MATERIALS

One of the technical problems at hand for the sculptor is the wise choice of materials, which, in his judgment, must conform to the best interpretation of his sculptural idea. Since it was the aim of the author to interpret specific movement patterns in three-dimensional abstract art forms, she found it necessary to define the general qualities and character of those movements to help determine what materials would best express those qualities in the final form.

All three movements--running, spinning, and the roll--have in common the qualities of airiness, lightness, and agility. All are characterized by the quality of vigorous motion and specific direction. All the movements are characterized by total body movement as well as angular movement of many body parts. All three movements involve sequential actions which convey further the idea of total body movement in a particular direction. The roll is characterized by its low, translatory movement, while running and spinning are movements of the body in a primarily vertical position.

Keeping the above descriptions in mind, the author decided the materials best suited for the interpretation of each movement in the art form would be a combination of wire, metal, and plaster, with primary

FIGURE I

WORKING SKETCHES: "RUNNING"

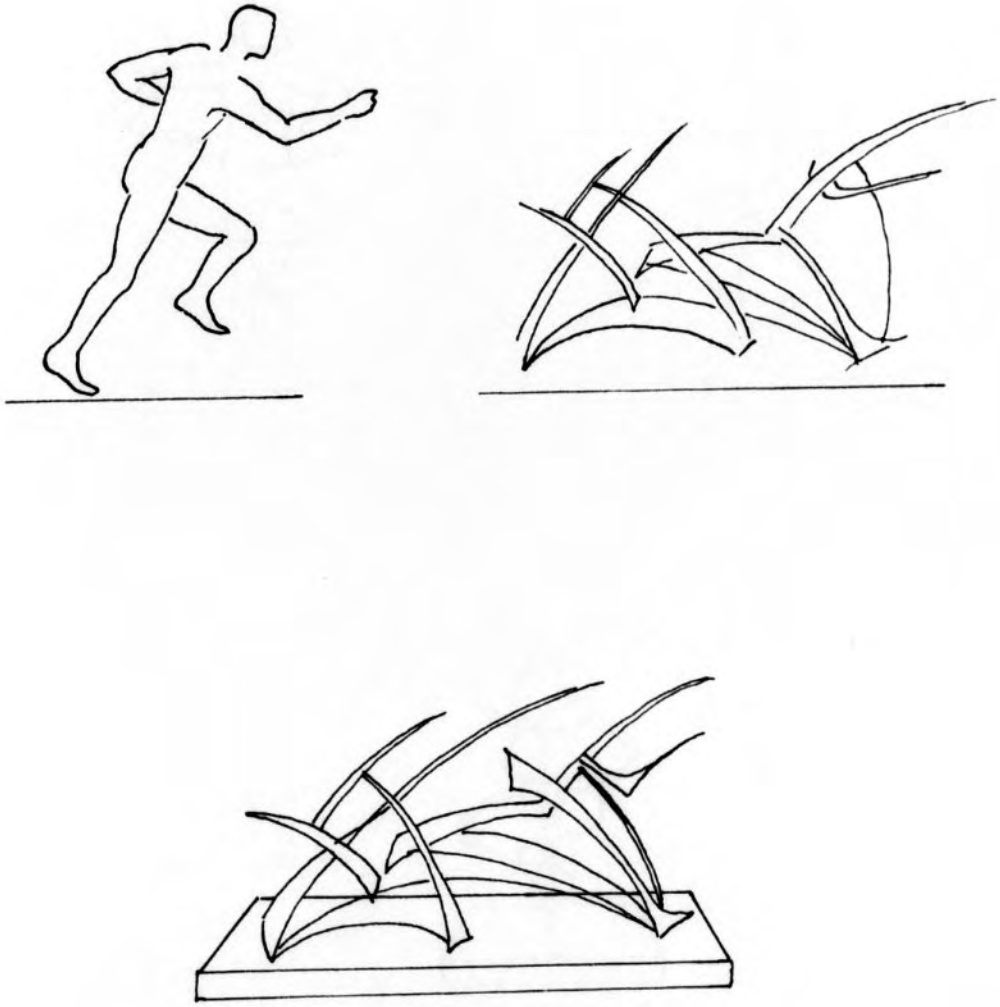


FIGURE II

WORKING SKETCHES: "SPINNING"

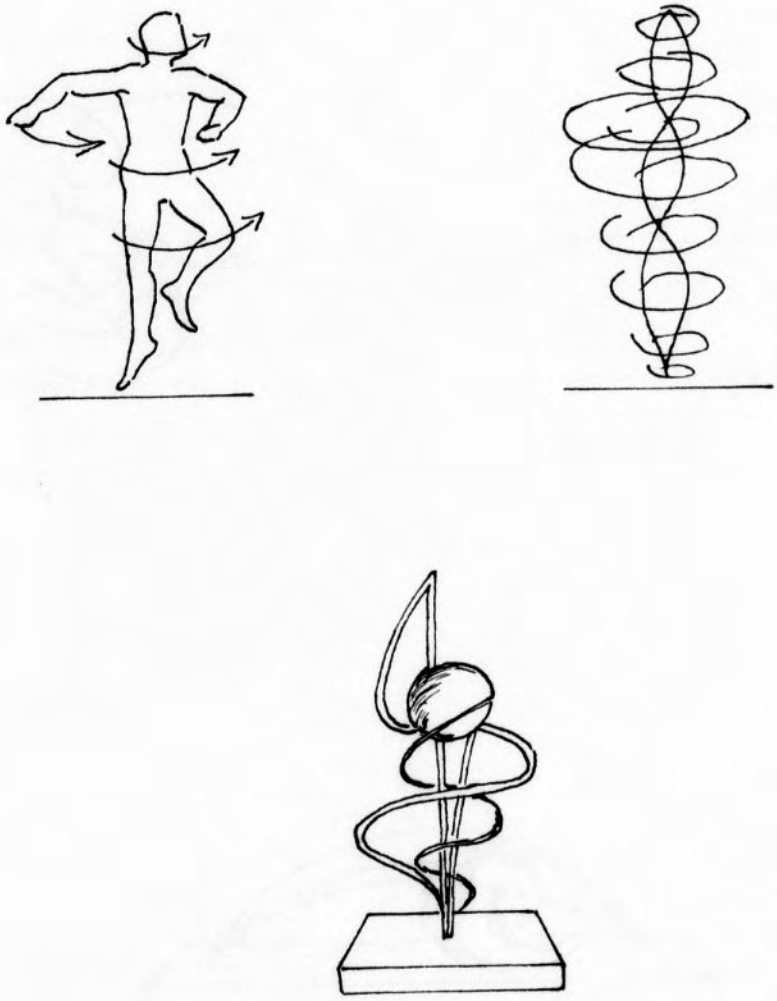


FIGURE III

WORKING SKETCHES: "THE ROLL"

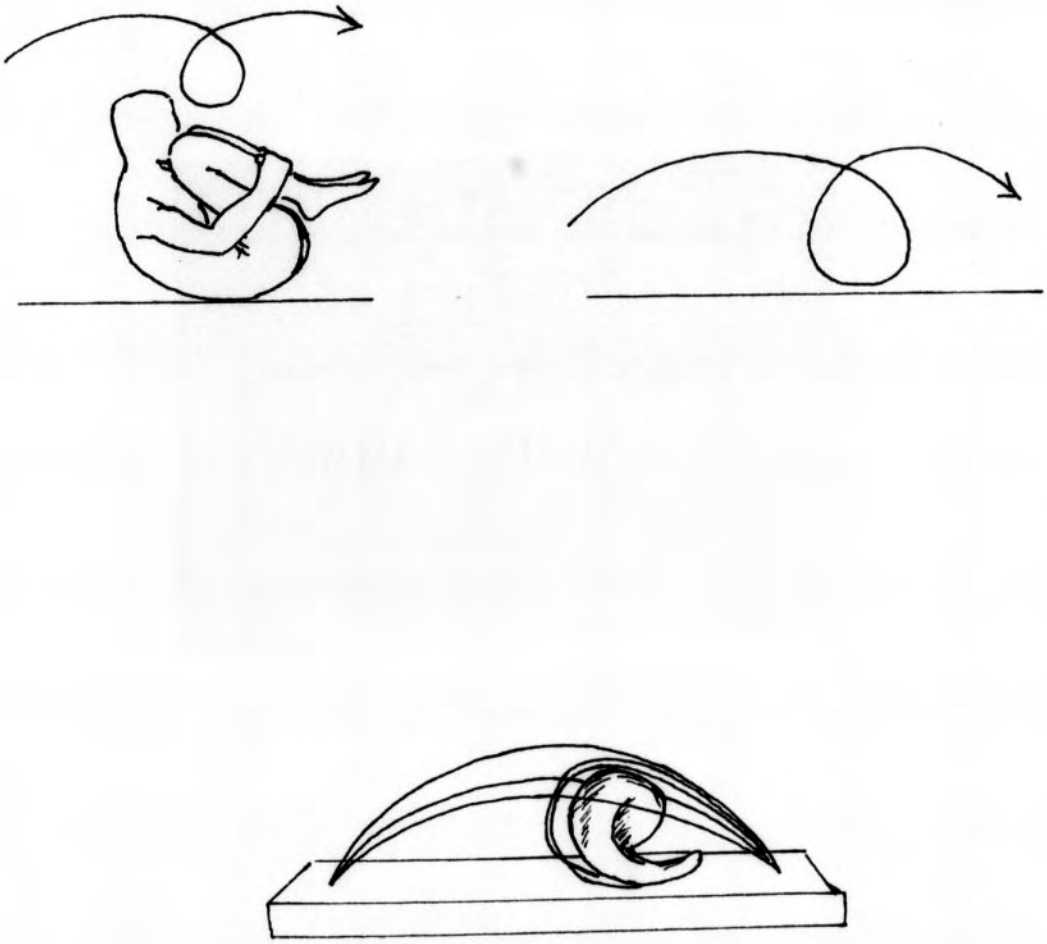


FIGURE IV

PHOTOGRAPH OF FINAL ART FORM: "RUNNING"

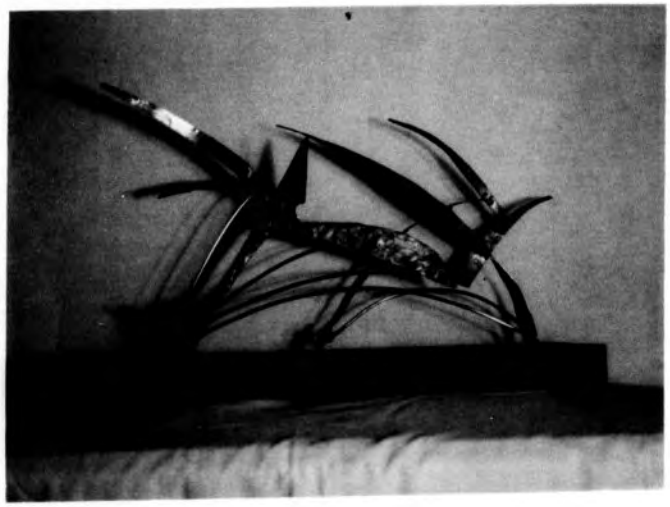
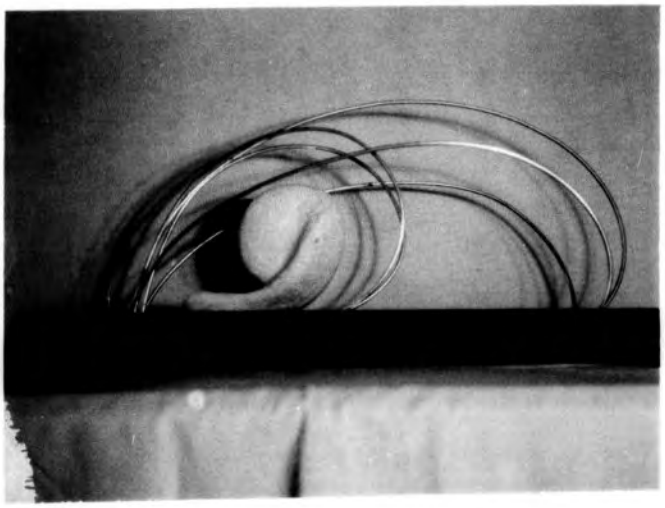


FIGURE V

PHOTOGRAPH OF FINAL ART FORM: "SPINNING"

FIGURE VI

PHOTOGRAPH OF FINAL ART FORM: "THE ROLL"



use being made of the wire and metal (copper). To express the qualities described above, materials which would convey the linear qualities of the movements must not be heavy nor cumbersome. The interaction of space and volumes with the forms becomes almost an activating force of the movement idea in the viewer's perception. Since plaster is essentially a heavy, solid material, it was used sparingly, not only to provide some contrast, but also to establish or indicate the presence of a core or center of movement. Both aluminum and copper wire and copper tubing were used, in addition to copper sheeting.

A combination of copper rods, metal, and solder were used in the form for running. With the exception of the rods, the copper metal forms were completely soldered, giving a dull variation in texture surface in places. The rods were left in their natural copper tone to provide contrast and emphasis on the linear movement direction through space, and to help suggest the characteristic horizontal component present in the forward motion of the body in the running form.

In all the art forms, there is evident the presence and feeling of large volumes of space interacting with the solid forms, so essential to the visual idea of movement, and to the unity of that idea and perception--a unity which expresses ultimately the living content of the form.

CHAPTER VI

SUMMARY

Man exists not only as an individual, but as a participating part of society. Therefore, man's mode of expression and communication is both individual and social in nature, for the individual and society insist upon reciprocal patterns of behavior. That man, as a part of society, is the central point of reference in all human activity is self-evident. The most basic fact of his existence is his biological character. If the individual is fundamentally his behavior, then all that he may be is always involved in the physiological texture of his life, for it is from man's physiological being that all his activities emerge.

Man's need for expression and communication is an essential part of his behavior. Whatever man's medium of expression and communication, it is always an effort to understand himself and the world in which he lives. The individual is able not only to perceive sensory experiences, but also to conceptualize about them in terms of symbols, whether it is through words, music, pictures, art, or movement patterns. In each activity, only the medium or symbols differ.

Movement is man's most immediate medium of expression and communication, and all other activities, directly or indirectly, are in-

fluenced by his movement patterns. The artist, through his art form, speaks also of life's experiences--only the medium is different. Thus, it is possible for the artist to interpret life through a permanent and specialized medium. Upon this premise, the author attempted to draw certain similarities of purpose in all expressive media; and finally to interpret through three-dimensional abstract art forms, her knowledge and experience of three specific movement patterns.

In conclusion, and in the opinion of the author, may it be said that while the various expressive and communicative media which man uses may differ in medium and direction, all of these media speak of the same thing--what life feels like to him.

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