DOCUMENT RESUME

ED 051 620 EC 032 684

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TITLE	Designing for the Non-Ambulatory.
INSTITUTION	Wisconsin Univ., Madison.
PUB DATE	71
NOTE	319p.; Author's Masters thesis submitted to the University of Wisconsin
EDRS PRICE	EDRS Price MF-$0.65 HC-$13.16
DESCRIPTORS	*Design Needs, Masters Theses, *Mobility Aids, *Physically Handicapped

ABSTRACT

Presented is a manner of organizing and grouping performance information to support the design and development of physical movement aids for non-ambulatory persons which enable them to ambulate or at least change their position in a semiambulatory fashion. Hierarchical levels of psychobiologic deficiency and corresponding condition variables are given for the various physically handicapping conditions which result in non-ambulation. Information on performance characteristics is intended to be used in design research for determining abilities and needs of specific non-ambulatory groups at all levels of non-ambulation and for determining the characteristics which the proposed dynamic artificial aids must possess. A case study using the data provided is included to illustrate that a psychobiologic approach to design is possible and to indicate the type of reasoning which needs to be followed in developing design solutions. (KW)

DESIGNING FOR THE NON AMBULA-TORY

DESIGN RESEARCH STUDY

"DESIGNING FOR THE NON-AMBULATORY"

BY

TERRAND BERNARD GRALL

A thesis study in Environmental Design is submitted to the graduate faculty in the Department of Environmental Design, University of Wisconsin, Madison, Wisconsin, in partial fulfillment of the requirements for a Master of Science degree in Environmental Design.

September 1970 to June 1971

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PREFACE AND ACKNOWLEDGEMENT

This study proceeded as my past interests and basic backgrounds in Industrial and Environmental Design were put into action. Throughout the course of this study I tried to remain impersonal to the study's problems. I attempted to play the many roles of an interdisciplinary design team by studying the varying topical areas in literature and by discussing throughout the study with individuals having varying interests in the study's problems. Through this effort, the philosophy of most of the interests, literature concerned and applicable to the overall problems of the study were obtained.

Sequentially, I collected, organized, interpreted and analyzed data in the study. I simultaneously developed a rationale to select and determine an order for the particular information required after showing how data and such an information system could be used.

Once the problem was fully identified, an eight-month period of study time was broken down. It took approximately three months to collect, review and discuss literature. Another one to two months was spent organizing and identifying data as to how it applied to the problem goals. I simultaneously began abstracting data.

I began to develop a case study strategy in which to develop design ideas for one kind of N.A. group, but before completion realized that all N.A.'s couldn't use or require the same optimal device...so I stopped. Then I re-evaluated my time to redevelop a strategy in which all N.A.'s could be taken into account. Two months were then left and used to test the overall information system and to see what criteria and ideas could be developed while this presentation was prepared. This study could not have been started or accomplished without the aid of a great many friends and associates. In particular, I am deeply indebted to Dr. Darell Boyd Harmon for his personal informational guidance on the dynamic nature of the human organism and design; to Dr. Robert A. Sievert, Director of Physical Rehabilitation at Madison General Hospital for his informational inputs on the nature of the non-ambulatory handicapped; and Mr. Steve Kayes, a non-ambulatory student of zoology, for his insight on problems of the non-ambulatory and together for their great willingness to discuss, share their time, knowledge and advice throughout this study. I would personally like to thank Professor Byron C. Bloomfield, Professor Donald C. Hay, Professor Ali Seireg and Dr. P. Murray, Director of the Kinesiology Lab, Wood V.A. Hospital, Milwaukee, Wisconsin, for their overall guidance, support and inspiration.

In addition, I would like to publicly express my appreciation to Mrs. Petra Jones, Director of Occupational Therapy, Madison General Hospital; Miss Paula Amazeen, physical therapist; Dr. Robert D. Harmon, a podiatrist; Mr. Ronald Peterson; and several of the non-ambulatory patients at Wood V.A. Hospital for their helpful comments and suggestions.

Finally, I must thank Professor Stephen Wasby of the Southern Illinois University, Carbondale; and my patient wife, Paula, for a great deal of aid in preparing and making this study a reality.

INTRODUCTION

Problem Statement

The overall problem statement or goals of this study are as follows.

To first find a manner of organizing and grouping in detailed, yet logical order, information to support the development and design of physical aids and surrounds for the N.A.

To be primarily concerned with an ability which most of us assume and heavily rely upon. The ability to stand, manipulate at will, and readily move or walk when and where we want our legs to go, is rarely, if ever even thought about. However, this study will extensively proceed to examine, understand, and identify the needs, characteristics and dilemma of those who do not regard walking as an expected and subconsciously common activity.

To develop alternatives and suggest a means by which the previously N.A. will be able to ambulate or readily move and change their position in at least a semiambulatory fashion. All the variables, factors, conflicts, research gaps, and interrelationships involved in determining and developing a system (subsystems) or means of supporting, powering and controlling artificially aided locomotion will be disclosed and discussed.

To attempt to resolve the question as to when, where, and how do you support the human organism, in order to make the proper interface for the varying locomotive demands. The intent is to answer the question of...how can you make man walk, climb stairs, etc., when he can't do so under his own power. Thus, the task of the problem is to find and define a valid and ideal manner in which to make self-ambulation possible for those who are physiologically not capable of walking.

Around these overall problem statements, I have structured and developed a research strategy which provides the basic data needed to resolve the needs that the statements imply.

Defining Non-Ambulatory and Unfunctional Performance

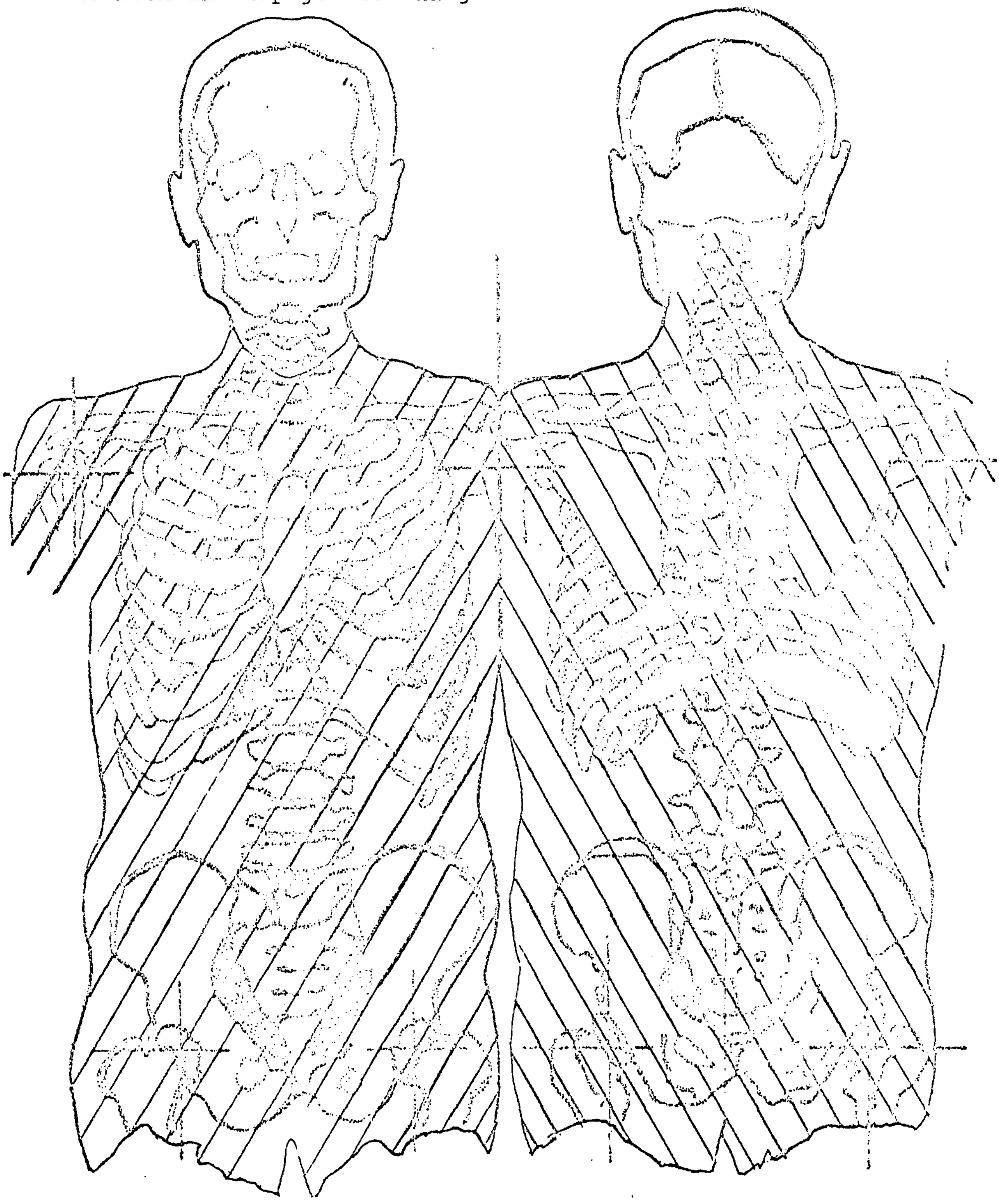
All biologic deficiencies causing conditions of unfunctional ambulation, whether they are innate, abrupt in onset, or slow to develop, will be accounted for in this study. Two characteristics which are common to all N.A. conditions need to be defined.

A N.A. human organism is unable to move functionally thru the vertical plane of space in a free and controlled pattern of body motion. The individual is unable to ambulate functionally under his own power or with the aid of existing physical aids. Someone N.A. is also unable to move with ease and resist the affects of external energies and forces.

N.A. performance conditions are likely to begin with the loss of hip joint control. In nearly all cases this means that bilateral lower extremity functioning is lost. In part this definition is dependent upon what existing physical aids can do for the biologically deficient, and on what we consider functional performance ability.

We must understand the difference between what is functional and unfunctional performance or locomotor ability. Locomotor or performance abilities that require to be maintained, not initiated more conscious, or mental effort than subconscious effort are to be considered unfunctional. Performance is also unfunctional if the

Non-ambulatory physical handicapping conditions are a result and differ only as the amount of biologic deficiency between the neck and hip joints changes



amount of physiological expense or strain and effort to use a physical aid makes performance inconvenient, impractical or quickly tiring within minimal dimensions of time and space.

Unfunctional locomotor performance is possible for the N.A., but at a greater than normal physiologic cost to the individual and with limited results or productivity. Thus, functional performance ability is achieved when results of effort outweigh the expense of maintaining that effort with more than marginal utility. We don't need any more philosophizing as to why the physically handicapped and particularly the N.A. need aid or assistance. The needs are real and a fact. What is the problem? Why are we as innovators of unbelievable gadgetry, flights to the moon, etc., and as people living in an affluent society unable to answer the N.A.'s needs in a real way? Why are we not resolving their problems? Why is the well intended piece-meal innovation and creativity that rectifies some of the results of their problems but not the problems themselves. Bracing, wheelchairs, etc. and talk of "barrier free" architecture are no shining examples of innovation. Advancements are occurring in methods of medical treatment and specialized arm substitutes and some toy development, but little has been done to make the N.A. functionally mobile.

In the course of this research and design study, some of the reasoning as to why I feel little or no progress in resolving the dilemma of the N.A. will be discussed and uncovered.

For over one-half of all the physically handicapped in the world, walking or being semiambulatory is an impossibility or mere dream. This sad dilemma affects thousands who are readily unable to support, use, power their own legs in a vertical locomotive posture. Some feel in a sense they are lucky to be confined to a wheelchair, while others just degeneratively lie or sit around. Well over one-half of all the physically handicapped in the world are and can be considered functionally N.A. Statistics in June 1970 estimate that there are over four million in the United States alone. How many there really are is unknown. The sad part is that most handicaps are children or in adolescent stages of life. "One in ten children in the United States are handicapped and six percent of all adults aged 21-64 are disabled. (Goldsmith S. 1969) Besides the many permanent N.A. conditions there are many semipermanent, and many short and long-term semifunctional ambulation condition. The majority of all handicapping conditions will have some movement restriction. For many, movement control and stability is still minimal, as they are unable to voluntarily move thru space with ease.

As a whole, I believe the neglect and lack of understanding of the handicaps problems primarily stems from the lack of information dissemination, availability and clear interpretation. Lack of interdisciplinary activity, remoteness of information for design decision making and specialism has caused a great deal of misconception about the handicap. Poor approaches and methods of design, engineering and research along with our society's uneven use of technologic advancement and progress are all contributors to this neglect.

Why Study Was Pursued

The need for further study was clear after my involvement on four other projects concerning the physically handicapped the previous year. Both academic and personal desires of learning more about interfacing man with his physical surrounds and possibly social benefit could be derived at the same time.

My major goal is to help end, destroy and rebuff the major physical, mental and literature barriers and hangups which I have briefly cited. As many before me, I became aware of the dilemma facing many thousands of people who are unable to functionally ambulate. The overwhelming need is obvious since apathy and specialism are unable to resolve the issue. I intend to provise data for those currently concerned with developing environments plus toys to support N.A. activity.

I want to assist efforts of bioengineering groups and make it clear to them what is essential and unessential. I hope to make it clear for them and others what should and should not be done in aiding the N.A. It is most important to provide data and results which will help guide and stress a direction as to what kind of hardware development is needed. Also I hope to identify what's involved in integrating the N.A. with any artificial moving system. To insure this, my intent is to identify information gaps, redundancies in human performance needs, and threshold or where important changes in performance criteria will occur.

The specific intent is to provide performance information which can be easily used within a modest amount of time to develop new and biologically beneficial movement aids for the N.A.'s must clearly communicate to users of information and allow all N.A. kinds to be helped. I must prove amplication of data, and show how it is used, showing that selective information can be developed into useful design decision making and evaluation criteria. Viable reasoning for reference and evaluation is necessary, to develop quantitative basis for solutions. The overall intent and reason for pursuing this topic is to help myself and others find a way to aid, support and move, or enable a N.A. individual to independently perform and move or walk in a graceful, vertical manner thru space.

Selling the N.A. Idea

Designing for the physically disabled N.A. is not "ivory tower" in nature as social priorities and concerns exist today. Hopefully society's means of judging what is important and how we measure "progress" will change.

It has been the assumption that the market for mass produced goods for the N.A. handicapped is limited. There are too many kinds, variations and conditions to contend with and understand. It has been believed that wide ranges in individual affects and degree of N.A. disabilities exist, these contentions have led others to believe that groups of N.A. having similar problems and needs was also small. Thus, the small size market is not thought of as interesting to mass production manufactures. "Statistics have been giving misleading impressions as to numbers involved..." (Goldsmith S. 1969)

Whether the N.A. market is small can be debated depending on how you look at its potential and how you actually cater or provide for it. Unnecessary fears of difficulties arising from small market standardization and mass production have developed. However, this is the same argument given about any new products when it comes to developing biologically suited, artificial supportive devices and surrounds. Determiners of all our new products have failed to recognize that there are underlying commonalities in N.A.'s just as in the nonhandicapped. The commonalities are biologically based in both cases. They have been only looking for superficial differences.

I strongly believe there is merit and reward in investing N.A. market if it's approached properly and understood. Although what is convenient for the N.A. may not be automatically suitable to everyone's use, there is also the potential of exciting spin off benefits, ideas and concepts.

Premise

It has been personally felt that a design research study must be new and creative, rather than a rewording of literature. With this argument, the study proceeded on the basis of several personal convictions, beliefs and aspirations concerning the role of design, basis and processes to design, and how the problems of the non-ambulatory, physically handicapped (N.A.) must be resolved.

Those of us, designers and others, who are or will attempt to plan, arrange, create or determine another man's physical surrounds, have a very grave responsibility, a responsibility and role which has not been fully realized to date to its vital importance. This responsibility is to serve mankind or the human being. The responsibility is to optimally reinforce the activities and dynamic nature of the "human animal". Only by adding to human knowledge or engaging in activities that have some social worthiness, can this responsibility be met or accomplished. I believe how responsible we become is going to directly influence men's lives, experiences and just how humane mankind will be in the future. As determiners of other men's physical surrounding we are inherently responsible for the present physical problems of mankind and must rectify them as we answer unresolved needs, without creating new problems. I believe that as determinors of other men's lives we must become agents of interdisciplinary thinking. We must develop "disciplined imaginations" and be able to interact with and use many disciplines, skills and factors, to create physical surrounds and devices which can enhance man's ability to meet his needs in a physiologically, psychologically and socially advantageous manner.

I am thoroughly convinced that past intuitive design or problem solving is misleading, invalid and impractical, particularly for large scale decision making. Optimal design decision making requires that all essential factors and aspects of a problem are accounted for. No problem or problems are possible to resolve without a thorough investigation into these essential factors, etc. A systematic and structured process of investigating is needed to interpret, understand and identify problems, needs and also the character of the tasks involved. Few, if any, problems exist, unless man is involved in some way. All decision making problems will involve or relate to some sort of human event, activity or interaction. Thus, an analysis to understand what performance or task situation and needs should be supported, is (I believe) a primary requirement before any decisions are made. I also believe there is a way to eliminate the intuitive gaps in the design process or stages between research and design application.

Although task analysis is basic to all problem solving strategies each investigation strategy in total will usually need to vary in the procedures and approach to understanding, since nearly all problems have a unique character themselves.

Biologically man never can isolate himself from his surroundings. He is continually interacting with the energies and forces about him. Man must remain dynamic to survive, or act and respond to the affects of these energies and forces. Man requires the freedom to move and respond to his surround in order to maintain internal integrity and ability to perform with least effort.

Thus, whatever is artificially provided for man must reinforce or support his biologic integrity and natural performance. The full development and proof of such a basis to design does not exist but is yet to be accomplished and be publicly recognized. However, there is no doubt that man tends to be the "common denominator" for all that is done and provided. So this study is an attempt to expand upon the still theoretical psychobiological basis and approach to design.

Throughout the entire study the assumption will be that the problems and subsequent dilemma of the N.A. have to be simplified and understood before they can be resolved. In this study, we will proceed to find a method and manner in which to organize and show how N.A. design decision making can occur. Such a system must be understandable and used by all disciplines concerning themselves with the N.A. There is reason to assume that a great many correlations regarding the N.A. and their needs have been never identified and need to be.

I hypothesize that there is a way to break down the varying components of human performance and relate them to biologic demands and varying amounts of biologic deficiency; with the hope of being able to determine quantitative differences between existing performance abilities and what the N.A. require. It will be my argument throughout this entire study that 1) all human organisms that cannot walk or readily move in a vertical posture because of a physical disability should be able to do so. 2) the human organism's ability to walk and readily move about is a natural, unique, efficient and necessary ability or activity of man and should be artificially substituted if the ability does not exist, as walking is the activity that distinguishes man from all other species, and 3) there is a very delicate, balance and interrelationship between the human organism's self functioning desires and the ability to walk in a self-propelling manner thru space.

The mysticism, etc., and stigmas that exist with the N.A. in general must be detached in thought and name, throughout this study. I feel I must convey the fact that just because someone is or has become a biologically deficient individual, it does not mean he is no longer a human being.

CRITIQUE

Societal Forces and the N.A.

Society as a whole has a tendency to do for the disabled N.A. what is really not necessary, and not do, what they really need, particularly when it comes to allowing the N.A. to live in the nonhandicap's environment. The social barriers the N.A.'s are forced to face often become more powerful than the physical ones they must put up with. Social complacency to aid the N.A. is seen by observing the amount of progress in providing the N.A. with new means of mobility, jobs, and access to facilities and public transit. Social discrimination is actually occurring.

The N.A. often have a hard time realistically seeing themselves as individuals, through the social stereotype they have been put in. Well meaning assumptions as to how and what N.A. ought to have and behave like have developed. Such social forces are often the cause of continuous embarrassment and involuntary harassment for many N.A.'s. The N.A.'s are continually faced with reminders as their being out of the ordinary. The subconscious harassment or anti-handicap feeling in society is possibly a result of the innate fear of not understanding.

> "...physical disability and wheelchair make people treat you as something less than human" (Fay L. 1969)

We need to change the presently poor social attitude, civil rights and cultural norms which have entrenched themselves in the minds of the healthy. They are stopping many N.A. from moving about and interacting in society as they could. Societal forces will continue to suppress the N.A.'s as individuals as long as they are treated as outcasted minority.

Past Assumptions on Designing Physical Aids for the N.A.

Basically, two attitudes as a result of false assumptions have prevailed with regards to designing for the N.A. One assumption has been that the N.A. want to be provided for and treated the same as those who are not handicapped. The cosmetic attitude is that aids should be indistinguishable in total appearance from that of the normal human body. The other alternate assumption is that physical aids and surrounds for the N.A. should be visually different from the nondisabled because their needs are different. I believe there may be a common medium between these two past assumptions.

Many current physical aids (bracing for example) are said to be effective only in superficial ways because they only test the N.A.'s physical capacity rather than enhance and support it. Also current aids neglect to allow for both practical and yet recreative usage. Developers of physical aids for the N.A. have not provided effective tools in which the N.A. can freely explore his physical surrounds. Most existing aids are difficult to use, energy consuming, lacking in dependability and require a great deal of mental effort to use.

> Severely handicapped patients must perforce accept almost any device which offers appreciable improvement in function regardless of bulkiness, poor appearance, cost, or other disadvantages. (E. F. Murphy 1965)

Many times physical aids are rejected when the N.A. finds or considers the aid of marginal utility without an effort required and can maintain a similar but less functional ability unaided with much less effort.

> Much of the mechanical self-help equipment given to patients at the time of discharge was little or never used. (L.Kaplan 1966)

Presently, the less deficient the N.A., the more effective the forms of physical aids are and the more biologically deficient the N.A., the less effective although the need is greater as the amount of deficiency increases.

The development of creative and functional physical aids and surrounds for the N.A.'s has not occurred. I believe definite misconceptions and false assumptions of the past have added to this problem.

First the "trial and error" approach to development of physical aids for the N.A. has been traditionally carried on. Making sure that there is something to physically show for one's work, whether on a viable basis or not, has been a safe way of measuring and verifying progress. A great amount of physical effort has been gone through to attempt and aid the N.A., but with little functional results.

Secondly, some engineering oriented disciplines have been guilty of developing partial models of human functioning, particularly biomechanic models. After doing so, they use the model to develop a comparable physical system to aid the N.A. using trial and error procedures and then attempt to relate the physical system to the users or human organisms that need to integrate with it. Poor biologic integrations between organic and the artificial have been the result.

There has been another false assumption and subsequent misconception concerning the importance of visual localization, that according to recent findings of Leonard Cohen and Darell Harmon, still misleads most of the design profession. Because of it we have had "design artists" (along with society) who have been lead to believe that visual localization (color, form and shape) is the basis of design. The appearance of physical aids became universally more important than design, based on maintaining the human organisms integrity by determining how well the mechanisms of visual orientation, balance and alignment were being supported. With a false basis to design and possibly some anthropometric data, "design artists" have been only able to conceive how the N.A. can be integrated with physical aids.

Thus, there has been a tendency up to this time to blame failures in physical aid development, on biological problems, of integrating rather than on errors and false assumptions of design, method of analysis and application. While it has been suggested, "...we need to learn from the mistakes of those in the proesthetics field" (Murray P. 1970). I also believe that designers must become more preventive oriented with regards to the problems of the N.A., than corrective oriented as the orthotic and proesthetic disciplines have been.

Information Use, Abuse and Gaps

Information concerning the topics related to designing for the N.A. is often overspecialized, unclear, contradicting and not applicable to design decision making. A great deal of it is only interpretable by the specialized groups that formulate it. Existing information is hard to locate and relate to real problems of the N.A. Lack of reliable statistical information prevents accurate estimation of the N.A.'s needs. Improper attitudes have developed because of emphasis in literature on special kinds of N.A. case histories and general surveys rather than on the N.A. as a whole. Minimizing social stigmas and the development of new aids for the N.A. have been thus curtailed.

Present knowledge of the human motor system is full of gaps, particularly neurophysiologically. It seems that what we know even about the human organism and its processes has been kept in an isolated and technically organized form. Understanding the performance of the human organism as a whole has been made extremely difficult. It is easy to see how isolated, biased interpretations and models are evolved as a result.

> A full synthesis of all the elements which simultaneously participate in dynamic locomotion has not been found. The primary determinants of it and dynamic performance ability. (Schermerhorn R. 1968)

Some misuse and contradicting interpretation of data comes about due to information usage biases and concern emphasis..."stay to the clinical side rather than the physical education interpretations of dynamic performance." (Murry, P. 1970) Availability of new materials and technological information for those concerned with patient oriented problems is tending to lag behind resources and information available to "ivory tower research efforts". Poor information dissemination is adding to this lag problem. As information of specialist research areas is not being interpreted for social usage or application. Research into the influences of combined stimuli and stresses on the human organism more than any other topic is needed to give us useful design information.

Barriers and Conflicts Between Disciplines

In order to resolve the problems of the N.A. there is a great need for interdisciplinary interaction. "...few, if any, disciplines stand alone..." (D. B. Harmon, 1971) There is a need to combine and synthesize all the points of view of disciplines related to the problems of the N.A. But first we must strip away the specialized terminology of the specialists. In particular, I feel design personnel need to seek full interaction between medicine, clinical and bioengineering groups. An increase in cross-communication between disciplines and literary terminology at all levels of personal interaction is necessary. More team studies are needed so that all aspects of the N.A. character can be understood. To date, all disciplines concerned with N.A., including designers, have been at fault for isolating themselves in the approach to the problems of the N.A. The medical profession or clinical disciplines are probably the most guilty. Due to their training, orientation and widespread prestige, they tend to be authoritarian arbitrators of biologic, information dissemination and use, while often unappreciative of the contributions other disciplines could make to help the N.A. Clinical disciplines have unknowingly controlled what becomes biological ethical, and often are an obstacle to advancement in the sharing and interpretation of their literature and terminology.

In the past individual groups of disciplines have been spurred to develop and emphasis tangible results. Research foundations prefer to associate and support these activities. Thus, in their desire and habit to prove tangible efforts, the use of technology has often been misused. Due to the lack of interdisciplinary interaction and proper approaches to problems of the N.A., unnecessary gaps between the present use of technology and its full potential, exists.

Those who determine the physical support and aid for the N.A. will need to seek more cooperation and minimize their research competition. They also need to increase their willingness, and abilities to expedite, carefully planned, creative leaps between ideas and application.

To beneficially account for the needs of the N.A., information concepts need to be unionized, particularly, within clinical disciplines.

> The mathematics of dynamic mechanics, action-reaction phenomena in different discipline languages must be broken down. (D. B. Harmon 1971)

The need to minimize barriers of specialist terminology and to develop the ability for communication in a common language, is a must.

Theory of Hierarchial Levels of Psychobiologic Deficiency

What is and how do you use the Key to hierarchial levels psychobiologic deficiency or N.A. condition involvement. All N.A. handicapping conditions were found to have one degree or another of performance loss due to biologic deficiency within so much of the body. This loss was usually to a moderate to full degree. At the same time there seemed to exist a correlation between what kind of biologic deficiency was occurring, how much of the body mass was involved and what kind of attributable problems and complications they had and/or soon developed. A theory developed, which later became evident, that N.A. human organism which were involved at the same level in the body, had basically the same characteristics, problems and resulting problems, etc.

Parameters as to when someone was or was not considered functionally ambulatory in a performance sense were set up. Thus, from the high neck area on down, to just below the hip joints, was the body mass area where I felt the variations in kinds of N.A. conditions fell for bilateral organic deficiency below this level is taken for granted. After carefully studying the N.A.'s handicapping conditions and how biologic structures, systems worked and where located, the area where variations in N.A. conditions occur was subdivided into eight significant biologic (body mass) areas or adjacent levels that if deficient would cause a definite change in total body functioning, or performance ability. The key is a guide enabling users to seek out and locate precisely what information they need to know. This key is essential to the entire information system for all of the data included in it, ties directly or indirectly in with the key. The key is directly interrelated with the chart on the N.A. condition kinds and to all of the characteristics needs, requirements which have been found to change as biologic deficiency and involvement increases and decreases.

Levels of the Hierarchial Key

With observation it is easily seen that the key is broken down into two kinds or sets of ordered categories which indicate a group of information. Numbered and lettered categories are given.

The numbered categories are arranged in a strict top to bottom order, each number category represents in a similar top to bottom order the particular body mass area from the high neck down to the hip joints. There are eight number categories each identifies and can lead a user to information on the particular body mass area that it denotes.

Mixed in with the categories indicating the levels of biologic deficiency or involvement are categories denoted by letters. These letters are presented in a less than perfect top to bottom alphabetical order because they will vary depending on the particular kind and level of deficiency rather than the deficiency order. The letters order is also less perfect because they often represent the indirect results of more than one level of biologic deficiency. There are two kinds of "lettered" condition variables thus occurring on the key. There are the performance variable changes which coincide with the particular level of deficiency. And there are the prominent characteristic condition variables that occur due to a particular body segment or area of deficiency. Each of the seven variable conditions have been placed in their proper progression of order as they occur with varying levels of deficiency. Each variable's own unique set of characteristics are thus properly additive to those of the overall deficiency level.

How To Use the Key to Hierarchial Levels of N.A. Biologic Deficiency

To use the key properly it must be remembered that its categories and their subsequent information are arranged in a carefully arranged and thought-out hierarchial order. There is a great deal of importance and meaning built into the way it's organized. The key will be a guide to using, locating, and comparing information within the information system. By using the key, it is easy to pick out where major changes in performance ability occur and/or what major condition variables can influence the overall N.A.'s condition character. The key will commonly be used after having to use the chart on the varying kinds of N.A. conditions and their level of involvement.

Procedure of use is simple since its order is self-explanatory. First, the highest level of biologic deficiency involvement or category interested in is located on the key. We must then determine what other categories of condition variable information on the key needs to be taken into account. This will usually vary depending on how biologically involved a group or kind of N.A. we are going to examine while keeping in mind that it is necessary to remember that each category given on key corresponds only to an independent group of information within the system. Next we must either simultaneously or separately check off and examine all of the numbered categories or levels of biologic deficiency from the highest involvement level on down, and take into account all letters within the highest levels category and any other proceeding letters which have similar "trail" numbers or are of a proceeding letter type. This gives us both a list of category numbers and condition variable category letters (with trial numbers). Added together, the information which corresponds to these categories now listed will provide an entire review of all the characteristics, problems, needs, etc., which are involved at this particular level of psychobiologic deficiency.

We must be careful when examining the information pertaining to the variable and be sure that it's being examined in light of its proper degree or involvement intensity.

A checklist is given to insure that the proper condition variables and characteristics below the highest level of deficiency we may be examining will be taken into account. Other than taking into account all deficiency characteristics falling below the highest level of deficiency indicated, the following lettered variables must be also included if the deficiency level is:

(1.1) A.1, C.1, D.1, E.1, G.1

(1.2) B , C.1, D.1, E.1, F ,G.1

(1.3) B , C.1, D.1, E.1, F ,G.1

(2.1) B , C.1, D.1, E.1, F ,G.1

(3.1) C.2, D.2, E.2, F , G.1,

(4.1) C.2, F , G.1

(5.1) A.2, C.2, G.1

(6.1) C.3

KEY TO HIERARCHIAL LEVELS OF BIOLOGIC DEFICIENCY
AND CORRESPONDING CONDITION VARIABLES

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p.101	D.1	MOVEMENT CAPACITY LOSS (moderate to full disruption or confined sitting & lying)
p.108	E.1	SELF-CARE DEPENDENCY (moderate to full)
p.114	3.1	MIDTHORAX AREA DEFICIENCIES (high abdomen-midback or T5-T8 innervation)
	D.2	MOVEMENT CAPACITY LOSS (moderate or confined, sitting and standing)
	E.2	SELF-CARE DEPENDENCY (moderate to partial)
p.121	4.1	LOW THORAX AREA DEFICIENCY (mid abdomen-low back or T9-T12 innervation)
p.129	F	HYPERTONIC-SPASTIC TO RIGID MUSCULATURE (moderate to full)
p.135	5.1	LUMBAR SACRAL AREA DEFICIENCIES (low abdomen-sacrum area or L1-S1 innervation)
	C.2	POSTURAL IMBALANCES AND DEFORMITY (moderate to partial disruption
p.145	G	CONTRACTURING OF BODY MASS (moderate to full)
	A.2	HYPOTONIC-FLACCID AND RIGID MUSCULATURE (moderate to full)
p.155	6.1	BILATERAL LOWER EXTREMITY AREA DEFICIENCIES (full)
	C.3	MOVEMENT CAPACITY LOSS (moderate to partial or confined,sitting & semiambulation

Kinds of Physical Handicaps and Their Common Non-ambulatory Onset Involvement Levels

All of the commonly found and existing physically handicapping conditions which are or degenerate into an N.A. performance condition can be represented along the hierarchial scale of biologic involvement. This has been done to clearly display and allow the user of the information system to compare the degree of biologic deficiency, the N.A. handicapping conditions are typically found to have at or when reaching their stage of unfunctional ambulation.

Due to their general nature some handicapping conditions must biologically degenerate to a higher level of deficiency before ambulation becomes unfunctional. Others are at an N.A. level from the start of their handicapping condition and while others degenerate into a stage of non-ambulation. Some do this faster than others, depending a great deal on the kind of biologic deficiency that is occurring. Examples of this: is in acute malformation and/or spinal deformities (A2), which first become N.A. when the deficiency or level of involvement reaches the 2.1 level. While multiple sclerosis will need to degenerate only to the 4.1 level to become a N.A. This chart ties directly into the key to the hierarchial levels of biologic deficiency and subsequent charts which tie into that.

KINDS OF PHYSICAL HANDICAPS AT THEIR COMMON N.A. ONSET INVOLVEMENT LEVELS

1.1	b1 High Quadriplegia	c1 Cerebral Palsy	c2 Acute Triplegia and Hemiplegia	
1.2	a1 Muscular Dystrophy	b2 Quadriplegia		
2.1	a2 Acute Malformation and/or Spinal Deformity	b3 High Thoracic Paraplegia		
3.1	b4 Midthoracic Paraplegia	b5 Polio-myelitis		
4.1	a3 Legg Perthes	b6 Low Thoracic Paraplegia	b7 Friedreiches Ataxia	c3 Multiple Sclerosis
5.1	a4 Rheumatoid Arthritis	b8 Lumbar Sacral Paraplegia	b9 Spina Bifida	
6.1	a5 Full Lower Extremity Amputation, Malformation and/or Deformity			

*see hierarchy of task performance levels corresponding performance ability and mobility conditions

HIERARCHY OF NON-AMBULATORY MOBILITY CONDITIONS

1.1 Lying only

1.2 Lying and Sitting only, self-propulsion is unfunctional

1.3 Sitting and Transferring, partial functional self-propulsion

2.1 Wheelchair, minimal to moderate self-propulsion

3.1 Wheelchair, full self-propulsion

4.1 Wheelchair, full independence

5.1 Unfunctional ambulation with supportive device and brace usage

6.1 Semifunctional ambulation with supportive device and brace usage

FORM OF PRESENTED INFORMATION

A great deal of personally interpreted informational data in the process of this study's investigation was collected, organized and put to use. Specific concern as to what type of data and how it would be needed and used developed. My belief, in organizing the data was that it had to conveniently guide and communicate in a logical manner with those interested in the problem but without a clinical background or a lot of time to find pertinent data. The information provided had to be easy to pull out of context, yet relate to the whole problem. Both detailed and general characteristics, requirements and needs of the N.A. had to be determined.

Thus, the preceding information is presented in a specific form to answer the needs and intent of this study. The datas form of presentation was developed with the belief that there is a close interrelationship between kinds of data and how data ultimately is and should be used. A systematic left to right top to bottom approach of tying the data together proceeded in collecting research data, breaking down and using data for analysis and problem solving, and testing or interacting data for problem solving evaluation and usage, to resolve the problems of one N.A. group in a case study. A method of collecting, arranging and breaking down informational data into sets and subsets, to determine their relationships and relevancy to the problems of the N.A. is apart of what's to be presented.

Because of my theory, an attempt to correspond all N.A. conditions to varying levels of biomechanic involvement and subsequent biologic deficiency is given. With the belief that changes in design will vary with the amount of biologic involvement and performance affected. Thus, the information to be provided is a means of comparing in regards to biologic performance, deficient human organisms to nondeficient performance and what's most important and essential to take into account when deficiencies do occur.

The preceding will emphasize that by understanding biologic deficiency and its affects on the body, we can understand the N.A. and their major problems of performance.

As an overall (STRATEGY) in which to organize, group and use information to support the development and design of dynamic, artificial supportive aids for the N.A. is presented with the desire of making design for the N.A. more simple and saleable. The goal of the following is to clearly identify and order pertinent data to develop informational criteria for design. So that the information presented can be used for the answers aren't there but the strategy and data as to why and how to design for the N.A. I believe are.

INFORMATION USAGE STRATEGY

PART ONE - Background Information

Background information on the N.A. handicapping conditions is essential in order to familiarize prospective users to and with whatever group of information corresponding problems, concerns they may be seeking, and wanting to use. Familiarization is important as it helps orient users to how and what information is given while it provides them with answers to questions of: who, what, when, how often and how much (to what degree) the N.A. are psychobiologically involved. This part can be used and as a basis to develop general followup and referral background for specific information.

Phase 1 Users of information should be able to quickly comprehend N.A. groups and/or kinds biologic state and what needs have to be taken into account. Defines what is considered as nonambulatory. Also defines and explains usage of the key to hierarchial levels of biologic deficiency.

Phase 2 There are four major ways in which users of system on index will be introduced and/or approach the body of information. Most are anticipated to be concerned about and interested in learning more about specific kinds or groups of N.A.'s conditions. Others will approach information with concerns for N.A.'s, biomechanic, performance ability or mobility condition remaining. And some will approach index of information with concerns for the N.A.'s psychologic, social or living condition needs and problems. Despite the interests or concerns of the user of this index they will be lead into the proper conditions with corresponding level characteristics and perspectives on how and why.

Phase 3 General information is provided to review the N.A. groups physiologic and psychology state. The kinds of N.A. conditions which are common in character to one another. Each of the three N.A. condition groups, overall characteristics are broken down into parts and performance affected.

Emphasis is on the severity and nature of group as a whole. It must be remembered that all characteristics will not be found in each of the condition kinds of the group, or in any one at one time. How particular N.A. kinds, groups will differ in biologic involvement and compare to kinds of N.A. which are at a similar level of involvement is disclosed for the user.

Phase 4 Information pertaining to the specific nature of the N.A. condition kinds is given with regards to condition group they belong and in order of severity. The common sex, onset age, cause, condition nature, and current potentials of eac kind of N.A. condition, are representative of the majority and may differ in particular cases. Nonambulatory onset age is a particularly important variable which I feel must be defined and carefully taken into account when analyzing the characteristics and needs of the N.A.

What is the N.A. onset age N.A. onset age, when referred to in this study indicates that this is when the N.A. condition reached a state or level of biologic deficiency, at which functional ambulation becomes impossible. Of course, when the N.A. onset occurs will depend upon the nature and cause of the N.A. condition. For some the N.A. onset is at birth, for others it's abrupt and for still others it becomes a matter of time until the body's performance ability diminishes to an unfunctional ambulation. The age or when the human organism becomes functionally N.A. I believe is important because of growth changes which occur due to man's development cycle. When and at what age or stage in the human organism's growth and development, the N.A. onset occurs must be seriously taken into account. There are basically three reasons; behavioral traits and attitudes will differ, tissue and cellur demands of the body change with age influencing the body's entire makeup and the N.A.'s potential for restoration changes.

In using this information system it must be remembered that the given factors are most representative of a young adult 21-28 year N.A. onset age, and need to be used as such. Although most characteristics given probably would not change in character at different onset ages, their influence at younger and older ages of onset possibly will.

PART TWO - Levels of N.A. Condition: Involvement, Characteristics and Needs

Users of this part will be able to determine in detail, exactly what biologic parts, performance and psychosocial factors are affected, changed or unaffected at the various levels of biologic deficiency. In a sense part two provides the user of information system with two logical and sequenced information orders. First the contents are arranged to correspond with the vertical hierarchial order of deficiency conditions and variables. Secondly, within each condition or level of biologic deficiency with its psychobiologic characteristic factors breakdown there is a sequential cause and affect factor rationale. After reviewing the general nature of the N.A. condition kinds and group characteristics this section should be utilized.

Phase 5 The general characteristics that result from biologic deficiency at such a segmental level in the human organism are given. These characteristics are broken down into their appropriate psychobiologic system and subsystem categories so that it's clear what is and isn't deficient.

The manner of and reasoning for the breakdown will become clearer as information system is used. However, such a breakdown of information will increase the comparability and meaningfulness of data and act as a base for continuous referral.

Leads into a detailed understanding of the importance and influence of each condition characteristic and how it affects performance.

Phase 6 Complications resulting from the characteristic at the varying condition and variable levels are given. The complications are presented as secondary effects which often accompany particular kinds and amounts of biologic dysfunctioning.

Performance inabilities that are attributable to the joint affects of the amount and kinds of biologic deficiency and its secondary affects are disclosed.

Characteristics of each condition involvement or variable level are broken down into their overall affect, or as problems which result from the total of inabilities, complications, and particularly characteristic factors.

Phase 7 Needs of condition levels are generated out of their preceding characteristics, problems and cumulation of resulting deficiencies. To make the needs easier to understand and more beneficial for later requirement development, they are arranged in their respective psychobiologic system and subsystem categories. The needs are and can be associated with what ability is missing or lacking at each of the particular levels of biologic deficiency or condition variable categories.

PART THREE - Advantageous Psychobiological Requirements and Beneficial Task Performance Range

This part of the strategy will provide an overview of how, and what is both physiologically and psychosocially advantageous for all N.A. Part Three will be indicating what can, often is, and could be clinically attempted or done to enhance the psychobiologic condition of any N.A. handicap. The differences between what is psychobiologically advantageous and what is psychobiologically beneficial for the varying N.A. condition levels, is emphasized. How advantageous needs interrelate with the N.A. primary needs, will be discussed. Indication is given as to how potentials, and requirements necessary to meet needs may change with varying ages, sex, and onset periods of N.A. conditions.

Phase 8 N.A. requirements are determined, listed, and categorized into what is physiologically advantageous with regards to the type and amount of therapy, care and equipment can aid the N.A. Psychosocially advantages are derived and broken down primarily from occupational, living, norm group, and self-image needs. We need to add Phase 8 (advantageous requirements or needs) with previous needs or requirements which came out of Phase 7 to determine Phase 9 or the total involvement level, user needs and requirements.

Phase 9 In determining the total user needs, both physiologic and psychologic constraints and precautions need to be added and/or taken into account with the total needs. These constraints are derived from clinical experiences and from reanalyzing what condition factors and characteristics are permanent.

Phase 10 The beneficial or desirable task performance capacity, or range is now possible to determine. Psychobiologic task performance parameters and goals can be set up for the particular condition level and/or kind of N.A.'s we are concerned with.

PART FOUR - Factors and Requirements of Varying Task Performance Ranges (Ability)

This part is primarily concerned with indicating how and what performance requirements vary depending upon the range of level of performance normally when human organism acts. Why task analysis applies to resolving the needs of the N.A. handicap is discussed. Rationale for determining the N.A. performance needs is given. How to select the ideal task performance range for the N.A. is discussed.

Phase 11 Fourteen task analysis are given for each of the major gross motor activities which lead up to full human locomotion.

Phase 12 Factors, biologic demands and variables of performance influence requirements to sustain tasks. Phase indicates how requirements vary depending upon level of performance range. What performance ability or biologic functioning is essential to sustain task ranges. How we are able to then correlate performance abilities to level of condition involvement and desired task range.

Phase 13 Breaks down the particular, normal performance ability down, into the same categories sets and subset of requirements that are necessary to meet the varying task performance levels analyzed. The basis of what is believed to make up and cause our dynamic structures perform the way they do will be briefly reviewed and discussed as how it applies to this study's objectives.

PART FIVE - Interact to Determine Condition Level (User) And Task Range Requirements Differences

How to determine differences between desirable performance ranges and existing N.A. performance ability is reviewed, with concern for difference between what biologic condition exists and what is beneficial in order to perform at a particular level. This part will indicate what criteria differences have to be artificially substituted or reinforced in order to make up for biologic requirement differences between task range required and existing N.A. ability requirements. The variables which occur at the varying levels of beneficial task performance range are taken into account. "Brain storming" for difference substitutes can take place.

Phase 14 Determines the requirement and ability differences between beneficial task performance levels and what performance ability it is. The requirement or ability differences will tend to vary the greatest at the ends of the hierarchial levels of biological deficiency. When the N.A. organism is extremely deficient there are a great many survival needs that have to be met. When the N.A. organism is at a lower level of involvement there is that many more performance abilities that should be supported. The kinds of requirements rather than the number or amount of requirements needed to ideally support N.A. conditions will change, due to the proportional shifting of amount and kind of requirements as task range performance abilities change or increase and decrease.

Phase 15 Determine what requirements need to be met, to interact on interface an artificial dynamic aid or support system with the deficient organism. We need to interact user needs with criteria that can substitute for difference or physical system requirements.

*INCLUDED IN APPENDIX is a review of a case study which was performed to test whether information system could actually develop the kind of pertinent decision making criteria, for design. A continuation of information strategy and how this criteria is put to use will be briefly discussed at this time.

PART SIX - Design Synthesis

Factors and requirements are to be reordered thru interaction. This is where we need to put groups of analyzed information to use. We must determine the problems and subproblems. We need to determine and identify any conflicts which will exist, the results of conflicts, response due to them, causes of conflicts, and suggest alternative ways to resolve conflicts.

PART SEVEN - Resolving Design Problems

We need to determine how alternatives must function and what componentry this will call for. We need to determine performance characteristics and how artificial componentry should interact. Design proposals are to be made developing new systems that use alternative function which will resolve needs, without conflict.

PART EIGHT - Making Design Proposals

This stage of the process is essential in order to three-dimensional test, reappraise and begin evaluating parts and the whole of the design proposals and their performance characteristics. Need to test crucial component interaction ideas on normal individuals first. Then design concept can be actually mocked up in full scale or in part. The need to test for extreme conditions that any design proposal is likely or could encounter in actual use situation. Measure normal individual's biochemical responses to system when using.

PART NINE - Design Implementation

Building of prototype to do complete evaluation is necessary. Field testing under actual user condition, with actual users, N.A. would be necessary. Any componentry revisions should be made at this time and then retested. Prototype would have to be put thru the array of potential dangerous situations in which it and its user may face in the environments it is to be used in. A one to two-year evaluation period is necessary before allowing it on the market.

NON-AMBULATORY PHYSICALLY HANDICAPPED GROUP (a)
MUSCULAR SKELETAL DEFICIENCIES AND/OR LOSS

CONDITION KINDS WITHIN GROUP

a1 Muscular dystrophy
a2 Acute malformations and/or spinal cord deformities
a3 Legg perthes
a4 Rheumatoid arthritis
a5 Full lower extremity, amputation, malformation or deformity

OVERALL GROUP CHARACTERISTICS

Basic body parts and areas affected:

Biomechanically, there is hard and/or soft tissue deficiency, warpage or loss. Their muscle fiber, bones, joints and/or ligaments are deficient and will be found to degenerate. Often their wrists, elbows and/or small joints will be involved. They are normally more severely involved in the lower extremities, pelvic and low thorax areas. The vertebral column is often thrown out of balance, due to uneven, asymmetric involvement. Contracturing of tissue is a major problem.

Biochemically, the peripheral circulatory system is minimally to moderately affected. Whereas, the respiratory mechanisms are minimally affected by the deficiencies.

Neurosensory, impulse patterns are interrupted. Feedback is unorganized due to mass deficiency or warpage. Pressure and thermal receptor feedback and response is usually present but not functioning properly. Their brain facilitation and awareness centers are not affected.

Basic performance affected:

Biomechanic, actions tend to be slow and stiff, while they are often unable to maintain or provide any muscular force. They are lacking or only have poor ankle, hip joint, and pelvic-low trunk rotation and extension-flexion capability.

Biochemical, fatigue is quick, with many only able to maintain short periods of activity. Respiratory and metabolic endurances are low. Circulatory support diminishes as does their oxygen and nutriment reserves will with time.

Neurosensory, is affected by partial paralysis sometimes. The lack of voluntary control over affected body mass is due to the masses physical inability to carry out the neural command. Poor feedback response is also diminishing voluntary body control. Neural receptor pathways will often, degenerate to a minimal existence, often becoming hypersensitive to abrupt stimuli.

a1 OVERALL BACKGROUND ON MUSCULAR DYSTROPHY

Common sex:	Is usually found in as many males as females
Non-ambulatory onset age:	Is commonly observed during either the 4-12 grade school, primary development period or the 13-20 adolescent, secondary growth period
Common cause:	Is thought to be a chronic noncontagious disease, with hereditary links
Common condition nature:	Is slow and progressively degenerative, quite predictable, and permanent. There is a continuous effort to maintain existing endurance
Current potential:	Is at present possible with full attention and care to maintain and sometimes stop degenerative character, but extremely difficult to regain lost capacity

a2 OVERALL BACKGROUND ON ACUTE MALFORMATIONS AND SPINAL CORD DEFORMITIES

Common sex:	Is usually found in as many males as females
Non-ambulatory onset age:	(Acute deficiency and warpage) is commonly observed during or right after birth, or the 0-3 preschool, survival mechanism development period
Common cause:	Is thought to be chronic, noncontagious and most often congenital with hereditary links. They have been attributed at times to artificial chemical inductions, and faulty genes
Common condition nature:	Is permanent, relatively unstable and yet predictable in condition change
Current potential:	Varies great deal, depending on the amount of care and therapeutic attention been given to individual. It is possible to replace missing mass and moderately straighten out warped body structure

a3 OVERALL BACKGROUND
ON LEGG PERTHES

Common sex:	Is usually found in as many males as females
Non-ambulatory onset age:	Is commonly observed during the 0-3, preschool, survival mechanisms development period
Common cause:	Is often attributed to congenital infection and/or physical disruption (congenital trauma)
Common condition nature:	Is slow and progressively degenerative, permanent, unpredictable and hard to maintain or prevent from worsening
Current potential:	Varies, although it requires extreme amount of daily, physical activity and care to maintain and restore some of its deficiency

a4 OVERALL BACKGROUND ON
RHEUMATOID ARTHRITIS

Common sex:	Is usually found in as many males as females
Non-ambulatory onset age:	Is commonly observed during either the 29-45 middle age, growth halt and decline period or 46-up, elderly growth-degeneration and decline period
Common cause:	Is thought to be a disease that has hereditary links and/or attributed to improper body nutriment, balance
Common condition nature:	Is slow and progressively degenerative, semipermanent and unpredictable or unstable in daily severity
Current potential:	Varies, although it may become subdued a bit in later life, it will leave victim with a permenent disability. Basic concern is on maintaining present state and controlling daily increases in discomfort

a5 OVERALL BACKGROUND ON FULL LOWER EXTREMITY, AMPUTATION, MALFORMATION OR DEFORMITY

Common sex:	Is found in both, although most acute amputees are males
Non-ambulatory onset age:	Is common for acute amputations to occur during the 13-20 adolescent, secondary growth period or the 21-28 young adult, final growth period Is common for malformation or deformity to occur during the 0-3, birth, preschool, survival mechanism development period
Common cause:	(Acute amputations) are usually a result of a traumatic accident, while the malformation or deformity is a result of hereditary, congenital malfunctioning or infection
Common condition nature:	(Acute amputations) are permanent, quite stable and predictable, while malformations or deformity will be semipermanent and more unstable

NON-AMBULATORY PHYSICALLY HANDICAPPED GROUP (b)
MUSCULAR CONTROL LOSS OR DEFICIENCY

CONDITION KINDS WITHIN GROUP

b1 High quadriplegic
b2 Low quadriplegic
b3 High thoracic, paraplegic
b4 Midthoracic, paraplegic
b5 Poliomyelitis
b6 Low thoracic, paraplegic
b7 Friedreiches ataxic
b8 Lumbar sacral, paraplegic
b9 Spina bifida

OVERALL GROUP CHARACTERISTICS

Basic body parts and areas affected:

Biomechanically, the existing structure and muscle linkage, force potential in the affected areas are unusable. All hard and soft body tissue and fiber in affected areas are indirectly influenced. The vertebral column is dislocated and/or deficient in strength, as is the pelvic girdle, hip joints, ankles, knees and often the shoulder.

Biochemically, the internal organs are minimally affected directly; and fully affected indirectly by the muscular control loss. Their chest, abdominal, low back, anal and vascular musculatures are all affected, and subsequently influencing their biochemical balance, in one way or another. Their natural aging process is greatly accelerated.

Neurosensory, peripheral neural pathways are fully affected in the involved areas. In fact some partial autonomic neural control is often affected. Their spinal column and its major neural pathways and/or fluid are disrupted. Their body mass position, direction and pressure receptors and/or feedback, no longer receive or can clearly reach the higher neural centers.

Basic body performance affected:

Biomechanic, is unable to balance or coordinate body mass segments about their structural framework. They are unable to voluntarily rotate, extend or flex body, mass segments in affected areas, except for reflex responses.

Biochemical, is often unable to maintain an infection free, internal or external state. A hypertensive biochemical, thermal, metabolic, circulatory imbalance or an extremely opposite hypotensive state will exist. The respiratory and metabolic system are most severely upset and the biggest cause of problems. Endurance is extremely low. The natural means of waste removal is usually abnormal.

Neurosensory, mechanisms still functioning are usually distorted and lack discrimination and coordination. The neural impulses from the high centers of voluntary control are cut off from destination. Some high neural center deficiency will sometimes accompany. Their sexual potency is often lost.

b1 OVERALL BACKGROUND
HIGH QUADRIPLEGICS

Common sex:	Is slightly more often found in females than in males
Non-ambulatory onset age:	Is most often found during the 13-20 adolescent, secondary growth period or the 21-28, young adult, final growth period
Common cause:	Is most often a result of traumatic injury to the midcervical (C4-C6) portion of the spinal cord, sometimes due to infectious disease
Common condition nature:	Is permanent, slow and progressively degenerative, with survival very unstable and unpredictable due to its extreme severity level
Current potential:	Requires an extreme amount of daily effort, aid and care just to maintain condition and prevent further degeneration and survival extinction

b2 OVERALL BACKGROUND ON
LOW QUADRIPLEGIA

Common sex:	Is more often found in males than females
Non-ambulatory onset age:	Is most often found during the 13-20 adolescent, secondary growth period or 21-28, young adult, final growth period
Common cause:	Is a result of traumatic injury which disrupts or blocks the low cervical (C7-C8) portion of the spinal cord, sometimes due to infectious disease
Common condition nature:	Is permanent, slow and progressively degenerative, and sometimes unpredictable due to its severity level
Current potential:	Requires a great amount of daily care and attention to maintain a relatively stable state...and to minimize survival threatening degeneration

b3 OVERALL BACKGROUND ON HIGH THORACIC PARAPLEGIA

Common sex:	Is more often found in males
Non-ambulatory onset age:	Is most often found during the 13-20 adolescent, secondary growth period or 21-28, young adult, final growth period
Common cause:	Is most often a result of a traumatic injury that disrupts and/or blocks the high thoracic (T1-T4) portion of the spinal cord
Common condition nature:	Is permanent, predictable in character, yet unstable as well as degenerative, due to the severity of trauma that usually is present with this degree of injury
Current potential:	Varies a great deal, depending how severe or shocking injury was at onset, yet requires an extreme amount of attention and care to maintain and/or partially restore some lost performance ability

b4 OVERALL BACKGROUND ON MIDTHORACIC PARAPLEGIA

Common sex:	Is more often found in males than females
Non-ambulatory onset age:	Is most often found during the 13-20 adolescent, secondary growth period
Common cause:	Is most often a result of a traumatic injury that tears, disrupts and/or blocks the thoracic portion of the spinal column somewhere between the (T5-T8) segments of the spinal cord
Common condition nature:	Is permanent, quite predictable in character yet unstable enough that it still requires a moderate amount of daily attention and prevention
Current potential:	Varies, although most are found with an acceptable level of self-care independence and a chance of some outdoor freedom

b5 OVERALL BACKGROUND ON POLIOMYELITIS

Common sex:	Has been found to strike as many males as females
Non-ambulatory onset age:	Is seemingly found at any age, although more common during the 4-12 grade school, primary development period or 13-20 adolescent, secondary growth period
Common cause:	Is found to be primarily a virus disease affecting the anterior nerve cells of the spinal cord or a disease of the central nervous system with the muscles being indirectly affected
Common condition nature:	Is semipermanent, quite stable or static and its paralysis severity is primarily based upon how many motorneurones are destroyed at the onset
Current potential:	Varies, although it usually does not have the inhibiting or complicative problems that others in its group have and has the greatest chance of developing in theory, new neuro pathways to the muscles which have been cut off and isolated from their neural impulses

b6 OVERALL BACKGROUND ON LOW THORACIC PARAPLEGIA

Common sex:	Is usually found more often in males than females
Non-ambulatory onset age:	Is most often found during the 13-20 grade school primary development period and/or 21-28 young adult, final growth period
Common cause:	Is most often a result of a traumatic injury of experience which disrupts tears or blocks the spinal cord somewhere between T9-T12 segments
Common condition nature:	Is permanent, predictable in character and moderately stable, with regards to complications
Current potential:	Requires a moderate amount of daily personal attention, and is possible to maintain and enhance condition status with a moderate amount of daily effort

b7 OVERALL BACKGROUND ON FRIEDREICHES ATAXIA

Common sex:	Does not seem to strike either of the sexes more often
Non-ambulatory onset age:	Is usually observed somewhere during the 4-12 grade school, primary development period and/or 13-20 adolescent, secondary growth period
Common cause:	Is thought to be an inherited disease, which first attacks the lumbar-sacral dorsal portions of the spinal cord
Common condition nature:	Is permanent, slow, progressively degenerates to a confined lying mobility state in later stages.
Current potential:	The potential of just stopping degeneration or maintaining a stable condition is very difficult

b8 OVERALL BACKGROUND ON LUMBAR-SACRAL PARAPLEGIA

Common sex:	Is a small tendency of it being developed more often by males than females
Non-ambulatory onset age:	Is seemingly more often during the 13-20, adolescent, secondary growth period
Common cause:	Is most often a result of a traumatic accident or experience which injures, tears or blocks their spinal cord's neural tail somewhere between the first lumbar and the fourth sacral vertebrae
Common condition nature:	Is permanent, very stable, and predictable in character
Current potential:	Seems to have the biologic and self-care potential to be independent outdoors, if provided with the proper mobility aids it is ideally unlimited

b9 OVERALL BACKGROUND ON SPINA BIFIDA (HYDROCEPHALUS)

Common sex:	Is no obvious prevalency of sex
Non-ambulatory onset age:	Is usually observed during the 0-3 preschool survival mechanisms, development period
Common cause:	Is thought to be a congenital disease of the central nervous system with hereditary links (faulty genes) that causes a malformation of the dorsal vertebrae, which in turn disrupts the spinal cord, and its fluid flow to the brain
Common condition nature:	Varies a great deal with three major variations. It is permanent, quite predictable in character although not normally degenerative, it is unstable at times
Current potential:	Is possible for them with effort to maintain a moderate degree of self-care independence and to control their condition variables

NON-AMBULATORY PHYSICALLY HANDICAPPED GROUP (c)
NEURAL CONTROL, HIGHER BRAIN TRACT
DYSFUNCTIONING

CONDITION KINDS WITHIN GROUP

c1 Cerebral palsy
c2 Acute hemiplegia and triplegia
c3 Multiple sclerosis

OVERALL GROUP CHARACTER

Basic body parts and areas affected:

Biomechanically, there are varying degrees of head and neck balance remaining. Usually they multiply, yet unevenely or asymmetrically affected. Their trunk and lower extremities are fully involved. The entire body and in particular their ankles are extremely weak. There will be both hard and soft tissue, fiber degeneration, with uncontrolled muscle tone. Spinal cord nerve disruption will occur.

Biochemically, their intestinal tract is usually upset as is their entire autonomic control of internal organ activity. They have poor peripheral circulation power. The hypothalamic and metabolic heat rates are disturbed as well as the bowel and bladder waste removal functions. Voluntary bowel and bladder control is lost.

Neurosensory, high centers of their brain, that control and initiate movement are malfunctioning due to varying areas of cell damage, within the cerebrum and motor cortex. Their heads sensory mechanisms for localization and orientation are dysfunctioning. The sensory tonic neck reflexs are disturbed and uncoordinated. Skin sensitivity is lost. The neural impulses controlling speech are partially blocked.

Basic performance affected:

Biomechanic, is no longer able to extend, stretch and/or rotate limbs and body outward. Fine body segment coordination of movement (motor skill) patterning is nearly impossible. They lack muscle control or coordination and become clumsy, awkward, and without agility. Any simultaneous joint action is disturbed. There is a great deal of extraneous movement in their faces and limbs. Their upper extremities usually maintain the greatest productive potential if their head and shoulders can be controlled.

Biochemical, endurance is low. All voluntary organ functioning is affected. They are weak and easy to fatigue. Both metabolic and respiratory mechanisms functioning, are under strain and pressure from being overworked and the asymmetrical disruption.

Neurosensory, is unable to correspond or integrate properly to environmental stimulus. The concentration and awareness level is low. They have poorly timed body movement, and find it difficult to maintain a relaxed position, particularly since they are hypersensitive to any abrupt stimuli. Their sexual potency is lost. Visual coordination is poor as well as their intellectucal and emotional capacities.

c1 OVERALL BACKGROUND ON CEREBRAL PALSY

Common sex:	Is usually found in as many males as females
Non-ambulatory onset age:	Is commonly observed after birth or during the 0-3 preschool, survival mechanism development period
Common cause:	Is usually attributed to congenital brain damage, malformation or trauma right after birth
Common condition nature:	Is incurable, permanent, slow and progressively degenerative and very unpredictable with varying intensity levels
Current potential:	Varies on location of brain damage, although with proper daily care and precautioning they can maintain and possibly restore some of their gross incapacities

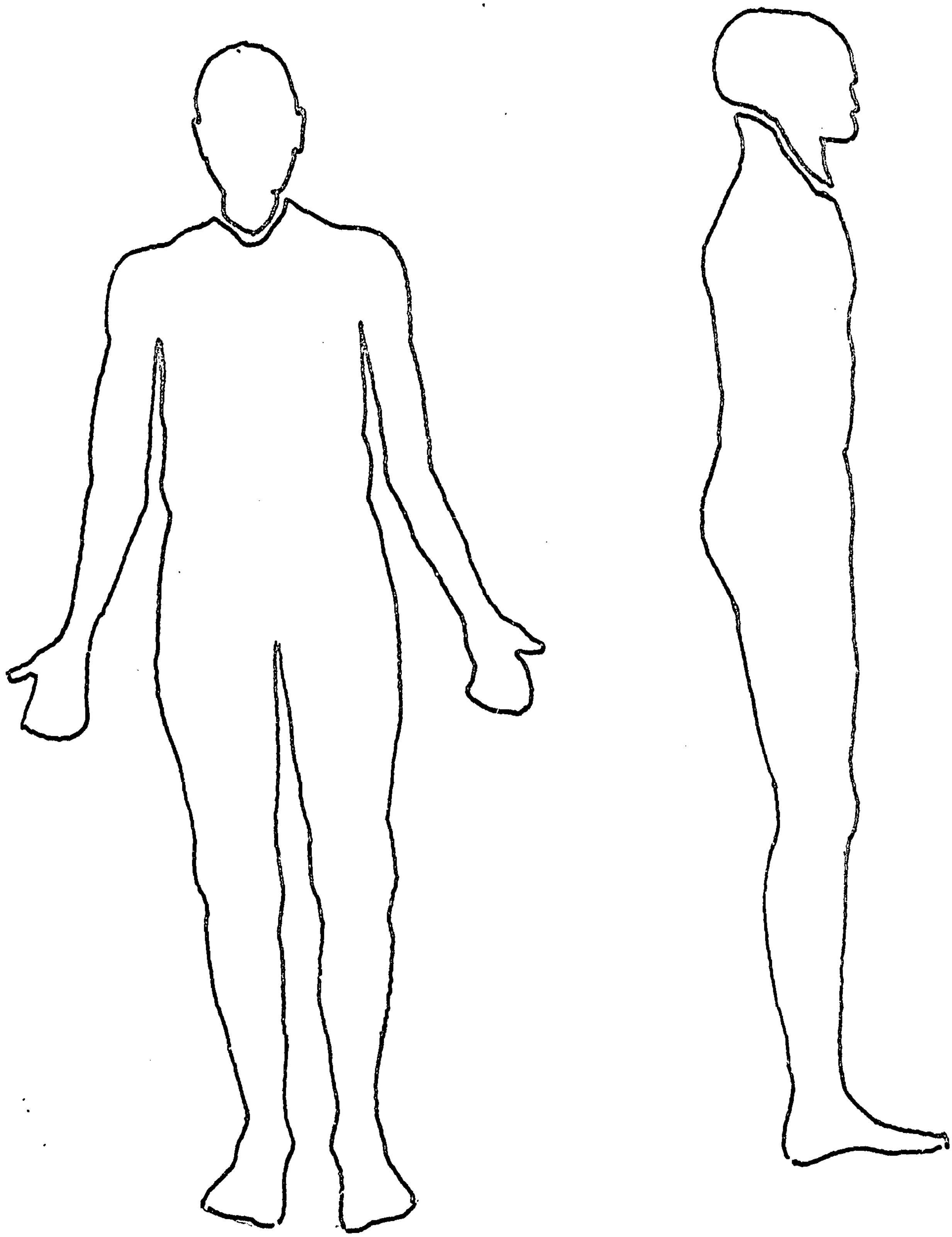
c2 OVERALL BACKGROUND ON
ACUTE HEMIPLEGIA

Common sex:	May be found slightly more often in females than males
Non-ambulatory onset age:	Varies depending on exact cause, but usually will be observed during the 0-3 preschool, survival mechanism development period, and incurred during the 13-20 adolescent, secondary growth development or 21-28 young adult final growth period
Common cause:	Is usually attributed to brain cell injury which can be congenitally caused or be the result of a traumatic injury
Common condition nature:	When severe, the paralysis is quite permanent throughout one-half of the body; mental damage as well as facilitation damage make it unpredictable, yet quite stable with regards to complications
Current potential:	Varies depending on extent of brain damage, but there is the potential with the proper care and exercise to maintain an infection free state and enhance their performance capacity

c3 OVERALL BACKGROUND ON
MULTIPLE SCLEROSIS

Common sex:	Although not exclusively, it is usually found most often in females
Non-ambulatory onset age:	Is commonly observed during the 21-28 young adult, final growth period, or 29-45 middle age, middle-age growth halt period
Common cause:	Is usually thought of as a degenerative familial disease, of the central nervous system that's related to tuberculosis
Common condition nature:	Is incurable, permanent, slow, and progressively degenerative, and very unstable, recurring unevenly in varying intensities
Current potential:	Varies on amount of spinal nerve fiber disruption but is very difficult to just maintain or control infection and contracturing from extinguishing their survival

***SEE THE NON-AMBULATORY INVOLVEMENT KEY (SCALE) FOR PARTICULAR HANDICAP KINDS, UNIQUE CHARACTER AND SPECIFIC NEEDS, WITH REGARDS TO LEVEL WHICH THEY ARE COMMONLY FOUND WHEN THEY CAN NO LONGER AMBULATE IN A FUNCTIONAL WAY AND BECOME NON-AMBULATORY**



1.1
GENERAL CHARACTERISTICS
RESULTING FROM HIGH CERVICAL AREA BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are commonly affected:

- Have limited head movement
- Have limited neck-head movement
- Slumping head-neck
- Have very limited physical strength (weak)
- Have little or no functional arm use
- High shoulder usage does not exist
- Little to no shoulder girdle lowering or raising

Neuromuscular parts and performance that are commonly affected:

- Often are found in a flaccid state (limp and clumsy)
- Sexual functioning and capacity is fully lost
- Nearly all of their voluntary control of body is lost
- Uncontrolled performance ability
- Uncontrolled trunk movement

Sensory parts and performance that are commonly affected:

- Partial to moderate neural mental disturbance may occur
- Moderate to full loss of sensory discrimination (feeling, touch)
- Autonomic nervous system is disrupted
- Sympathetic neural activity and influence is diminished
- Usually involvement is most severe because of neural control loss
- Have little to no eye-ear coordination
- Have little to no eye-trunk (body) coordination
- Motor skill is uncoordinated

Biochemical parts and performance that are commonly affected:

- No vital respiratory capacity

- Very weak capillary activity
- May have poor red blood cell count

Psychosocial behavior and attitude that are commonly affected:

- .Have no occupational potentials or hope
- .Have minimal communicative ability
- .Have extremely poor perception of surrounds
- .Remain or become very immature and childish
- .Extremely unpredictable and erratic behavior

1.1
COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

.Disrupted gravitational orientation mechanisms

.Disrupted visual orientation mechanisms

.Poor orientation or spacial overlapping and matching

.Directionality of eye-head and eye-body is awkward

.Squirmy appearance

.Depth perception, visual acuity and binocular convergence are distorted

.Contracturing or tightening of head, shoulder, and neck movement

.Overall bone density, skeletal framework warpage

.Vascular tone is disrupted

1.1
INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

.Unable to rotate head horizontally thru 45 degrees of motion or vertically thru 30 degrees of motion

.Unable to properly control head movements in extension, flexion or rotation

.Unable to perceive sensory stimuli properly

.Unable to learn properly (Take in information), or understand others trying to communicate

1.1 (Continued)

- Little to no communicative ability thru speech
- Unable to transfer body weight anywhere, by themselves
- Unable to maintain a secure or stable cervical vertical axis (vertebral column)
- Unable to use wrists or hands functionally
- Unable to move in a smooth manner
- Unable to produce or maintain any resistive activity and force for any limited duration

1.1

OVERALL PROBLEMS RESULTING FROM CONDITION

- Have limited visual frames of reference
- Unstable retinal patterns and visual input
- Can't perform eye-hand manipulations
- Even minimal self-care tasks are impossible
- Can't reach any secure vertically erect balance, without falling and collapse
- Fear of falling or loss of balance looms in nearly all propped positions
- One or more threats on survival continually loom in reality
- Can't meaningfully concentrate on anything
- Have little or no meaningful awareness of surrounds or of their body and mind's activity
- Dependent for all self-care
- Must rely on full-time assistance for their entire life span
- Confined to mostly lying during entire life span
- No endurance or fatigue power
- Slight competitive feelings or activity with others quickly becomes frustrating and depressive

1.1
OVERALL NEEDS RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

- .Stabilized head and neck movement
- .Structurally coordinate head and neck movement
- .Independently shift from lying to sitting positions
- .Independently regain basic movement abilities of rolling and crawling
- .Support, guide, and power shoulder-head movements
- .Keep shoulder and neck muscles from tightening or deforming
- .Increase amount of physical strength as much as possible
- .Proper postural support of head and necks
- .Restoration of basic arm-hand usage
- .Support arms, hands and shoulder girdle

Neuromuscular need is for:

- .Ability to maintain a restful body tonus
- .Ability to think clearly on one's own
- .Replace the missing sensory tonic reflex action, ability

Sensory need is for:

- .Coordinate visual orientation with gravitational mechanism
- .Communicate and properly receive information stimuli (particularly auditory and visual)
- .High amount of visual contrast in visual surrounds
- .Strong vertical and horizontal cues in near space

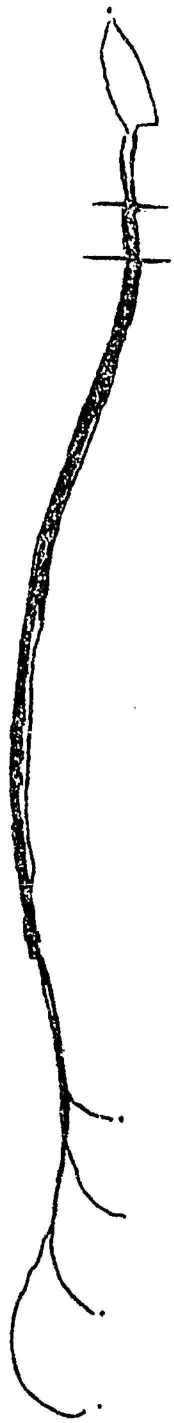
Biochemical need is for:

- .An increased amount of oxygen in their blood
- .Minimal biologic endurance to sustain short periods of physical activity
- .Protection from minor thermal changes
- .Increased circulatory support

1.1 (Continued)

Psychosocial, behavioral or attitudinal need is for:

- .Minimal ability to meet very basic self-care requirements for eating and grooming
- .Have basic movement capability to manuever within homes freely in some manner or form
- .To perform minimal sedentary occupational task
- .To perform with daily consistency
- .To cope with drastic body image change



b1
High quadriplegics, with a third cervical, spinal cord segment injury or blockage are unique because voluntary body control is near to fully lost. There is usually only very partial shoulder elevation, deltoid strength, with minimal or weak neck rotation and stabilization ability. There is zero hand or wrist functioning. Their internal organs are completely dependent upon reflex autonomic control, with the parasympathetic division being cut off from the higher centers of control and subsequently dominant.
*See condition variables: b,c,d,g, and f.

b1.2
Unique character of high quadriplegics that are of a fourth cervical spinal cord segment, injury or blockage. The parasympathetic division of the autonomic nervous system usually is dominant. There is some added shoulder muscle capacity that allows some external and internal arm rotation and stabilization. They will have partial to moderate bicep strength and thus moderate elbow flexion. Some may have weak wrist

extension action, hand closure ability and are users of exotic hand bracing. Some are able to roll over in bed and with the right equipment transfer from the bed. Because of elbow flexion, they are minimally able to self-propel specially devised wheelchairs but in an unfunctional manner.

c.1
A unique character of cerebral palsy, non-ambulatorys can be centered about their extraneous body and sensory behavior. Their sensory discrimination is very poor. Most are unable to bilaterally integrate limb movements thru their midline, along with poor body segment positioning sense. They are continually losing their balance. The lack of sensory tonic neck reflex control and poor visual orientation are major contributing factors. The visual resolution of two and three dimensional space is bad, while approximately fifteen to twenty-five percent have hearing problems. Over fifty percent will often be found crosseyed.

They are hypersensitive to nearly any stimuli, particularly noise, bright sunlight and any sudden movement about them, any of which can push them into a startle reflex. Many cerebral palsy victims are found to be left-handed with a unilateral arm deformity, a low pain threshold and slumping shoulders and head.

They all tend to have a specific need for colorfully contrasting equipment aids and/or surrounds (particularly blue and green) (Bayes K.) They need resistive exercise on facial, chest, abdominal musculatures to aid them in their speaking. Slow, uninhibited, relaxing gross body movements are to be stimulated. Lying or putting them on their backs is not recommended because it tends to tense them up and rigidizes their legs. There are five variations or types of cerebral palsy that are common, with the spastic and anthetcid types being most frequent in number.

cl.1
Uniqueness of spastic type cerebral palsy is in its severity of hypertonic reflex muscular activity. Spastics are unable to time or balance muscular actions or reflex, due to direct motor cortex, neural tract disruption. They are unable to control the reflex contractions which occur. Their discrimination of space and of themselves is completely distorted.

cl.2
Uniqueness of anthetoid type of cerebral palsy is in its squirmy movement behavior. They are plagued with a continuous uncontrollable, involuntary movement. Their major need is to relax the hyperspastic musculature.

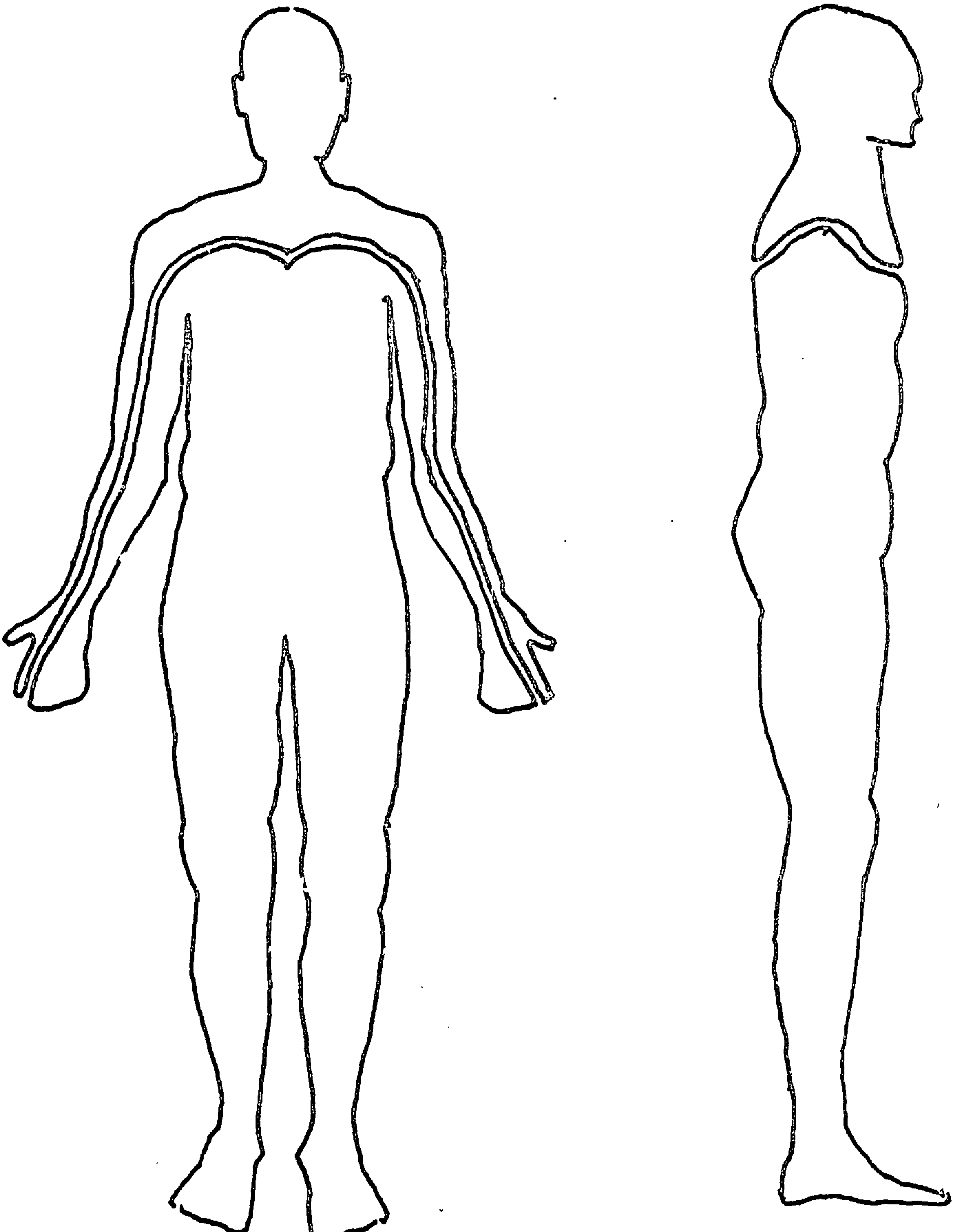
cl.3
Uniqueness of the ataxic type of cerebral palsy is in their extremely low muscular tension. They are plagued with continuous uncontrolled floppiness or wobbling movement

behavior.

cl.4
Uniqueness of the tremor type of cerebral palsy is characterized by a continuous shivering, or oscillation of the body mass. Tremor is common in older or adult cerebral palsies.

cl.5
Uniqueness of the rigidity type of cerebral palsy is that their musculature is stiff, but not tense. Their joints are usually locked in midrange.

c2
Unique characteristics of acute hemiplegia and of triplegia is that both result in a great deal of asymmetric imbalance. The acute hemiplegic is paralyzed, completely thru one full half or side of his body, while the triplegic thru all but one of his arms. In both their facial muscles, visual localization and hearing are severely disturbed. Both move very slowly and tend to always favor the unaffected body segments by supporting the deficient with the unaffected. The triplegics will have more mental damage than the hemiplegics, and are more involved with less of a chance of any recovery.



1.2
GENERAL CHARACTERISTICS RESULTING
FROM LOW CERVICAL AREA BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are commonly affected:

- Have weak neck strength
- Impossible to use arms functionally
- Weak biceps
- Can minimally raise and lower shoulder girdle
- Have no trunk stability, or suspension in vertical plane
- Intercostal (chest) musculature is fully affected
- Have only minimal to no functional voluntary ability to perform
- Have little to no physical power
- Have very minimal trunk rotation ability

Neuromuscular parts and performance that are commonly affected:

- Have poor control of head
- Often found with a semiflaccid or rigid muscular tonus
- Minimal head-shoulder coordination
- No shoulder-trunk coordination
- No reciprocal balancing of body mass is causing a dead weight feel

Sensory parts and performance that are commonly affected:

- Autonomic nervous system is disrupted
- Involuntary control loss
- No to little eye-trunk and body awareness
- Moderate to full loss of sensory discrimination
- Sympathetic neural influence is partially diminished

Biochemical parts and performance that are commonly affected:

- Have zero to no vital capacity or only approximately 20% normal capacity
- Have only diaphragmic respiration
- Little or no respiratory reserve (minimal residual capacity)
- Have a great deal of trouble just breathing
- Have changed and abnormal breathing and coughing patterns
- Can't sneeze or functionally cough
- Have a minimal expiration ability
- Respiratory abnormalities tend to cause a postural twist to the preferred side of the body

1.2 (Continued)

- .Electrolyte and homeostatic balances are fully disrupted

- .Have a great lack of functional blood reserves
- .Have a great deal of blood pooling
- .Have an extreme potential of fainting

- .Unable to adequately sweat, shiver, or change blood flow to control body temperature
- .Chill extremely easy

- .Full evacuation assistance is usually required

Psychosocial behavior and attitude that are commonly affected:

- .Unable to develop or sustain any motivation from within
- .Have only minimal mental stability
- .Don't ever really adjust to their handicap
- .Don't usually have any occupational potentials
- .Unable to communicate clearly or easily with others
- .Are socially alienated and can't integrate with others
- .Have erratic and unpredictable behavioral pattern
- .Have a distorted mental awareness
- .Live in a seemingly confused state of mind
- .Great deal of social and emotional insecurity
- .Must relearn nearly all activities of daily living
- .Have a great deal of orthotic equipment about them, particularly exotic hand splinting
- .May only slightly adjust to handicap thru time
- .Have a great subconscious fear of surviving
- .Attitudes of anxiety, fear and depression are strong

1.2
COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

- Postural trunk warpage due to bilateral balance disturbance
- Uncontrolled and/or uneven muscular pull on or thru the trunk
- Too much lying around
- No energy reserves or physical endurance
- Needs all available strength just to maintain breathing
- Awareness of body part locations is completely distorted
- Accumulation of fluids in the lungs
- Unstable heart rate (slower)
- Vascular dilation
- Increased blood pressure due to severe pulmonary complications
- Lungs decrease in their ability to expand
- Breathe a great deal thru their mouths
- Have dry inner mouths
- Have abnormal breathing, rhythm sounds
- Shoulder girdle musculature quickly tightens up
- In a continuous state of mental and physical fluctuation

1.2
INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

- Unable to perform manipulative tasks
- Unable to use arms in any functional manner
- Unable to sit up on their own in an erect posture or transfer body mass

1.2 (Continued)

- Unable to shift body position practically at all
- Unable to rotate shoulders thru a minimum of 8-10 degrees in the horizontal plane
- Unable to control trunk in a sitting position
- Unable to control or move shoulders thru even a minimal range of:
  Extension.....48°
  Flexion......176°
  Adduction.....39°
  Abduction....115°
  Lateral rot...19°
  Medial rot....75°
- Unable to maintain or develop any kind of respiratory reserve
- Unable to lift trunk up well and often not at all

1.2
OVERALL PROBLEMS RESULTING FROM CONDITION

- Shoulder and neck muscles become very strained and sore
- Self-care remains very difficult if not impossible
- Require full-time assistance
- Unable to rotate thru their vertical axis at all
- Very unstable vertical axis, tension, or balance
- Can't lift or move body weight
- Occupational potentials still are not practical and remain nearly nonexistent
- Can't support arms properly
- Skin breakdowns occur frequently about upper neck and trunk increasing respiratory distress
- Rapid musculature tightening

1.2 (Continued)

- Postural positioning greatly influences their remaining respiratory ability

- Improper postural positioning causes respiratory hysteria (Gasping, etc.)

- Usually unable to functionally self-propel themselves in a wheelchair

- Unable to roll over or come to sitting posture

1.2
OVERALL NEEDS RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

- Maintain and reinforce moderate arm and hand functioning
- Full grasp and extension functioning of hands
- Keep all musculature loose and from tightening
- To externally rotate and elevate shoulder girdle
- Lift and support rib cage or thorax cavity
- To vertically suspend vertebral column and shoulder girdle (full trunk support)
- To minimally sustain resistive physical actions
- Ability to moderately range all involved musculature
- Independently move from lying-sitting, and sitting-standing

Neuromuscular need is for:

- Stabilize, coordinate and guide shoulder-arm movements thru gross patterns of action
- To support and guide arm, hand and shoulders with eye-hand desires

Sensory need is for:

- To replace missing gross control and feedback signals from shoulder joint

- To replace missing feedback as to hand's action and position

1.2 (Continued)

Biochemical need is for:

- To relieve any respiratory musculature tightening
- Guard against respiratory infections
- Use corset when sitting to increase diaphragm's affect on inhaling and exhaling
- Decrease overall oxygen requirements of body by taking Vitamin "E" supplements
- Increase endurance and fatigue power thresholds
- Use full chest and diaphragmic, respiratory support (abdominal support spring)

- Full circulatory support

- To be in a fully controlled environment with narrow thermal and humidity variance range
- For thermal support and balance aid

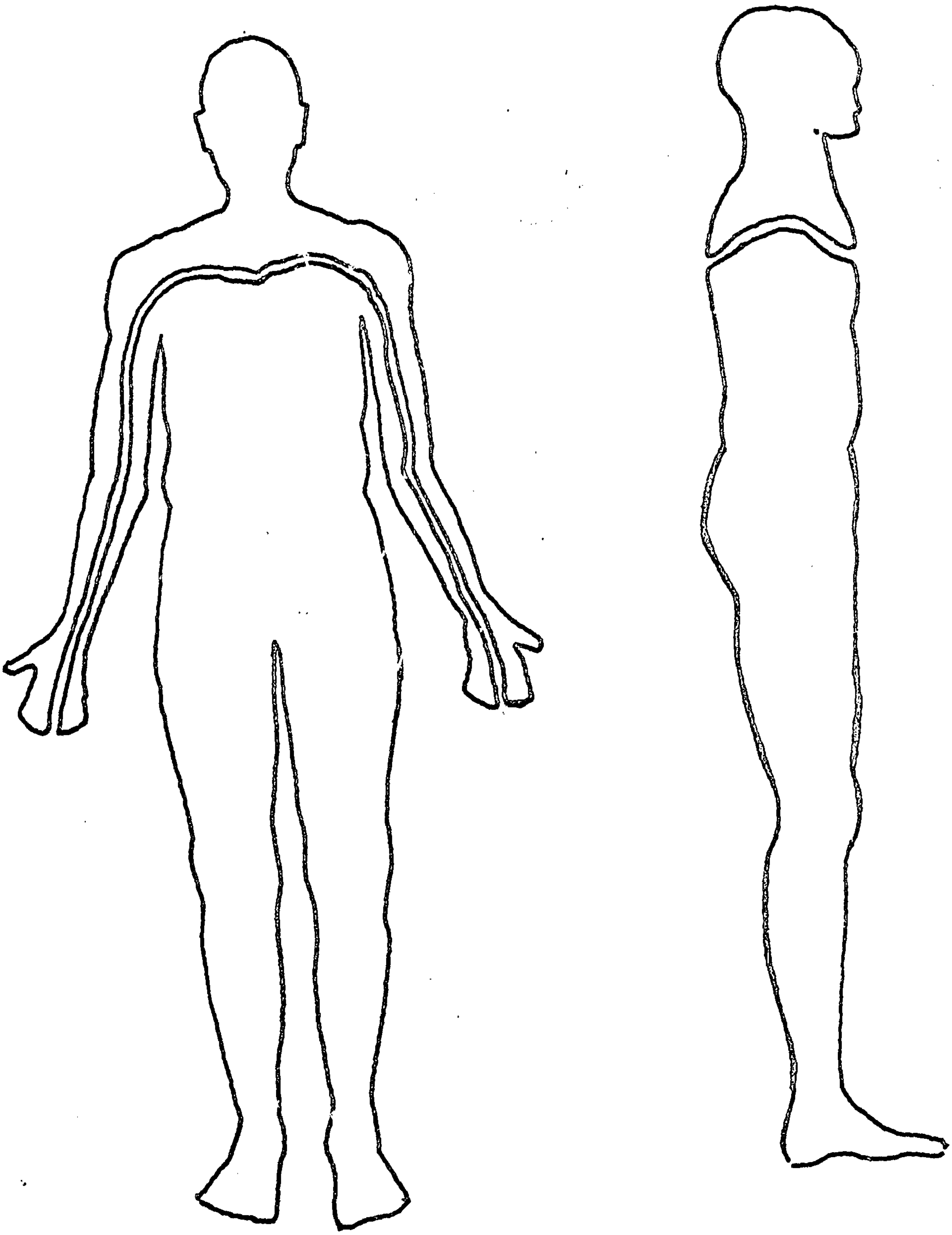
Psychosocial need is for:

- Short-range indoor locomotor independence
- To use public transit or have full access to private transit
- Protect and not disturb usage of orthotic aids and/or splints
- Minimal self-care arm-hand usage (grooming and eating)
- Relax and be comfortable while maintaining personal poise

al

Uniqueness of muscular dystrophy is that muscle fiber is progressively replaced by fat tissue, causing a diminishing lack of voluntary body control. The disease moves in time from the proximal trunk body mass areas, distally outward, to the muscles of the extremities and face. They will be strong looking but extremely weak, slow moving, and clumsy. Uneven paralysis and multiple deformity due to contracturing tissue will both plague victims. Thru time victims often become bedridden for they are extremely vulnerable to pneumonia and have a very low threshold to pain. Acute inferiority complex problems are a resultant.

b2
The unique character of quadriplegics with a fifth or sixth cervical segment, spinal cord injury or blockage is that, fracturing of the vertebral column most frequently occurs because of the high degree of natural flexibility in this part of the neck or vertebral column. Also there is no longer much interruption of the parasympathetic division of the autonomic nervous system, but now the sympathetic division. The sympathetic division is most often extremely more dominant than normal. They will often have partial to moderate power of grasp and release due to some functioning of long finger flexors and extensors. Quadriplegics will have moderate shoulder strength, strong biceps, and elbows that can now moderately stabilize in extension. Arm pushing strength is weak or lacking, but yet many manage to minimally transfer between seating positions.



1.3
GENERAL CHARACTERISTICS RESULTING
FROM LOWER UPPER EXTREMITY AREA BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are common affected:

- Unable to use arms and hands functionally, or in a beneficial way
- Has limited shoulder strength and upper arm usage
- Erect sitting, is still moderately insecure
- No or very little hand or forearm power or strength
- Zero to partial trunk suspension

Neuromuscular parts and performance that are commonly affected:

- Have no feeling, sensitivity or kinesthetic awareness in area

Sensory parts and performance that are commonly affected:

- Little or no voluntary or involuntary muscular action
- Improper feedback as to where hands are

Biochemical parts and performance that are commonly affected:

- Distal thermal control in arms and hands
- Distal circulation
- Tissue atrophy

Psychosocial behavior and attitude that are commonly affected:

- Self-care
- Dependency on others
- Frustrations due to clumsiness
- Depression due to inability to manipulate in a productive manner
- Helplessness feeling due to inability to use hands

1.3
COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

.Slow down or atrophy of upper extremity growth will often occur

.Hard tissue atrophy and/or warpage

.Muscle fiber atrophy, in lower arm

.Rigidness of joints

.Turning in of limb segments (internal rotation)

.Brittleness of bones causing easy fracturing

1.3
INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

.Has little or no pulling or pushing strength in their arms

.Can't maintain or move independently into a sitting position or posture

.Can't lift body mass

.Extremely difficult to roll over by themselves

.Have minimal arm stabilization ability

.Can't move or control thru a minimal range:
Extension of wrist......30°
Flexion of wrist........70°
Wrist abduction.........18°
Wrist adduction.........40°

Forearm supination
(inward rotation).......91°
Forearm pronation
(outward rotation)......50°

(Barter & Dempster)

1.3
OVERALL PROBLEMS RESULTING FROM CONDITION

- Full-time assistance and aid is required most often
- Unable to provide self-care for themselves
- Have minimum to no independent capabilities
- Lying about a great deal
- Lack motivation to do anything
- Unable to perform any manipulative occupational tasks with precision
- Abrupt tension or twisting in upper trunk can rupture vertebral column
- Very depressive anxiety exists
- Lack upper trunk performance
- Adjacent shoulder-neck musculature often become unusable because of complacency
- Require exotic forearm and hand bracing just to have grasp or pinching capability

1.3
OVERALL NEEDS, RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

- Prevent or eliminate any shoulder or arm deformity
- Maintain or increase adjacent musculature strength
- Maintain minimally, full shoulder range of motion
- Make hands moderately usable
- Arm and shoulder reinforcement support
- Protect arm from external impact
- Minimally replace missing hand forearm functioning of extension and grasp

1.3 (Continued)

Neuromuscular need is for:

- .Fully reinforce arm-shoulder coordination and guidance
- .Coordinate hand-forearm movements with existing upper arm and shoulder movements

Sensory need is for:

- .Feedback as to where the hands are in relation to the arm and trunk

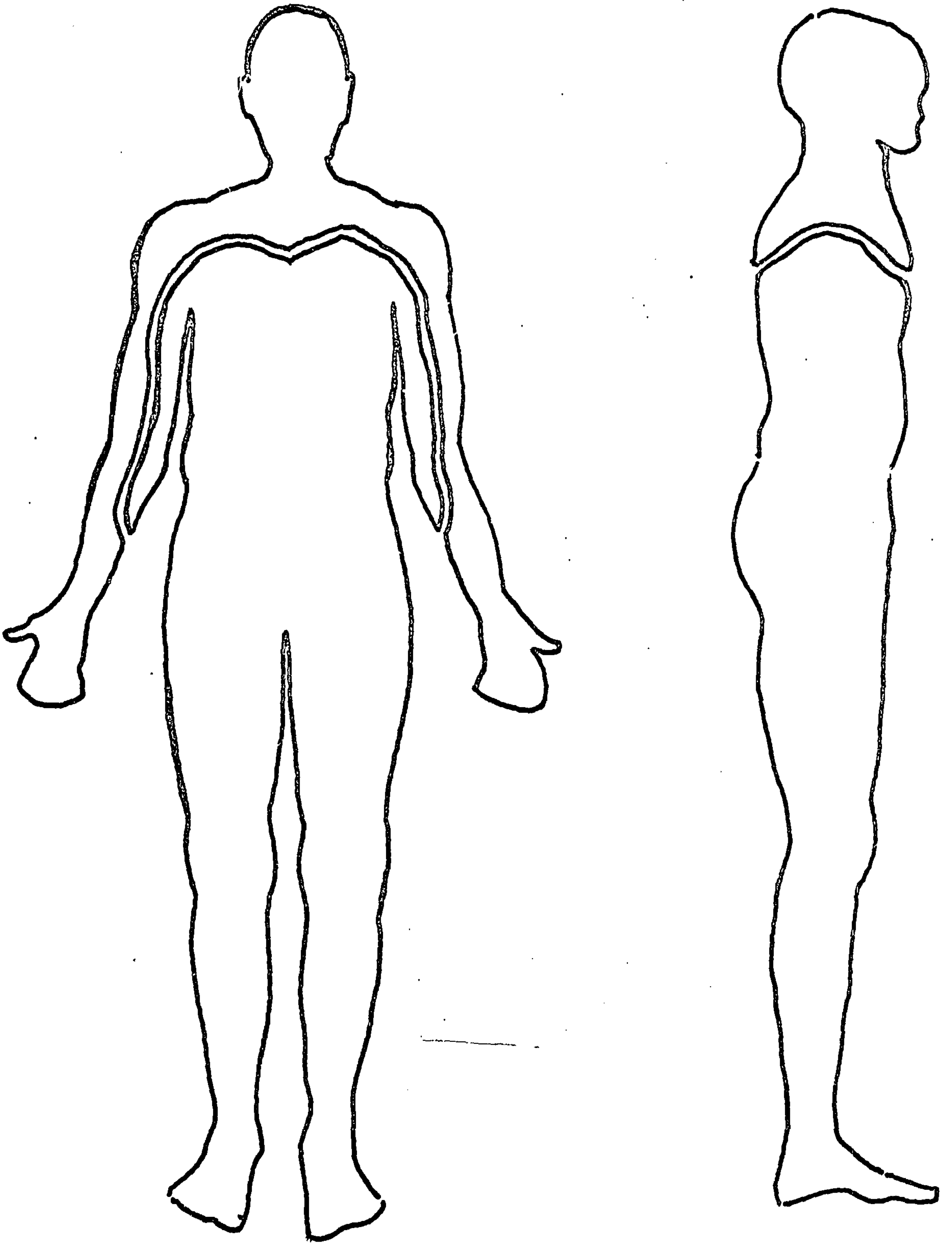
Biochemical need is for:

- .Increased circulatory strength and flow
- .Increased tissue protection (hard and soft)

Psychosocial need is for:

- .Support and guide basic arm movements for full self-care
- .Decrease their helplessness feeling (tones)

*See appendix and case study (CS1) to find out how this amount of N.A. biologic deficiency can be artificially supported



2.1
GENERAL CHARACTERISTICS
RESULTING FROM HIGH THORAX AREA BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are commonly affected:

- Chest musculature is moderately to fully involved
- High back musculature is fully involved
- Intercostal muscles between ribs are full to moderately involved
- Have full shoulder strength
- Have minimal trunk vertical stability
- Have fair to moderate use of hands and arms
- Grasp strength is fair to moderate
- Have full flexion arm strength
- Moderate arm extension
- Can roll over independently by themselves
- Contracturing of their limbs is common

Neuromuscular parts and performance that are commonly affected:

- Sexual functioning and capacity is often lost
- Nearly all of their trunk and lower extremities voluntary control is lost
- Uncontrolled performance ability
- Often found in a spastic or hypertensive state

Sensory parts and performance that are commonly affected:

- Sympathetic neural activity is increased greatly
- Autonomic neural system is disrupted
- No head-shoulder to trunk coordination
- Moderate to full sensory discrimination loss below high chest

Biochemical parts and performance that are commonly affected:

- Have a moderate degree of breathing difficulty
- Injuries and/or stress about the soft tissue of the neck often occur and increase respiratory distress and further decrease respiratory capacity
- Learn how to breathe thru their mouths (frog breathe)
- Easily choke by putting something in their mouths
- Irregulary breathing rates, usually faster and shorter

2.1 (Continued)

- Maintain a slightly lower than normal body temperature
- Stringently hold a 34-35° C. (basal limit) body temperature

- Have a great deal of genitourinary infection and disturbance
- Have a great deal of urinary and bowel tract disruption
- Unable to control evacuation of body wastes

Psychosocial behavior and attitude that are commonly affected:

- Have moderate to only partial self-care dependency (bathroom)
- Often use a powered wheelchair
- Acute isolationism develops
- Great deal of family conflict often occurs
- May develop a hatred attitude toward normals and/or outside world
- Mentality is often psychologically disturbed
- Are often found extremely moody and/or belligerent
- Socially are isolated and limited to close friends contact if any at all

- Have great deal of subconscious anxiety and fear
- Extremely afraid of being in emergency situations (fire particularly)
- Vegetative attitude develops
- It seems that behaviors rarely become normal if there is autonomic nervous system disruption
- Permanent and/or semipermanent autonomic nervous system disruptions will tend to cause an accompanying attitude change which also remains permanent (never adjust to handicap)

2.1
COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

- Little or no real good control over internal circulation
- Visceral functioning is disrupted and out of balance
- Metabolic rate is hyperactive
- Often show signs of autonomic hyper reflexia
- Great deal of extraneous movement that is uncontrolled occurs
- Accident rate increases due to uncontrollable muscular state and/or precarious stability
- Can't properly clear throats
- Hyperactive gastrointestinal activity

2.1
INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

- Have partial wheelchair independence
- Low to moderate endurance rate
- Minimal respiratory reserve power
- Minimal ability to lift trunk and body mass
- Minimum sitting tolerance
- Partial to moderate body transfer ability
- Moderate self-care ir .ependence

2.1
OVERALL PROBLEMS RESULTING FROM CONDITION

.Requires most of extra residual respiratory reserve gained to meet normal existence

.Primarily is wheelchair bound, extremely unfunctional brace usage

.Uncontrollable reflex extension and flexion of limbs

.Disruption of poised or comfortable resting positions

.Become nervous

.Strain musculature in upper trunk

.Auditory and visual communications and stimulation may become unclear.

2.1
OVERALL NEEDS RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

.Increase arm strength as much as possible
.Transfer strength from upper arms to weak trunk areas, if possible
.Provided with full trunk stability and support
.To have limited ambulation or locomotor capability
.Whole body physical activity capacity (swimming particularly)
.Stretch, push, and extend body segments outward
.Extension body activities
.Must move legs

Neuromuscular need is for:

.Full gross body movement capability
.Moderate rhythmic movement capacities rather than patterned movement
.Full trunk balance
.To control and/or eliminate symptoms of hyper reflexia

2.1 (Continued)

Sensory need is for:

- Maintain a restful neural state
- Mental and physical quiet
- Minimally replace missing lower extremity and trunk position feedback
- Control neural disruption in autonomic system

Biochemical need is for:

- Keep body at a basal metabolic rate and thermal temperature to minimize oxygen demands on respiratory system
- Provide full respiratory aid
- Some sort of portable respirator aid (belt type)

- Must alleviate any urinary tract obstructioning
- Protect against any genitourinary infection or bowel swelling

Psychosocial need is for:

- Guard against any disruption of any hand splints usage
- Fully increase their self-care potentials
- Provide them with a means to get outdoors independently
- Increase their occupational potential to a minimal level
- Allow them to be fully independent of any full-time assistance
- Control their autonomic nervous system activity in order to help them adjust to condition
- Three-dimensional experiences with the surround
- Stimulate them to be active rather than passive

a.2
The unique character of acute malformations and/or spinal deformity is that in each, severe warpage of the body results in external as well as internal performance malfunctioning. The bilateral vertical body mass support and balancing systems are extremely deficient and lacking. They are unable to coordinate their centers of gravity with the body mass position because of the severe asymmetric warpaging. Often so severe that they are not able to sit up. The acutely deformed are quick to develop an extreme amount of internal cavity pressure that leads to intestinal and digestive tract disturbances. Visual orientation, localization and coordination are also severely disturbed.

b3
The unique character of a high thoracic paraplegic, somewhere between a one to fourth thoracic spinal cord segment injury or blockage, is that the sympathetic division of the autonomic nervous system is fully disrupted. An intense amount of vertebral column impact and/or compression is required to fracture the vertebrae in this area. If there is fracturing here, the complications which result are usually twice as great and severe than any other level of the cord. In fact, a great deal of emotional or mental disturbance (nonorganic) is not uncommon. Pain is more prevalently experienced also. Their grasping power and generally weak lower arms dexterity is increased.

CONDITION VARIABLE 8

Sympathetic nervous system disruption can be anatomically related to bodily damage. Damage which is severe due to the location of its roots which influence the major organs of body activation. Such damage is and will be obvious when the controls for expenditure of body energy and activation become deficient and the inhibitory controls of the body cannot balance the sympathetic's activating affects. Permanent autonomic nervous system hyperactivation results in severe organic imbalance. The normal involuntary balance and functions of the internal organs is lost and everything must function at a too fast, too high and/or too hard an uncontrollable rate. This is probably the most serious of the condition variables. For it is possible to partially control its affects but not to correct or eliminate their cause. Its complications are life threatening, striking at the heart of the biochemical systems. Therefore, it must be considered as an extreme constraint on any design aid aspirations and in setting performance goals.

B

GENERAL CHARACTER OF
SYMPATHETIC NERVOUS SYSTEM DISRUPTION

- Condition is a result of cerebrum damage or autonomic nervous system blockage and malfunctioning
- Condition variable is most commonly found in traumatic, spinal cord injured (fifth thoracic cord segment on up)
- The body is able to maintain only a reflex control over its vital internal organs and their balance
- Disruption will result in moderate to full involuntary control loss
- There is an autonomic nervous system imbalance between body's activating and inhibiting mechanisms
- There is a dramatic increase in the sympathetic nervous system's activation
- The autonomic nervous system's activating half is continually functioning or being "kicked in" and overacting
- The autonomic nervous system's inhibitory half (Parasympathetic controls) affects are being masked out
- The hyperactive sympathetic activity is the cause of a great deal of homeostatic (body equilibrium), internal stress, and imbalance

COMPLICATIONS OFTEN RESULTING FROM SYMPATHETIC NERVOUS SYSTEM DISRUPTION

- Hyper reflexia behavior is developed
- Vascular constriction is to increase unless stopped
- Blood pressure is increased with flushing in the face commonly occurring
- Cardiac condition is unstable with the threat of fainting spells common

B (Continued)

- The hypothalmus's control over sweat glands or body temperature is lost with periodic bursts of excessive sweating
- Sharp and unpredictable body temperature rises often occur
- A feverish feeling is common along with the threat of going into a convulsive state
- The metabolic rate is greatly increased causing an excessive heat output and thru time, a fluid, electrolyte imbalancing often occurs
- Excessive glygogen breakdown occurs, thus there is an abundance of unused energy to increase nervousness and spastic tendencies
- Enzyme secretion is diminished, thus lowering their natural protection against bacteria
- Glaucoma is common with increases in intraoccular pressure due to constriction of the occular muscles
- Headaches are common
- Dilation of pupils will accompany occular stress
- Respiratory passages are constricted further decreasing their already limited respiratory ability
- Nasal passages are constricted and thus congested
- Secretion of saliva is diminished causing dryness of the mouth
- Gastrointestinal activity is increased with stomach ulcers not uncommonly following
- Severe constipation and unpredictable diarrhea are caused by unstable bowel musculature control
- Voiding and evacuation wall constriction is cause of urinary tract blockage (constipation) and subsequent infection of the tracts
- There is an increase in tissue atrophy and constriction
- Musculature is very hypertonic

B (Continued)

- Contracturing of body segments is severe
- Uncontrolled erection is frequently embarrassing

B

RESULTING INABILITIES FROM SYMPATHETIC NERVOUS SYSTEM DISRUPTION

- Emotional adjustment to condition is nearly impossible because of the hyper reflexic state
- Circulation of body fluids is completely out of balance and being greatly restrained by condition variable
- Relaxation is a near impossibility as long as condition variable is not controlled
- Sexual functioning is fully disrupted and adding to frustration
- Metabolic rate is difficult to adjust to
- Can't adjust and increase oxygen intake to meet demands

B

OVERALL PROBLEMS RESULTING FROM SYMPATHETIC NERVOUS SYSTEM DISRUPTION

- Motivation is completely lost
- For one reason or another survival is constantly being threatened
- Heart attacks are easily brought on
- Major threats to survival are from either liver or kidney malfunctioning
- Fainting spells are cause of accidents that cause further injury
- Thermal limits are very narrow due to extreme sensitivity to any changes in body temperature

B (Continued)

- Complications are usually two times as prevalent and intense than with any of the other condition variables
- Bladder is usually under a great deal of pressure
- Body temperatures are very sensitive to hot weather with body temperatures quickly rising
- Urinary appliances are adding to distress, infection and often the cause of further reflex activity
- Nature of condition variable, variability is great, anyone or combination of discussed complications may be present
- Drenching outbursts of sweat are extremely hard to handle

B

NEEDS OF THE CONDITION VARIABLE

- Needed is a minimum of two to three quarts of water per day
- Need to control their oxygen intake and exhaling after it is increased in capacity
- Control musculature tension after it is decreased in order to obtain a restful state of mind
- Provide some degree of comfort that is obtainable at any time
- Hold and control the surround temperature so it is possible to keep body temperature at a basal level
- Urinal, evacuation and eating patterns are to be stringently developed
- Venous and capillary strength are both requiring reinforcement and support
- Bowel and bladder are to be relieved of any tension or compression
- Hyper reflex (reflexia) spasms are to be minimized and controlled for they can trigger heart attacks and convulsions

CONDITION VARIABLE C

Postural imbalances and/or deformities are the cause of sensory and sensory awareness distortions, due to disturbance and disruption of the mechanisms of visual orientation. Secondly, they can upset and/or suppress the functioning of the internal cavities, and in particular diminish respiratory capacities. The imbalance problems begin with structural imbalance, which can with time, lead to further biomechanic, sensory and later biochemical strain and stress.

This postural warpaging is indicated twice in the "key" to hierarchial levels of non-ambulatory condition involvement. It is a threat in one degree or another in either case. However, it must be considered a major constraint on performance potential when present in moderate to full severity. Postural warpage that is of a moderate to full severity can only be partially corrected. Constant prevention of further imbalances is essential.

C
GENERAL CHARACTER OF MODERATE TO FULL
POSTURAL IMBALANCES AND DEFORMITY

- Prevalent more often and in a more severe way if there is uneven, asymmetric involvement or partial neural control loss

- Uneven muscle pull and tension on body frame is major cause of postural warpage

C (Continued)

- Trunk is unstable over the pelvic girdle
- Unnecessary pressure on kidneys and torsional pressure on viscera are prevalent
- Vertebral column is unstable for one or more reasons
- Missing vertebral segment is often a cause of uneven pull
- Surgical fusing of vertebral column in one area is nearly impossible to do without causing some asymmetry in the vertebral column's overall alignment
- Flat or reversed lumbar spines (most common in spinal cord injury cases) will cause the pelvic girdle to tilt backward and thus throw alignment further off
- Knotting of musculature in abdomen or waistline is both an instigator and a result of progressive postural imbalance
- Weak para spinal (intravertebral) muscles are not properly pulling on the vertebral column
- Forward tilting of pelvic girdle will increase alignment problems causing lumbar lordosis
- Location of masses center of gravity is out of place
- Eighty percent of the time postural warpage will tend to be to the right with a counterclockwise rotation in lumbar area (Olsen G.A. 1966)
- Body mechanismsare often unaware of warpage and/or will adapt mechanisms around malalignment
- Bilateral mechanisms are not able to naturally correct due to the lack of neural integration (feedback and control) across the midline vertical axis of the body
- Deformities are either a rigid (fixed), hard tissue bone change or in a flexible state where tissue is only deformed (before) bone change

C

COMPLICATIONS OFTEN RESULTING FROM POSTURAL IMBALANCES AND/OR DEFORMITY

- Accompanying pain will occur in the intercostal musculature
- There will be an increase in respiratory suppression and decrease in the vital capacity
- Occular functioning is strained and quickly deteriorates
- Mechanisms of visual orientation are misaligned, and their visual localization diminishes in capacity
- There is an increase in the biologic stresses in the body particularly in the biochemical systems
- There is an increase in skin breakdown, pressure sores due to increase in irritation of the skin surface and poor body mass positioning
- Extreme lordosis and scoliosis are common
- Compensatory disalignment from one postural warpage will cause another, and most commonly a counter reversed curve or "S" (Kyphosis)
- There is often late deformity which occurs in weak cervical areas
- Blood pressure is increased due to internal stress or visceral compression and kidney tension
- Organ efficiency is decreased due to internal organ displacement
- Visceral kinkage will occur due to bowel and bladder compression
- Circulatory capacity will decrease with severity of warpage

C

RESULTING INABILITIES FROM POSTURAL IMBALANCES AND/OR REFORMITY

- There is an inability to bend through the waist
- There is an inability to fully bend or rotate thru any surgically fused vertebrae which usually integrates one or two adjacent vertebrae on each end of break
- It is difficult to hold trunk in desired or proper alignment without applied forces
- It is difficult to maintain proper visual and gravitational directionality or acuity
- There usually is greater lateral imbalance than sagittal
- Sustaining any activity becomes increasingly difficult due to low endurance caused by warpage
- It is often difficult to straighten or feel misalignment
- It is increasingly difficult to sustain purposeful movement of trunk due to misalignment of parts and growing lack of coordination
- Unable to move the center of gravity with the base of support
- Bilateral balance is not obtainable in an erect posture
- It is difficult to securely maintain a sitting position, comfortably
- It is later thru time often impossible to even sit upright
- Meaningful awareness is progressively decreased due to warped spatial orientation

C

OVERALL PROBLEMS RESULTING FROM POSTURAL IMBALANCE AND/OR DEFORMITY

- Maladapt to improper visual orientation which will cause permanent binocular disparity
- Eye-hand coordination is greatly diminished in meaningfulness
- Ear-eye alignment to stimuli is more difficult and less accurate
- Their meaningful concentration abilities are decreased
- Base of supports are disoriented with other body parts
- Sometimes are only able to slump in high thoracic, cervical areas because of postural warpage and/or waistline knotting
- Coordination is disproportionately reduced to degree of warpage
- Neurological degeneration is increased
- Muscular atrophy is enhanced
- Center of pressure and center of gravity correlations are distorted
- Any or all growing skeletal parts are influenced
- Body loses part of its gravitational axis or it is shifted due to loss of bilateral balance, neural muscular controls
- Poor surgical wiring or fusing of vertebral columns is sometimes possible
- Rapidity in fatigue and its onset is increased
- Movement ability, skill and/or efficiency progressively decreased
- Personal appearance and subsequent body image acceptance is greatly diminished
- Emotional depression is greatly increased

C
NEEDS OF THE CONDITION VARIABLE

- Required is proper anatomical, limb alignment
- Overall trunk suspension, stability and bilateral balance is necessary
- Reinforce vertebral column and cervical vertebrae
- Must recenter trunk musculature over the vertical axis
- Shoulder girdle is to be suspended about the vertebral column
- Provide a continuous rebalancing mechanism effort
- Provide additional stimuli for that which is missing
- There is a need to artificially return or replace lost proprioceptive responses
- Damaged balancing mechanisms are to be reinforced and rebalanced
- Asymmetric imbalances require an increased amount of external control and support to rebalance
- Distorted centers of pressure are to be compensated for
- Decrease stress and strain on cardio vascular and respiratory systems
- Internal pressure and compression on lower trunk and viscera are to be relieved
- Misalignments of vertebral column are to be artificially made up for and/or corrected
- Continually changing rigid support forces are required to correct fixed deformities
- Continuous outward leg rotation and anti "preferred hand twist" resistance is necessary
- Surgically realign as perfectly as possible if there is a fixed bone deformity and balance

CONDITION VARIABLE D

The results of movement capacity losses are cumulative in nature with regards to time. Losses are felt by the entire body in general. For this capacity is depended upon by the biochemical to aid it in its fluid and waste movement, by the biomechanic to maintain its tone, by the neurosensory to maintain its awareness.

Its loss can be most noticeably measured in amounts and/or degrees of: tissue atrophy, perceptual deprivation, and psychosocial impact.

The variable is indicated three times along the "key" to biologic involvement because it is common to all N.A.'s where only amount of immobility differs. Its complications should be seriously taken into account when loss is severe. Resulting vascular and fluid movement disturbances are hardest to alleviate and make up for at any of its levels. But all N.A.'s seem to have some degree of safe movement potential. Minimization of this condition is primary for all design efforts.

D

GENERAL CHARACTER OF MODERATE TO FULL MOVEMENT CAPACITY LOSS

- Usually are unable to self-propel wheelchair functionally by themselves
- If they are able to use wheelchair it usually must be electrically powered
- Wheelchair range, confidence of usage and capability are very limited
- It is not possible for them to confidently lift or transfer body mass (wt)
- Waistline musculature is knotted up
- Disuse atrophy is progressive
- Abdominal muscles are progressively losing ability to contract
- Lower back musculature is to progressive weaken
- There is a general increase of all their complications
- Pressure sores and genitourinary problems are most bothersome
- It is necessary to drink two to three quarts of water per day (one glass per hour) approximately sixteen per day
- They are not able to use public transit
- Even in wheelchairs their access capabilities to public facilities are poor
- Occupational capabilities are minimal to zero
- Adjustment potentials to disability are usually poor to zero
- Behaviors are very dependent on preinjury behavior
- They will often remain in a long depressive, self-mourning state
- There is a great deal more of unhappiness felt and shown in males
- A great fear of being with nondisabled and that everyone is looking at them
- The adolescent aged are hardest affected by great dependency demands they must (learn to) make

D

COMPLICATIONS OFTEN RESULTING FROM
MODERATE TO FULL MOVEMENT CAPACITY LOSS

- There is an increase in average resting pulse and blood pressure
- Obesity increases and is cause of additional heart and circulatory stress
- Metabolic effectiveness is decreased by increases in obesity
- There is an overall decrease in heart rate
- There is a great suppression of capillary circulation
- There is a high potential of rupturing capillaries of veins
- Swelling of lower extremities is common
- There is an increase in body tissue and capillary constriction
- There are increases in the frequency of skin infection and/or pressure sores due to poor capillary circulation
- Skin is drying up
- Skin is becoming callous and degenerating
- Arthritis of low back is common
- Atrophy and compression of aqueous nerves is common
- The weak abdominal action is increasing low back degeneration
- Weak back muscles are decreasing ability of musculature for elimination which affect elimination control
- Within four to six months, bones are becoming very fragile and atrophy is near complete (without any passive ranging)
- Rapid bone demineralization and bone and tissue atrophy are occurring
- A slow progressive atrophy of neuromuscular system is occurring

D (Continued)

- There is a progressive decrease in the body's need for nutriment
- There are increased amounts of nitrogen being excreted in urine
- Rate of sedimentation or settling out of particles in body fluids is increasing
- Drastic change in vocational role and sexual identity are most disturbing
- Behaviour patterns are extremely variable, depending upon past experiences, length of disability and degree of disability and when it began to affect body (onset)
- Introversion occurs and is most often severe
- Inferiority complex are developed

D

RESULTING INABILITIES FROM MODERATE TO FULL MOVEMENT CAPACITY LOSS

- There is a lack of normal skin sensitivity to minute pressures most often
- Unable to maintain continuous body oscillations or minute position shifts
- It is usually very difficult for them to eliminate by themselves
- They are unable to stand for any length of time
- There is a diminishing of desire to be socially involved or active, become timid and lack initiative
- It is very difficult and often impossible to fully accept or understand changed body image (form)
- It is most often impossible to carry thru original life style desires
- It is very difficult to admit or face up to physical condition and/or state

D (Continued)

- It is very difficult to go out in the outside world to test physical state and find out who one is

- It is very hard to interact in public with nondisabled

D

OVERALL PROBLEMS RESULTING FROM MODERATE TO FULL MOVEMENT CAPACITY LOSS

- There is usually an increase in bone fracturing, particularly in the limbs, pelvic girdle and skull

- There is a progressive decrease in the range of motion

- There is an increase in the lack of sensory stimulation with time

- There is a disruption of perceptual mechanisms

- Pressure sores and urinal blockage or infection are causing a great deal of distress

- The increase in infections is cyclic for it further decreases the already limited movement capability

- There is an increase in biologic imbalance as infections increase

- Urination and water requirements are increased with an increased lack of abdominal action

- Increasingly unreliable patterns of excretion are prevalent

- Deformity problems are tending to increase along with a progressive decrease in proper postural alignment

- Daily activity level and self-help capabilities are slowly diminished, along with incentives to recreate or play

- Static postural positions are held too long

- Circulation stoppage due to circulatory atrophy is continually more easy to cause

- There is an increased pooling problem in feet abdomen

D (Continued)

- (Visual and auditory) communicative abilities become more limited
- Attitude is continually attached to situations
- There is an increase in unconscious behavior
- Continuous feelings of frustration and stress seem to grow
- Slowness or inability of ego to accept what the changed body looks like and how it is and will perform in the future
- Increases in abnormal body image, movement patterns
- Tension is increased between individual and those who must attend to family and interhospital relations

D

NEEDS OF THE CONDITION VARIABLE

- Visual perception and distorted occular functioning are to be accommodated for
- A minimum of one to two hours of fully assisted vertical righting are required daily in order to maintain a minimum vascular tone and bone density
- Some stress and pressure on bones when standing (vertical righting) is necessary in order to strengthen the bones
- There is a need to restructure and reorganize their surrounds and life style or daily activity patterns
- Independent access to sources of water such as sinks, bubblers, etc., is necessary
- It is necessary to continually make minute body oscillations or shifts without conscious effort, in order to prevent skin breakdown
- It is advantageous to maintain or restore skin tonus to a maximum
- Ability to sleep a full night without having to be disturbed is desirable
- It is necessary to maintain or increase the daily range of motion capability

D (Continued)

- It is necessary to provide stretch on the lower back musculature and spine thru the vertical axis (Harmon D.B. 1970)

- Prevention of pooling is particularly a necessity in the legs and abdominal cavities

- It is advantageous to increase blood flow thus increasing oxygen distribution in order to help remove wastes in the body's system

- It is necessary to increase the nutriment demands of the muscle fibers in order to decrease their atrophy

- Increase use of existing neuromuscular pathways in order to increase nutriment demands and help stop neural degeneration and muscle atrophy

- Physical activity not just passive is to be engaged in and maintain daily

- It is advantageous to increase the body's strength, enhance coordination

- Increasing back musculatures will enhance the elimination strength and control

- Master and control changed physical state and image

- Motivation is to be stimulated in order to switch from passive way of doing and thinking, into active

- Dependency frustrations and/or helplessness feelings are to be overcome as soon as possible

- It is essential that the individual continually be given the opportunity to prove and reprove to a maximum their mastery over the damaged body form

CONDITION VARIABLE E

The amount of self-care dependency loss is also an indicator of psychosocial stress. Dependency losses will directly relate to individuals with a greater number of complications, performance and mobility losses. As long as dependency exists, there will be some behavioral as well as attitudinal conflicts and problems.

The variable is indicated twice on the "key" to biologic involvement and will indirectly correlate with some sort of upper extremity instability and/or deficiency. With regards to design, the minimization of the causes of dependency loss is essential in order to motivate and provide individuals with any personal acceptance and/or satisfaction. Psychologically, alleviation of this loss is more important than rectifying any other condition variable. Some self-care independence is possible except at the most acute levels of biologic deficiency.

E

GENERAL CHARACTER OF MODERATE TO FULL SELF-CARE DEPENDENCY

- Will usually require full to nearly full-time assistance or personal aid to live
- Will be confined to lying and sitting most of the time for the rest of their lives
- Some will be able to groom and eat only
- Many are unable to manage their daily lives and take care of themselves at all
- Many are unable to functionally propel wheelchair with existing strength and/or endurance
- There is a need to rely on a huge amount of appliances and aids just to survive
- There is a very limited amount of physical energy, let alone energy reserve
- Will probably be involved in the upper trunk and/or upper extremities to some degree (high thorax area up)
- Will lack voluntary control thru the upper extremity and/or upper trunk area
- Many are unable to even enjoy passive activity, let alone active except possibly "water sports"
- Many will no longer come in contact with many new people, particularly those who aren't handicapped
- Will commonly have or develop a helpless attitude
- Often will have only a limited, meaningful awareness

E
COMPLICATIONS OFTEN RESULTING FROM
MODERATE TO FULL SELF-CARE DEPENDENCY

- The common, moderate to full movement loss and confinement complications are evident
- Often must be returned to hospital for surgery and/or therapeutic care due to complications and serious return of infections
- Often are very slow in healing (unless partiall involved)
- Minimal rehabilitative goals and/or potential are usually set (unless partially involved)
- Often will degenerate further, rather than maintain or regain lost abilities
- Usually will have lost any chance of having or siring children
- The simplest of life's tasks are extremely difficult and frustrating
- Their life often seems, and are just prolonged
- Suicidal attitude is developed
- Usually are living under constant threat to survival
- Become verbally aggressive, hatred feeling and/or inner hostile feelings will quickly develop
- Will often gain varying amounts of unnecessary weight and become obese
- The dramatic body image change is too great for character to withstand and adjust to
- Usually will have some sort of lower extremity and foot spasticity or inability to control

E
RESULTING INABILITIES FROM MODERATE TO FULL SELF-CARE DEPENDENCY

- Often are unable to control or fulfill any realistic life style plans
- There is a great inability to cope or adapt to minor changes in situations affecting the body or his body's surrounds
- It is difficult to have any homebound occupational potential, if any
- It is very difficult for individuals to feel or gain any real self-satisfactions out of life
- Often requires a great deal of apparatus, cumbersome equipment and appliances to exist in a nonvegetative form
- Many are unable to relearn lost ability and routines or to adjust to care, eating habits, etc., by themselves
- Unable to overcome many of biologic complications, if any at all
- Unable to stabilize condition as it continues to slowly degenerate
- It is very difficult to ever cope with total image change and/or adjust to it thru time

E
OVERALL PROBLEMS RESULTING FROM MODERATE TO FULL SELF-CARE DEPENDENCY

- There is a complete feeling of life being dependent upon others and physical devices
- There is little to no independent life style remaining or foreseeable in the future
- Great amount of depression is due to inability to come even close to original life plan or desired way of living

E (Continued)

.Individuals are not able to even cleanse or go to the bathroom (evacuate) by themselves

.Will require assistance to shift or change one's postural position or maintain them, except for lying

.Vertical positioning is impossible to achieve on one's own

.Great amount of difficulty and interpersonal distress is due to complete personality change and the reactions it brings out

.It is very difficult to overcome in any way the tremendous limitations that have been imposed

.There are an insurmountable number of social and emotional barriers facing them due to zero performance ability

.Even semiadjustment to the new body form is nearly impossible

.There is difficulty in overcoming fears and frustrations

.Personal appearance and how they feel others look at them is depressive

.There is a growing increase of mental concentration or inward thought due to emotional trauma

E

NEEDS OF THE CONDITION VARIABLE

- There is a great need for new, noncumbersome and flexible self-help devices

- There is a need to maintain or increase individual's self-help capability to a maximum

- Basic self-care requirements and duties are to be met by the individual

- The ability to perform tasks outside of the bed or a wheelchair is essential in order to enlarge the individual's world

- It is essential that the minimal to zero capabilities be expanded to some degree of independence

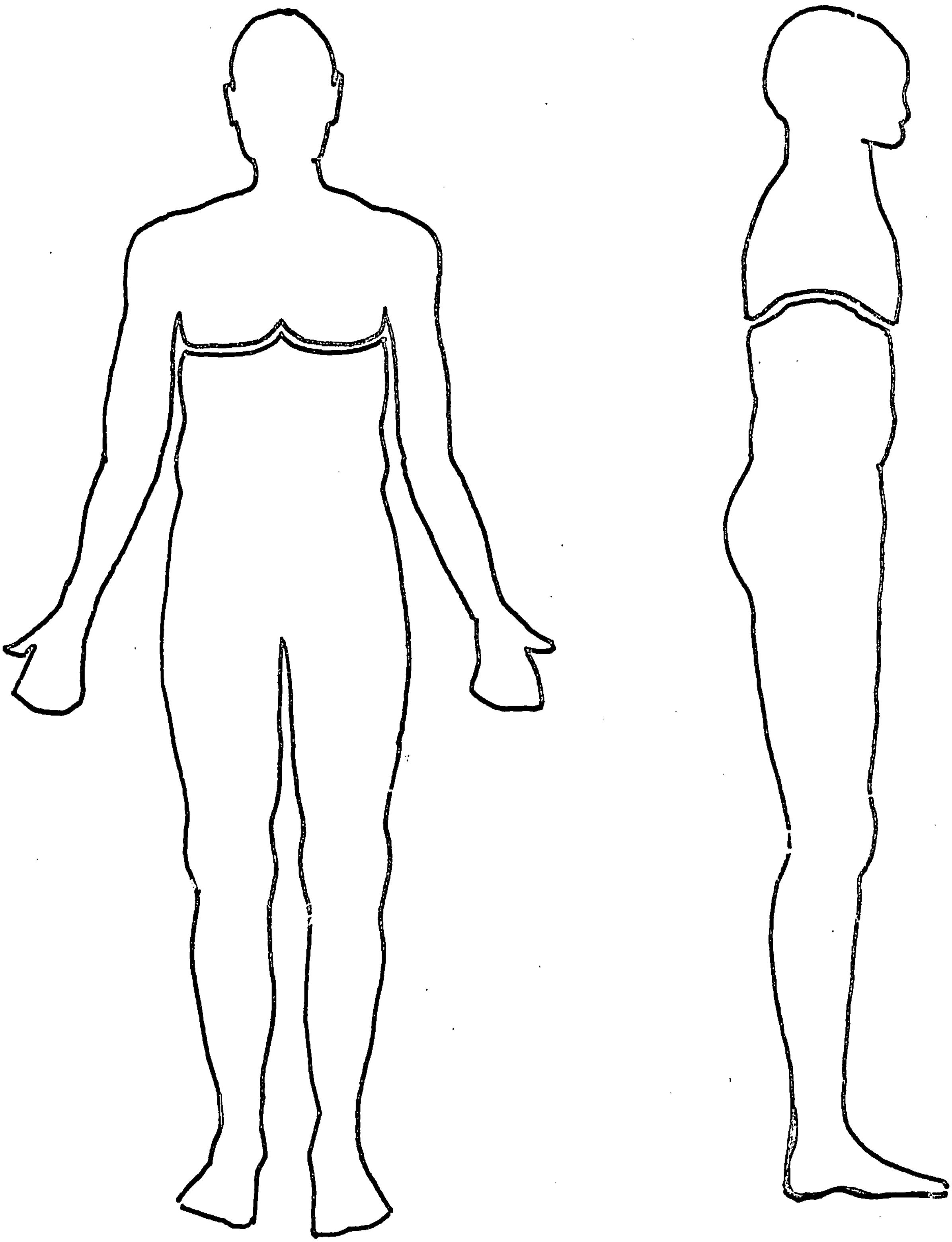
- Decrease as much as possible, individual dependency on others

- It is essential that the individual has the minimal ability to read a book, blow his nose, go to bathroom, transfer his body from sitting positions

- An understanding of potential abilities and limitations is necessary and should be reached as soon as possible

- There is a need to gain some self-satisfaction of accomplishment

- In some, at least minimal ways, it is necessary for them to be happy and productive



3.1
GENERAL CHARACTERISTICS RESULTING
FROM MIDTHORAX AREA BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are commonly affected:

- Intercostal musculature is still minimally involved
- Have a moderate amount of physical endurance
- Have a minimal amount of physical strength to physically power artificial aids
- Have moderate independence in a wheelchair
- Will usually self-propel themselves in a wheelchair
- Have moderate lifting capacity
- Have good upper back musculature strength
- Can transfer body weight easily and push up from lying position
- Have strong upper extremity usage and grasping power
- Have good independent sitting balance

Neuromuscular parts and performance that are commonly affected:

- Unable to coordinate trunk with pelvic girdle
- Voluntary control losses are only prevalent
- Unable to fully balance trunk on pelvic girdle

Sensory parts and performance that are commonly affected:

- Often have little or no more sympathetic nervous system disruption
- Often will not show any symptoms of autonomic hyper reflexia
- Moderate sensory discrimination loss remains in trunk

Biochemical parts and performance that are commonly affected:

- Breathing rhythm is near normal
- Often have a slightly higher than normal breathing rate
- Have a partial respiratory reserve
- Contracting chest walls decrease their ability to inhale and exhale
- Require a great deal of physical energy just to continue breathing at a minimal yet more normal capacity
- Pneumonia is a common threat to survival and it is easy for them to develop
- Will have nasal congestion problems and are unable to properly clear nasal passage by sneezing

3.1 (Continued)

- .Lack control over sweat glands and virtually body's thermal control and balance due to lack of hypothalamus control
- .Lack of inhibition in chemical heat production increases sweating
- .Hot weather or room temperatures will rapidly increase their body temperatures and with rapid heat buildups

- .Will usually have only partial voluntary control over bladder causing inability to voluntarily void
- .Have a moderate fainting potential due to poor circulation
- .Have overworked heart due to strained vascular systems, therefore pooling of blood in internal cavities occurs
- .Rapid changes in position can easily cause visual blurring, ringing ears and possibly loss of conscious control

Psychosocial behavior and attitude that are commonly affected:

- .Will usually rely on wheelchair for means of independent mobility
- .Have full to moderate self-care independence
- .Manifest a great deal of sexual frustration, due to inadequacy
- .Develop very self-centered attitudes
- .Fear social contact or facing real life experiences again
- .Good-for-nothing feelings arise and are directed toward their very limited real-life occupational potentials
- .Suicidal ideas loom in their subconscious
- .Moderate family friction, often concerning financial matters

3.1
COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

.Chest musculature often tightens up

.Intercostal muscles become rigid like

.Respiratory system is still susceptible to easy infection

.Minimal amounts of dietary supplements are required

.Biochemical and/or homeostatic balance remains poor

.Genitourinary organ control is minimal

.Unstable circulatory output

.Abdominal pressure and tightening up

.Abdominal compression (visceral organs are strained)

.Overall body tension and nervousness

.Blood pooling problems of swelling legs and feet remain severe

.Kidney problems and infection

3.1
INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

.To maintain or push himself to a standing position with support bracing on

.Unable to functionally use existing bracing

.Unable to bend at the waist properly

.Digestive processing is unable to maintain a stable balance

.Unable to control metabolic rate

.Unable to cough well

.Unable to fully control trunk on pelvic girdle

.Unable to fully rotate pelvic girdle

.Unable to independently move thru shoulder to thigh flexion

3.1

OVERALL PROBLEMS RESULTING FROM CONDITION

- Must depend solely on the wheelchair to obtain any occupational potentials
- Can't get independently into a standing position
- Can't get down from a standing position into a sitting position independently
- Unable to use public transit
- Only has a moderate to low respiratory endurance
- Have moderate energy potential
- Have respiratory capacity suppression due to improper supportive aid application
- Has limited outdoor occupational potential
- Of sitting too long and having skin breakdown or ulceration

3.1

OVERALL NEEDS RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

- Keep chest musculature from tightening up
- Reinforce abdominal strength with pressure
- Keep abdominal musculature from tightening up
- Increase midtrunk stability
- Increase pelvic stability
- Increase lifting and pushing ability
- Increase low back muscular strength and support
- Minimal ability to step up and step down with aid (rails, etc.)
- To bend freely at the waist in at least the sagittal plane

Neuromuscular need is for:

- Increase trunk and pelvic girdle coordination
- Reinforce trunk and pelvic girdle balance

3.1 (Continued)

Sensory need is for:

- .Feedback from lower extremity bases
- .Position sense of leg position

Biochemical need is for:

- .Moderate amount of respiratory aid
- .Coordinated rhythmic chest and abdominal musculature lift and lateral positive pressure (diaphragmic action)
- .Decrease rapid and/or irregular rate of breathing
- .Increase their endurance level

- .To lower body temperature slightly to decrease oxygen requirements of living tissue (is 20% less at 34° C than it is at 37° C.)
- .To closely protect tissue from abrupt thermal and humidity changes including wind chill
- .Stay within narrow thermal exposure range that is supportive of condition

- .Control undesirable affects of blood pooling in lower extremities
- .To stimulate and greatly increase venous contraction power to push blood back up to the heart
- .Decrease any reflex vascular constriction (peripheral) or high blood pressure despite venous blood pooling that occurs
- .To take full precaution against vascular strain or heart attacks

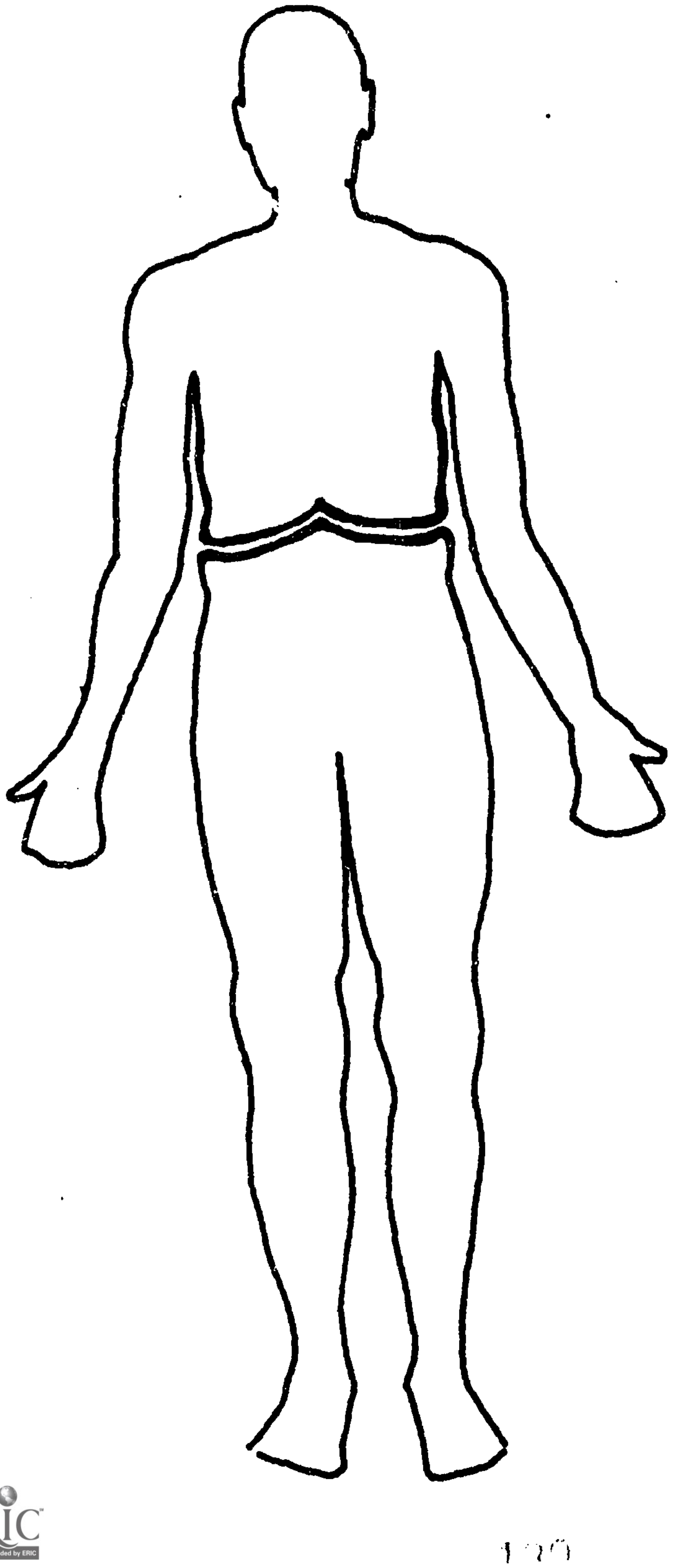
- .Evacuation appliance aid and/or safeguard controls

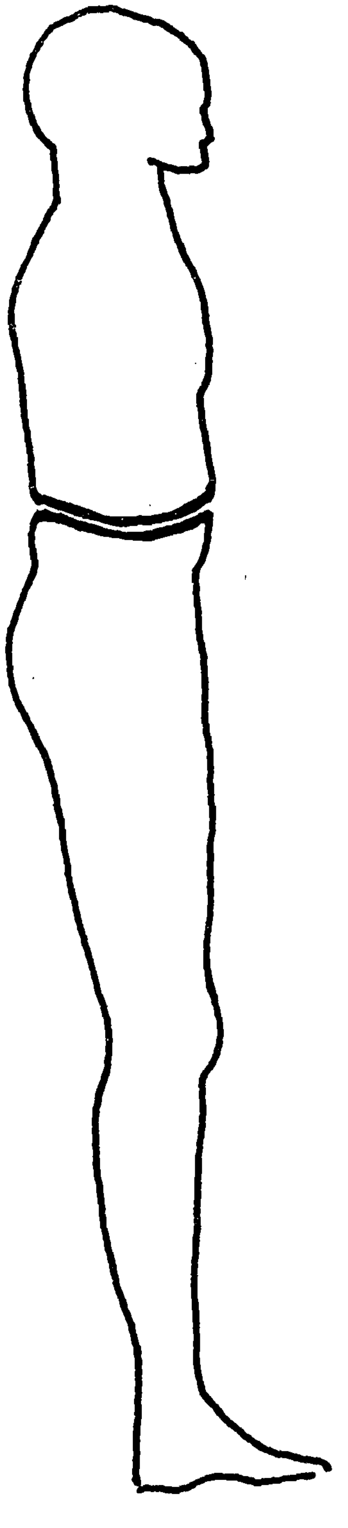
Psychosocial need is for:

- .Moderate occupational freedom outdoors or in public sectors
- .Full sedentary freedom without worry
- .Help adjust to meeting people
- .Help make acceptable to public
- .Increase their visual appearance

b4
The unique character of a midthoracic paraplegic, somewhere between a fifth to eighth thoracic, spinal cord segment injury or blockage, is that the autonomic, sympathetic neural control's activating and inhibiting balance will be undisturbed. For interruptions are usually from the fifth segment on up. Thermal control imbalance will remain as a definite problem. Hand grasping is however strong and tight, making it possible for some, with assistance to stand up, using a full amount of current supportive equipment. Only a few are able to negotiate curbs with their wheelchairs. The midthoracic are the most common type of paraplegic found today. "Approximately 70-83% will remain semidependent for their entire lifetime" (Kaplan L. 1966)

b5
The unique character of poliomyelitis is that it's primarily a disease that affects the anterior nerve (horn) cells of the spinal cord. The paralysis which occurs is unevenly distributed thru the affected areas, with local tension occurring, but with relatively few other complicative or inhibiting affects or factors accompanying. Their muscle fibers are unaffected by the paralysis and can be readily increased in size. They are also able to sire children.





4.1
GENERAL CHARACTERISTICS RESULTING
FROM LOW THORAX AREA BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are commonly affected:

- Have a moderate to full abdominal musculature
- Have moderate abdominal strength
- Have full chest musculature
- Have moderate to full trunk stability
- Moderate to full shoulder to thigh movement ability in sagittal plane
- Have full upper trunk horizontal rotation
- Have little to no abnormal bending thru the trunk
- Have full upper extremity physical strength capability
- Lumbar vertebral column is distorted
- Have minimal pelvic girdle rotation and strength

Neuromuscular parts and performance that are commonly affected:

- Have full upper trunk control
- Minimal trunk pelvic girdle coordination
- Zero coordination with lower extremity

Sensory parts and performance that are commonly affected:

- Have no awareness as to lower extremities position or direction
- Minimal sensory discrimination in low trunk

Biochemical parts and performance that are commonly affected:

- Have moderate to full diaphragmic action potential
- Have nearly full respiratory capacity
- Having varying degrees of coughing ability
- Respiration decreased because of abdominal involvement
- Chest walls are being pulled down by hanging visceral bodies
- Have minimal lack of respiratory musculature performance, tending to cause a decrease in heart rate, increase pulse and blood pressure, accumulation of fluids in lungs

- Have occasional outbursts of excessive sweating

4.1 (Continued)

- .Have moderate voluntary bowel bladder control
- .Often lack involuntary signal as to when they must void
- .Kidneys are overstrained and sensitive
- .Have renal infection
- .Often no signal for evacuation

- .Have symptoms of constipation
- .Gastrointestinal tract disturbances, indigestion and gas are often severe

Psychosocial behavior and attitude that are commonly affected:

- .Can usually adjust thru time to emotional shock of disability
- .Have a great deal of difficulty overcoming visual acceptance and social attitude barriers of society
- .Self-care independence lessens family conflicts and emotional strain
- .Moderate body form control confidence can be developed
- .Some limited outdoor access potential enhances motivations
- .Can drive specially equipped automobiles

4.1

COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

.Are usually full to moderately infection free

.Are still susceptible to pressure sores and some genito-urinary area infection

.Have moderate to full cardiac output

.Moderate peripheral circulatory abnormality

.Lack sensitivity in lower extremities

.Have moderate to full thermal balance

.Sacrum pressure buildups

.Tailbone pressure sores are common

.Have a flat or reversed lumbar vertebrae curvature

4.1 (Continued)

.May have irregular bony protrusions in low back

.Abdominal musculature knotting

.Great deal of torsional compression on visceral organs

.Kidney and/or liver malfunctioning will occur with time

4.1
INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

.Have functional appliance standing ability

.Have unfunctional bracing or appliance aid ambulation

.Unable to fully rotate pelvic girdle

.Unable to extend leg

.Have minimal ability to lift leg

4.1
OVERALL PROBLEMS RESULTING FROM CONDITION

.Have minimal to no usable back musculature strength

.Tire quickly beyond minimum physical efforts

.Use of public transit is not practical

.Usually must maintain sedentary or semisedentary occupations

.Semiambulation with appliances (bracing) if possible is quickly fatiguing

.Must do all body lifting with arms

.Unable to shift body mass weight without conscious effort

.Still have moderate, lower extremity circulation problems

.Sit most of the time because of convenience

4.1 (Continued)

- Limited range of motion due to limited range of daily activity normally participating in

- Of getting out and meeting people

- Of proving to themselves and others that they can make it in the real world

4.1
OVERALL NEEDS RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

- Provide full trunk suspension between pelvic girdle and shoulder girdle
- Integrate trunk with pelvic girdle
- Maintain caution against overexertion or musculature
- Cautiously reinforce and protect vertebral column in the lumbar area
- Take advantage of standing ability and find a way to functionally ambulate
- Have dependent stair-climbing ability
- Increase overall strength to maximum

Neurosensory need is for:

- Trunk-pelvic girdle coordination
- Trunk-pelvic girdle balance
- Gross reciprocal action and reaction between shoulder girdle and pelvic girdle

Sensory need is for:

- Have minimal to no pelvic girdle and lower extremity position awareness
- No hip joint receptor feedback

4.1 (Continued)

Biochemical need is for:

- .Maintain proper postural positioning at all times to preserve full respiratory capacity
- .Protection against any limitation on inhaling and exhaling action
- .Abdominal support, corset in sitting to increase diaphragm's effect
- .Increase oxygen carrying capacity of the blood
- .Increase respiratory capacity to as high a level as possible in order to help prevent metabolic complications
- .Decrease quick fatigue rates

- .To control any excessive sweating because it's uncomfortable, embarrassing and its wetness requires clothing changes and adds to body odor problems
- .To control or absorb drenching perspiration, keeping it from overflowing from unaffected areas onto affected areas
- .Be cautious of extreme thermal conditions below freezing and/or above 80° F

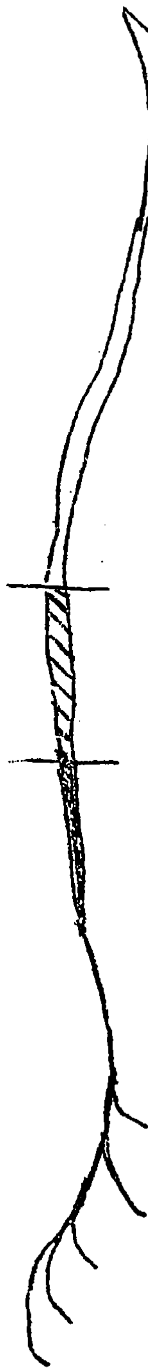
- .Eliminate or control blood pooling in lower extremities
- .Increase energy reserve to maximum

- .Abdominal spring pad to relieve symptoms of constipation
- .Minimize compression on visceral organs
- .Protect kidneys
- .Relieve any genitourinary infection and then prevent involuntary voiding warning

Psychosocial need is for:

- .Full access to public facilities and transit without a wheelchair
- .Moderate to full occupational performance abilities
- .Help to increase visual acceptance
- .Gain satisfaction out of what they do and (out of life)

a3
The unique character of legg perthes is that it's primarily a bone disorder and that they have a great deal of painful lower limb contracturing occurring. Their hip joints and associated ligaments are extremely affected, making lower extremity outward rotation and/or extension difficult and painful. They are not able to bear weight on their lower limbs. A great deal of cautiously guided extension and outward ranging activity is needed for they must stringently resist contracturing forces and protect their tender joints.



b6

The unique character of a low thoracic paraplegic somewhere between a ninth to twelfth thoracic spinal cord segment injury or blockage is that they will have a relatively normal homeostatic balance, or internal state. Their nutriment supplements are no longer needed and with care they can live relatively infection free. Many will be found to have an irregular lumbar vertebrae curve, being flat or nearly reversed and causing discomfort. From the tenth segment of the thoracic segment on up they will have full diaphragmic action while those from the twelfth segment on up will have moderate to full upper extremity, chest and abdominal functioning. They will also have full pelvic rotation, and trunk-pelvic stability, but a weak low back. They will maintain a rigid characteristic. Braces are extremely tiring and time consuming to use.

b7
The unique character of friedreiches ataxia is that it's thought to be a spinal form of hereditary sclerosis, where the lower extremities are fully paralyzed. Friedreiches ataxia is characterized by ataxic movement behavior or incoordination, clumsiness and body mass swaying. Their incoordination worsens from the distal ends inward. They are quick to fatigue. Thru time, trunk and head control is lost and chest deformities often occur.

c3
The unique character of multiple sclerosis is that the disease will destroy, unevenly in patches the protective coverings or myelin sheaths about the lower spinal cord's neural fibers, causing a diffused and sporadic paralysis. In a sense their neural fibers insulation is stripped off. Thus the neural impulses controlling movement speech, vision and learning are "short circuited" or blocked. The intensity of the short circuiting tends to move slowly upward with time...until mental faculties become seriously impaired. Their musculature is extremely weakened as their movement behavior takes on a staggering "drunk-like" appearance. Epileptic attacks will sometimes occur.

CONDITION VARIABLE F

Hypertonic musculature and accompanying spasticity are due to one or another muscle stimulation disturbance. When severe or above the high thorax area, condition level, muscle disturbance is a result of sympathetic neural fiber disruption. The uncontrolled, extraneous body oscillations are both disturbing internally and externally to the body. Thus the variable is the cause of a great many complications, as a result. The variable can be indicated along the involvement scale due to its relevance to the condition variables and levels above which can cause and/or stimulate it.

It is important to control this variable in order to bring the affected body into a state of readiness to perform. Both mechanisms or orientation and localization are upset otherwise. Without controlling it, it is impossible to alleviate any body infections or problems of external body damage.

F

GENERAL CHARACTER OF
MODERATE TO FULL HYPERTONIC MUSCULATURE

- A lack of proper muscle, biochemical or neural stimulation that is causing an increase in muscular tension or spasticity

- Some degree or amount of autonomic hyper reflexia is usually accompanying

- Continuous muscular tremor is common

- This is a cyclic type of condition variable which increases complications and those increases stimulate spasticity intensity and reoccurrences

- Prevalent are the symptoms of involuntary reflex or contracturing of trunk limbs and/or lower extremities (mass flexion)

- There is a continuous resistance to stretching out of muscles

- Contractural deformity will usually occur at a fast pace

- Total voluntary activity of individual is usually affected

- Produces stiff jerky movements that are often poorly timed

- Often will reoccur in the same patterns

- Body will have only minimal soft tissue atrophy because of hypertonic state

- Will have an intermittent and/or continuous nature, continuous more often being found in neural control losses

- Will have a dead weight feel due to disruption of the normal neuromuscular counterbalancing

- Can be isolated to particular segments or very widespread or gross thru the entire body

- Most are unable to sire children

- In some cases it will be very controllable and others not

F

COMPLICATIONS OFTEN RESULTING FROM
MODERATE TO FULL HYPERTONIC MUSCULATURE

- There is an increase resistance and tightening of muscle fibers
- Ranging of limbs and maintaining daily range of motion is more difficult
- Body segments will reflexly rotate and flex inward
- Limb joints will tighten up much faster as flexion contracture complications increase
- There is an increase in the frequency of backaches
- Will often lead to skin abrasions and/or frictional burns
- There is an increase in the chances of developing pressure sores
- There is an increase in peripheral vascular constriction
- Usually will fatigue much faster
- Any purposeful movements will or can be disrupted by extraneous movements of spasticity
- There often is severe intraoccular pressure which accompanies
- Will further stimulate, excessive sweating
- Nervousness is increased
- Further frustration due to further lack of ability to control one's body

F

RESULTING INABILITIES
DUE TO MODERATE TO FULL HYPERTONIC MUSCULATURE

- Usually are unable to maintain any stabilized patterns of motion or hold a stable posture for any period of time

- Will be unable to voluntarily coordinate body segments motion

- Will even further lack fine sensory discrimination (even if limbs aren't paralyzed)

- Will be unable to judge spacial distances well

- Will be very difficult to come to full body relaxation

- It becomes very difficult for individual to lose or control any excessive body heat

- Will most often be unable to use extraneous movements to their benefit

F

OVERALL RESULTING PROBLEMS
DUE TO MODERATE TO FULL HYPERTONIC MUSCULATURE

- The chances of protracting greater or more infection are progressively increased with increases in occurrence and/or severity

- Will increase in occurrence and intensity if there is not enough physical moving or standing exercise

- Sitting too long, fatigue or remaining still for long periods of time will usually make it worse

- Often disrupts sleep and resting potential

- Reflex spasms will be set off by any abrupt external stimuli, such as temperature changes, pressure or movement

- All movements will lack precision with abnormal motor patterns becoming very obvious to observers

F (Continued)

- Will be unable to perform desired motor tasks, skills or accomplish and specific task goals

- The amount of ranging, therapy time will be increased, to keep limbs from turning in and contracturing

- Will often throw the body into an unstable and/or falling postural position

- Will increase the occurrences of broken limbs

- There is no known way to fully control, even though it may subside thru time

- Will increase individual's emotional stress and tension

- Psychosocial potentials are limited, for it often prevents individuals from going out in public

F

NEEDS OF THE CONDITION VARIABLE

- It is advantageous to stand as often as possible

- It is necessary to prevent kidney and/or bladder disruption, (reduce stones in urinary tract) in order to limit their instigating more spasticity

- There is a need for moderate body segment movement

- Will need moderate degrees of heat treatment to help control

- It is necessary to move body parts smoothly and with care

- Avoid and control contracturing if it is at all possible

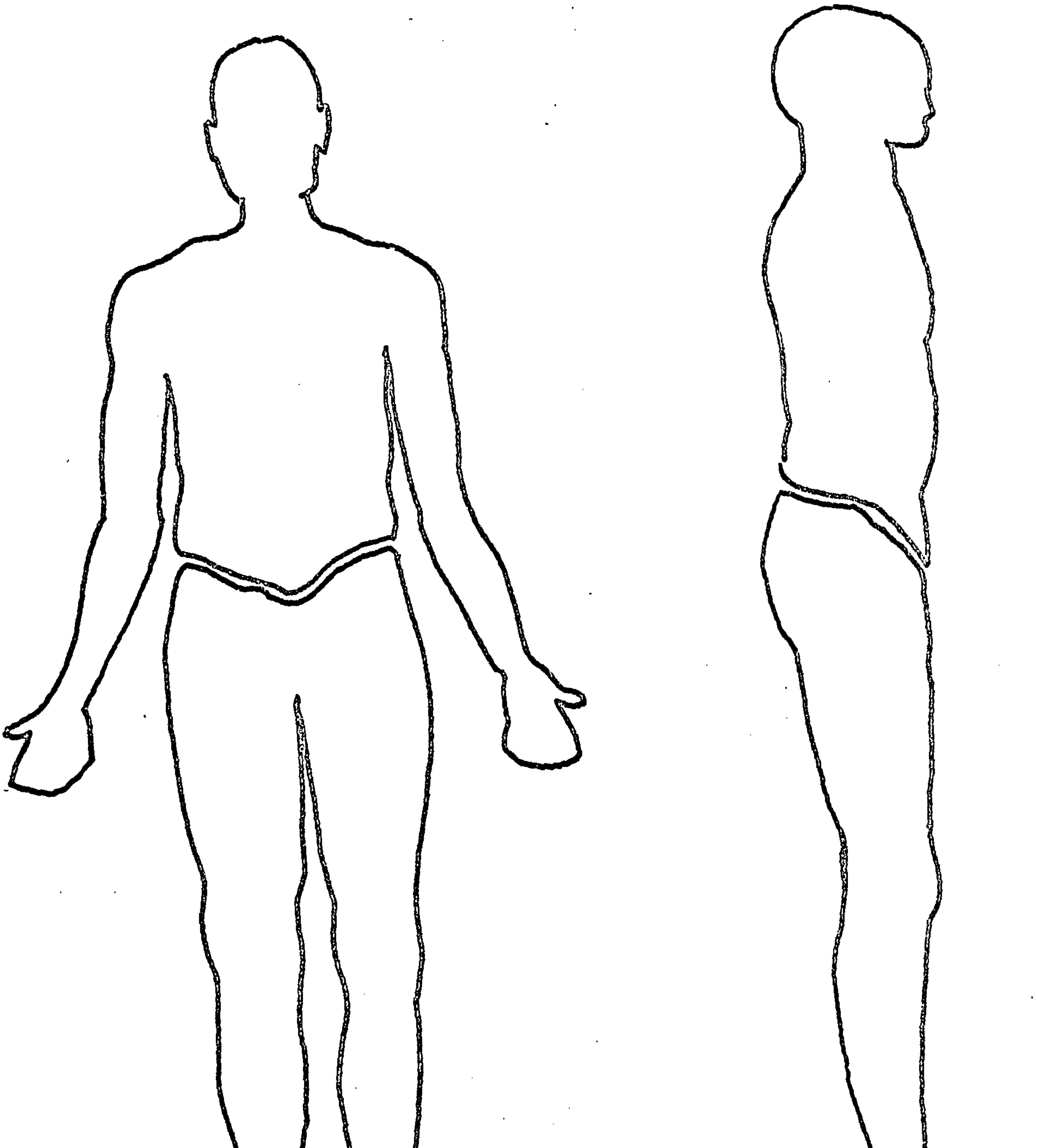
- Provide control to limit as much as possible the intensity and number of occurrences

- It is necessary to maintain some muscle tone but decrease the general overabundance

- It is necessary to decrease any pain and/or eliminate its cause

F (Continued)

- If possible, it is advantageous to use and control the reflex spasms in helping user maintain some productive performance ability
- There is a need to protect ankles and heels of spastic limbs (sheepskin booties)
- The feeling and maintaining of a comfortable state is important



5.1
GENERAL CHARACTERISTICS
RESULTING FROM LUMBAR SACRAL AREA BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are commonly affected:

- .Have a moderate amount of pelvic girdle strength
- .Have full sitting and standing functional appliance usage
- .Have moderate to full low back musculature
- .Have minimal to moderate hip and knee extension strength
- .Have moderate to full pelvic rotation
- .Have toes that curl in along with drop feet

Neuromuscular parts and performance that are commonly affected:

- .Center of gravity control is not complete
- .Have minimal hip and knee control
- .Have full upper trunk (rib cage) balance

Sensory parts and performance that are commonly affected:

- .Little or no proprioceptive feedback from hip joints
- .Little or no feedback from lower extremities

Biochemical parts and performance that are commonly affected:

- .Atrophied body parts have a faster rate of heat exchange due to the decrease or lack in tissue insulation around vessels
- .Unable to constrict and dilate their blood vessels properly thus affecting their blood pressure, flow and heat control

- .Have moderately complete urinary control (complete control is only found in incomplete paralysis)
- .Poor trunk suspension disrupts their kidney functioning
- .Abdominal pressure causes bowel kinkage
- .Have bowel functioning stoppage and full bladder tension (at times)
- .Unable to fully control voiding
- .Have kidney infection of some sort
- .Body odor problems
- .Have to wear some sort of urinary appliance

5.1 (Continued)

- May have deficient ratio of red cells in blood stream
- At times, poor circulation to spinal cord

- Will have some problems of metabolic balance as long as there is moderate circulation and minimum respiration deficiency
- May have infected and/or enlarged livers, along with large starch deposits, low in protein and iron levels
- May develop either of the two kinds of diabetes
- Have a high sedimentation rate or settling out of solid parts in the body fluids
- Have impaired nutritional balance

- Have a moderate, amount of physical energy reserve or capacity

Psychosocial behavior and attitude that are commonly affected:

- Emotions are often mixed and jumping between hopes and frustrations
- Have a good occupational potential
- Have some degree of self-motivation to get around their disabilities limitations and/or to conquer their limited ability
- Have good potential of socially integrating and communicating in public facilities
- Have good potential of getting outdoors
- Have potential of restoring confidence in themselves and what they can do
- Must rely on wheelchair for convenience
- Have a moderate to full amount of orthotic device leg support along with full crutch support

5.1
COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

.Have rigid or uncontrollable foot joint action

.Weak arch support and bone structure

.Develop arthritis in lower back

.Develop lumbar root compression, a pinching of the cauda equina nerves

.May develop acute lumbar lordosis due to semiambulation muscle strain and fatigue and poor pelvis support

.Strain quadriceps of leg extensor muscles

.Develop sores and destroy nerve endings under arms from a great deal of crutch usage

.Minor circulatory pooling in low, lower extremities (feet)

.Genitourinary infection potential is minimal to nonexistent

5.1
INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

.Unable to lift and swing legs forward with any control or strength

.Unable to functionally move in vertical posture without the full aid of crutches

.Unable to move in vertical posture with full bracing for any practical distance

.Unable to fully realize or perceive where their lower limbs are beneath them unless they watch them

.Unable to stand with bracing for long lengths of time

.Unable to move up and down without fatiguing rapidly (in sitting to standing particularly)

.Unable to stabilize hip joint and thigh action

5.1 (Continued)

- Unable to stabilize hip joint and thigh action
- Unable to use ankles
- Unable to pick themselves up from fall unless they "worm up" against a wall
- Unable to make quick and/or abrupt locomotor direction shifts

5.1
OVERALL PROBLEMS RESULTING FROM CONDITION

- Lacks subconscious ambulation ability
- Have extremely limited duration and distance semiambulation capacities
- Approximately one block of full semiambulation effort and will be extremely exhausted
- Have insecurity and subconscious fears about using full bracing for daily semiambulation
- High potential of stumbling and falling, fracturing bones and causing injury due to fall
- Have limited low extremity range ability due to tightening of ligaments
- Inconvenience of relying on orthotic equipment daily
- Difficulty of getting in and out of orthotic equipment, and maintaining it
- Quickly fatigue with changing activity postures
- Have extremely limited use of orthotic devices over and/or about varying surfaces and in varying climatic conditions
- Have very limited speed range with full orthotic device and/or braced semiambulation
- Lack thigh-pelvic strength, control and coordination

5.1 (Continued)

- Procure low backaches and discomfort from short term use of equipment to support semiambulation
- Only able to extend limbs as far as their everyday usage requires
- Not all will be able to establish an excretory and voiding pattern
- Reliability and dependability of existing urinary appliances is poor to fair (particularly females diaper-type)
- A lot of water drinking is necessary, yet becomes harmful thru time
- Complacency towards being physically active
- Current urinary appliances often have leakage problems and tend to add to chances of picking up urinary infection

5.1
OVERALL NEEDS RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

- Increase pelvic strength
- Increase pelvic rotation capacity
- Reinforce the low back musculature
- Reinforce and support flexion and extension about the knee
- Full low abdominal cavity support
- Physical capacity to easily, without fatigue, reach public facilities, despite their physical barriers
- Elimination of distance and duration constraints on locomotor activity
- Full walking capabilities, minimum but independent stair-climbing and ramp or incline ability
- Moderate base of support reinforcement for each leg

Neuromuscular need is for:

- Full lower extremity bases of support coordination
- Coordinate lower extremity bases of support with pelvic and trunk coordination
- Reinforce hip and knee control
- Control ankle

Sensory need is for:

- Position feedback between lower extremities and pelvic girdle
- Replace missing hip joint feedback
- Feedback from the bases of support in lower extremities
- Direction feedback from lower extremities

Biochemical need is for:

- Protection of lower extremities tissue from external thermal change and/or conditions
- Fully aid lower extremity blood circulation

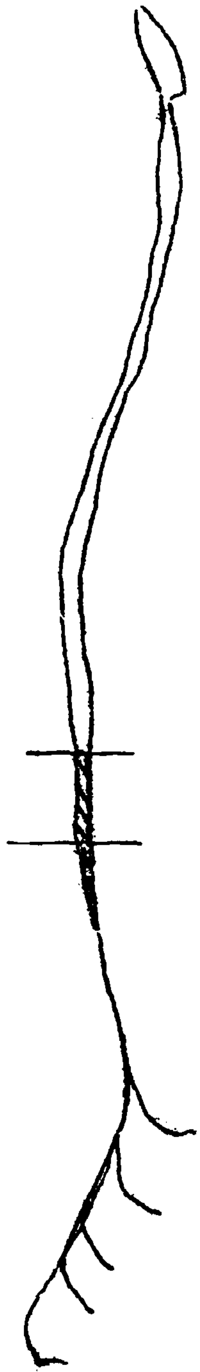
5.1 (Continued)

- .Maintain an infection-free urinary tract and/or eliminate any urinary tract infections
- .Balance bowel-bladder functioning to decrease the chances of kidney failure
- .Eliminate bowel stoppages, irritation and bladder tension
- .Decrease all urinary problems in order to have full occupational potentials
- .Large amounts of water daily to prevent and/or control urinal and kidney infections
- .Empty uncontrolled bladder every 3-4 hours
- .Establish an excretory, voiding, and eating pattern, within two year's time (approximately 80% reliably can)
- .Protect and not disturb urinary appliances, puncture bags pull mountings loose, etc
- .To become appliance free
- .Two-three liters of water per day
- .To eliminate compression on visceral organs by insuring full trunk suspension
- .To extend visceral cavity in order to manage bowel-bladder functioning and metabolic balance
- .To reinforce nutritional balance
- .Increase nutriment balance and metabolic rate, to resolve tired blood problems (increase iron)

Psychosocial need is for:

- .Elimination of the huge amount of orthotic equipment needed to have semiunfunctional ambulation
- .Full walking (vertical locomotor) task ability
- .Safe movement thru space
- .Full occupational potential
- .Full daily activity potential (does not need, however, to run, jump or be able to compete in competitive activity)
- .Increase self-confidence
- .Increase visual acceptance
- .Increase functional ability to perform
- .Minimal social harassment

a4
The unique character of rheumatoid arthritis is that, a degenerative lack of movement range, in the connective tissue and joints occurs. First, the small and then the major joints soften and swell up, stiffen and can stop moving. The contractural deforming forces are continually increased as, muscle strength and coordination diminish. Both their postures and internal organs are seriously threatened. Weight bearing, activities are impossible or painful. Full thermal protection of their bodies is a necessity. Pain and the contracturing forces may both subside later in life but will leave them with a permanent disability.



b8
The unique character of lumbar sacral paraplegics, somewhere between a first lumbar to a first sacral, spinal cord segment injury or blockage, is that they all have some varying amount of pelvic, hip and possibly knee strength. However, they are not able to stabilize their legs about the respective hip joints. Many will have a moderate amount of low back, abdominal and quadricep musculature stre gth allowing them to support their kne s in extension. In fact some are able to stand for indefinite periods of time with current supportive equipment although quickly tire when trying to lift those same legs with their quadriceps in a nonfunctional semiambulation. "Drop foot" (an inability to flex foot) will not be gone and they are still lacking any ankle and knee flexion power and control.

b9
The unique character of spina bifida is that it results from improper growth of the vertebrae tissue, which in turn causes a defect in the spinal cord's canal. A full to moderate amount of unevenly distributed muscle weakening and sensory paralysis loss below the affected area occurs. Approximately three out of every one thousand are born with the defect, which occurs in three variations, as of date. In all variations the vertebral column and spinal cord are very sensitive to any pressure or sudden movements.

b9.1
The uniqueness of the meningocele type is due to an irregularity of the spinal fluid flow caused by the abnormal vertebrae growth. The fluid is collected or pools, abnormally within the skull until the skull enlarges. It is then referred to as hydrocephalus or water head. Hydrocephalus is the most common of the three types.

b9.2
The uniqueness of the meningomyelocel type is due to an irregularity where spinal fluid collects in a sac, along the dorsal or posterior of the vertebral column and often protrudes out from the back.

b9.3
The uniqueness of the hernia type spina bifida is caused when a hernia-like slippage of the spinal cord's canal occurs. An abnormal opening in the malformed vertebrae allows the cord's canal to slip and it is thus damaged between the vertebrae.

CONDITION VARIABLE G

Contracturing is a tightening and/or shortening of the body masses tissues. It can occur both unilaterally or bilaterally in any asymmetric pattern. The amount of contracturing is directly related to the amount of existing body warpage, movement capacity loss, and abnormality of musculature tension.

It is indicated as a common threat to nearly all non-ambulatories. It will usually lead to painful, noncongenital body warpage and later deformity. Without control both severe soft and then hard tissue contracture occurs. Without control it is impossible to maintain functional performance capacities, alignment or comfort.

G

GENERAL CHARACTER OF
MODERATE TO FULL CONTRACTURING OF BODY MASS

- Stiffening of the joints and contracting of muscle fiber length

- A lack of limb and muscle use or spasticity will normally cause

- Soft tissue contracting will begin and cause contractural deformity thru time

- The body segments take on an abnormal bend thru progressive stages of tightening

- It occurs as often in those with hypertonic (spastic) musculature as those with hypotonic musculature (flaccid)

- Normal joint extension and flexion ranges are often tightened up, causing a rigid contracturing state as the limb's range diminish

- Contracturing may be very slow and progressive or very fast and unpredictable, as when accompanying spasticity

- The body segments contract and rotate inward as range of motion decreases

- Spastic contracturing is more often painful

- Pain does result particularly when attempting to stretch out contracted limbs

- It is most often found in neural control losses, particularly the traumatic SCI's

- Will occur most frequently in upper and lower extremities and particularly about the pelvic girdle

- Will occur most extreme and seriously in the upper trunk, shoulder, and intercostal areas

G

COMPLICATIONS OFTEN RESULTING FROM
MODERATE TO FULL CONTRACTURING OF BODY MASS

- Deforming forces are progressively applied to the skeletal framework
- Muscular pull is thrown out of or further thrown out of its natural balance
- Increases potential and occurrences of skin irritation and subsequent pressure sores
- Asymmetric contracturing is most deforming
- The bones (hard tissue) slowly contract and deform as the soft tissue is continually attempting to tighten
- Distal contracturing often leads to proximal part contracturing
- There is an increase in circulatory stress and strain

G

RESULTING INABILITIES FROM
MODERATE TO FULL CONTRACTURING OF BODY MASS

- There is a decreasing inability to move body segments fully about their joints
- There is a decreasing ability to extend limb outward and sometimes inward if joints become rigid
- There is increased limits to the already limited ability to sit or rest comfortably
- It is very difficult to align one's body visually or gravitationally along its vertical axis
- It is impossible to stop contracturing forces without externally applied resistive forces

G
OVERALL PROBLEMS RESULTING FROM
MODERATE TO FULL CONTRACTURING OF BODY MASS

- There is a cyclic lack of limb use which continually increases contracturing of body segments
- There is too much tightening up of the muscle fiber about the joints and the limbs
- The joints will fix or become rigid in a deformity producing position
- Rehabilitative training and potentials are upset and held back
- Urinal care and appliance wearing are complicated and upset
- Overall care and treatment are disrupted
- The use of supportive equipment is upset and becomes less effective
- Will cause extra problems in wearing clothing and shoes
- Wheelchair sitting promotes lower extremity contracturing
- Sitting independence is decreased
- Self-care and occupational potentials are very limited
- Complacency will increase its severity

G

NEEDS OF THE CONDITION VARIABLE

- There is a need for consistent daily limb ranging for at least two to three hours per day
- There is a need for active, resistive forces to counteract the forces of contracture
- Individuals must attempt to increase the use of their muscles
- Weak muscle fiber and soft tissue are to be protected from forces of contracture
- There is a need to gradually extend and stretch limbs to as far a range as possible however without overstretching
- Stretching activities are to be engaged in and stimulated
- Lying or sleeping is to be in a prone positioning
- Inward movement of limbs is to be resisted in any way possible
- Daily standing is a necessity
- Range hips, pelvic girdle, knees, toes, ankles, and the arms
- Minimally maintain a stable range of motion ability
- Alleviate any and all contracturing pain.

CONDITION VARIABLE A

The hypotonic musculature variable is important, primarily because of the dramatic affects it has on the structural system of the body. Body tonus or tension is lacking and/or gone, making the body masses hyperextensive and unstable. The neural mechanisms are unable to firm up the biomechanic system.

The variable is indicated below in the lumbar sacral involvement level because of its frequency of occurrence. However, it is indicated at the acute level also. Both levels along the involvement scale are correspondent to the anatomical locations of the major parasympathetic neural roots. There is obviously disturbance of the parasympathetic or energy conservation and restoration, inhibiting division of the autonomic nervous system. It also is correspondent with the contracturing variable (G).

Only control over this variable is possible. Without control of this variable complications resulting from hypotension, particularly vascular inadequacies and functional performance orientation and comfort are impossible.

A
GENERAL CHARACTER OF
MODERATE TO FULL HYPOTONIC MUSCULATURE

- It is most prevalent in lumbar sacral, involvement or conditions (cauda equina) and often found in acute cervical area conditions

- The parasympathetic nervous system is disturbed, thus limiting body's expenditure of energy and masking the affects of the sympathetic nervous system

- The tonic reflex activity of the sympathetic system is minimal to nonexistent causing a hypotonic or flaccid muscular tonus

- The autonomic nervous system's counterbalancing is out of balance and now favoring the inhibitory side

- The neuromuscular counterbalancing is disrupted

- Minimal to full autonomic hyporeflexia accompanies

- A great deal of soft tissue atrophy will result

- It is not as common a condition variable as the rigid or hypertonic musculature condition variable

- It is uncontrollable, with a great lack of muscular tone

- Ligament tightness is gone

- Limps are often overstretched beyond their normal range and become elastic in looks and behavior

- Muscle tissue is soon soft and flabby

- Constant uncontrollable body motion occurs and is wobbly in character

A
COMPLICATIONS OFTEN RESULTING FROM
MODERATE TO FULL HYPOTONIC MUSCULATURE LOSS

- Bones are very easily dislocated from their joints
- There is a uncoordinated limpness of body mass segments
- The tearing of ligaments is a constant threat due to overstretch
- Bones are very susceptible to fracturing
- Soft tissue atrophy is extreme
- Blood vessel expansion and swelling will occur, due to vascular dilation
- The capillary and vein strength is very weak
- There is a decrease in blood pressure with low pulse rate
- Will lack proper body heat and/or are hypothermic
- Will have low body temperature most of the time
- Will have a low metabolic rate and heat output

A
RESULTING INABILITIES DUE TO
MODERATE TO FULL HYPERTONIC MUSCULATURE LOSS

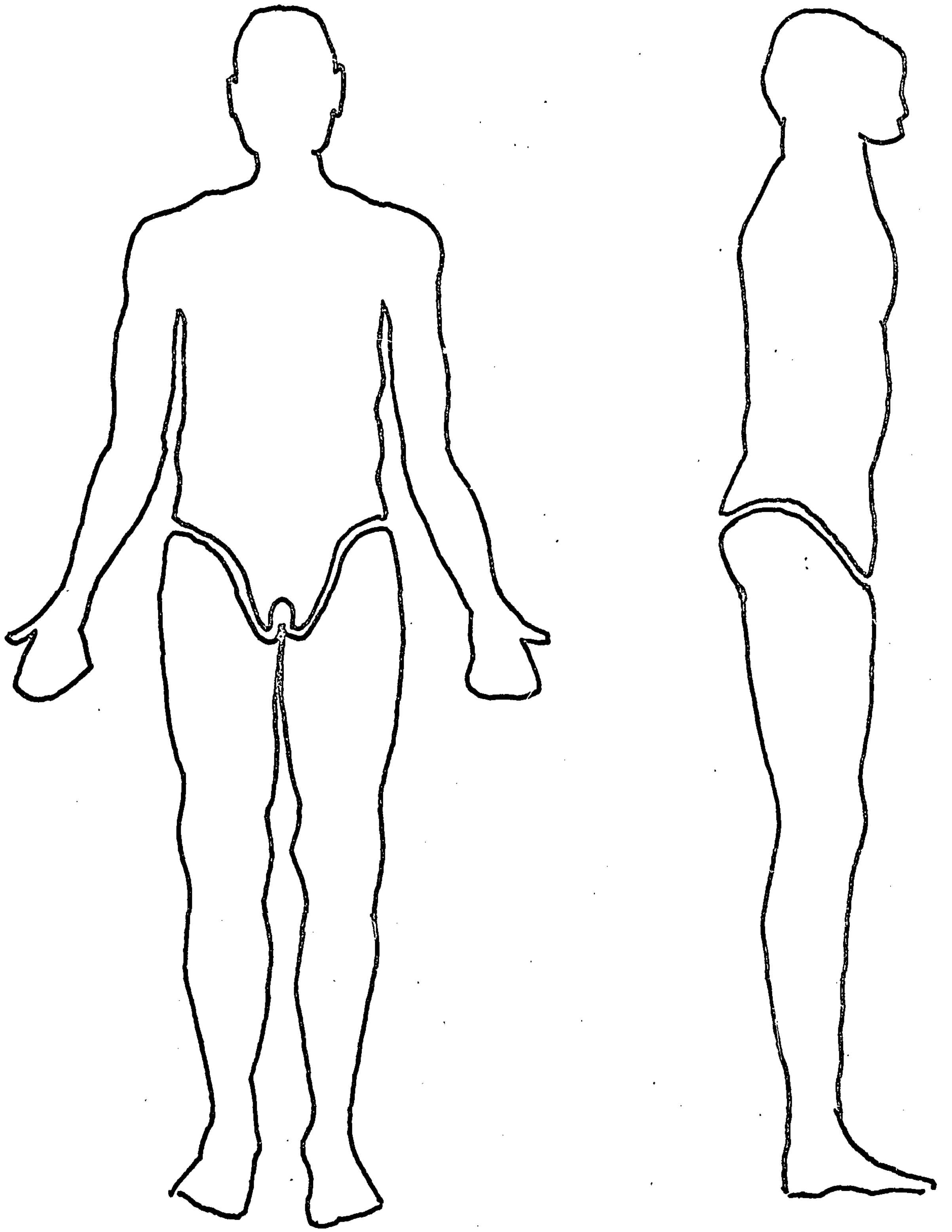
- Will be unable to hold limbs or joint rigid, particularly when at rest
- Will be unable to maintain secure joint sockets for rotation
- Limb and body mass positions are hard to control
- Unable to stabilize their muscular tension thus it becomes very hard to keep still
- Limbs are unable to lift, pull, or push anything
- As of date is incurable

A
OVERALL PROBLEMS RESULTING FROM
MODERATE TO FULL HYPOTONIC MUSCULATURE LOSS

- The muscular skeletal framework is in a collapsing condition
- The limbs are too elastic and will easily overstretch
- There is too much limb extension
- Body segment movement is uncontrollable
- Hard and soft tissue atrophy (bone and muscle fiber, etc) are extremely difficult to stop
- Vascular dilation is difficult to control and/or rebalance
- Body temperature is usually too low and is hard to balance
- Complain of being cold
- Rehabilitative potential is greatly diminished
- Dependency partially increases as it is more difficult to maintain self-care

A
NEEDS OF THE CONDITION VARIABLE

- There is a need to stabilize and control all joints and their mass segments
- There is a need to stabilize the entire muscular skeletal structure
- It is essential to properly align the entire body
- Overstretching of ligaments or of limbs is to be guarded against
- Fracturing due to any extraneous impact or weight bearing strain are to be guarded against
- Muscle and tissue tone are to be increased to their normal maximum
- Mass segment incoordination is to be decreased
- Legs are to be moved in any way possible
- Capillary and venous strength are to be reinforced and increased
- Standing is to be promoted and aided as much as possible
- Bone strength is to be increased by making calcium to return to the tissue
- Body is to be stabilized to insure restful postural positioning



6.1
GENERAL CHARACTERISTICS
RESULTING FROM BILATERAL LOWER EXTREMITY BIOLOGIC DEFICIENCY

Biomechanic parts and performance that are commonly affected:

- Have full pelvic girdle rotation strength and integrity
- Have moderate hip joint strength
- Have functional appliance, semiambulation, vertical locomotion capability
- Have up and down elevation activity ability
- Have moderate to full, thigh-shoulder action capacity
- Have a moderate locomotor duration and distance capacity
- Have minimal to no thigh-leg and leg-foot action ability

Neuromuscular parts and performance that are commonly affected:

- Have full pelvic girdle balance and control (stability)
- Have minimal to moderate hip joint control (stability)
- Have minimal to no knee control
- Have no ankle control

Sensory parts and performance that are commonly affected:

- Have limited feeling or sensitivity
- Have poor limb position and direction feedback or awareness
- Have little full leg voluntary action ability
- Have little to no extensor reflex response in legs

Biochemical:

- Have full respiratory capacity and ability

- Have minimal to moderate tissue atrophy
- Have poor lower leg and foot thermal protection

- Have complete bowel-bladder balance and control

- Have venous pooling in feet and ankles
- Lower leg and feet capillaries are weak
- Have swelling in feet when making abrupt postural change to standing
- Have lymph circulation which is impeded in prolonged standing causing lower legs and feet to swell

6.1 (Continued)

Psychosocial behavior and attitude that are commonly affected:

- .Have a commanding way of communicating with others
- .Have full respect and little to no harassment from others
- .Can perform and act as leaders when given the opportunity
- .Great deal of motivation
- .Frustrated by inability to functionally move about on nonsolid surfaces
- .Often only require leg bracing from upper thigh on down
- .Stiff leg gait is practical
- .Don't need crutches, etc., to semiambulate, but often use to protect against falls
- .Have moderate to full occupation freedom and full potential
- .Become annoyed by the inconveniences and precautions required when using bracing

6.1
OVERALL PROBLEMS RESULTING FROM CONDITION

.Minimally need some sort of mass support from the high to midthigh down

.Poor foot arch support

.Poor foot surface protection causing extreme callousing and/or skin breakdown

.Weight of supportive equipment is too great

.Unstable knees

.Amount of lift pelvic girdle must supply in order to maintain vertical locomotor, semiambulation (which is still unfunctional)

.Unable to perform in even semiskilled motor activities

.Extreme fatigue in attempting to move over anything but flat and hard surfaces

.Unsafe to move over grass, gravel, or any unstable surfaces

6.1 (Continued)

- Poor fitting supportive devices which exist that are causing surface irritation and sores
- Great deal of shin irritation
- Requires great amount of conscious effort to move in described fashion without using crutches
- Great deal of falling due to stumbling

6.1

INABILITIES ATTRIBUTED TO AFFECTS OF CONDITION AND COMPLICATIONS

- Unable to independently locomote thru space without some kind of lower leg and knee support stabilization
- Unable to fully control the placement of each leg movement
- Unable to fully range limbs independently
- Unable to gracefully move thru space in a more natural pattern of movement
- Unable to fully push or swing legs forward
- Unable to push with feet (no metatarsal-foot action)
- Unable to control "drop foot"
- Unable to functionally rotate leg segments in locomotion
- Unable to travel up and down full staircase without extreme fatigue and caution
- Unable to lift legs for more than moderate durations of time particularly up and down any inclines without fatigue

6.1
COMPLICATIONS OFTEN RESULTING FROM CHARACTERISTICS

.Great deal of physical fatigue

.Tightening up of limb's extension ability (range limits)

.Alignment problems

.Lack of neuromuscular balance and/or stability in limb's mass segments

.Susceptibility to lower back stress and strain causing backaches and difficulties

.Minimal atrophy of bones or tissue causing a slow down in their proper growth

.Minimal amount of demineralization of bones

.Bursting of blood vessels in feet

.Breaking of bones in lower limb

6.1
OVERALL NEEDS RESULTING FROM BIOLOGIC DEFICIENCY AT THIS CONDITION LEVEL

Biomechanic need is for:

.Full lower extremity, leg lifting capabilities
.Ankle flexion and knee flexion capabilities
.Foot-metatarsal (toe) joint action
.Horizontal rotation of limb mass segments
.Full leg extension capability
.Have full, normal vertically erect, locomotor capability and potentials
.Perform all gross motor skills
.Exercise the neck, trunk, and upper limb muscles
.Increase all of their muscle fiber size

6.1 (Continued)

Neuromuscular need is for:

- Sequence and coordinated leg action
- Coordinated bases of support action
- Stimulate, redevelop or reinforce neural pathways
- Fully balanced support bases

Sensory need is for:

- Feedback as to where bases of support are
- Feedback and control between center of gravity location and bases of support
- No conscious effort demands to productively move thru space

Biochemical need is for:

- Increase endurance

- Eliminate venous pooling in lower legs and feet by increasing muscle action
- Aid capillaries to withstand increases of blood pressure when standing and during abrupt postural shifts
- Slow down abrupt blood pressure flow going down to feet
- Protect against any circulation stoppage in legs
- Increase the veins and capillaries strength by increasing their use thru exercise or increasing contraction against the veins

- Gradually decrease bone atrophy (rapid aging) and stimulate new cell production in bones again
- Soft tissue massage and support in lower extremities to replace deficient muscle action

Psychosocial need is for:

- To make safe abrupt direction changes, climb stairs and inclines without fatigue
- Increase their visual acceptability
- More maneuverable in physical surrounds
- Full locomotor capabilities over common, semistable surfaces
- Move in a more natural manner and pattern
- End frustration of using complicated and cumbersome supportive devices

a5
The unique character of any full lower extremity amputation malformation or deformity is that, for one reason or another no hip joint stabilization occurs. Either an extreme bilateral limb loss with the mass massing has occurred or the lower extremities are so very twisted and out of align. In either case, with existing supportive equipment it is impossible to move thru space or stand for any period of time in a vertically erect, functional manner.

USING THE INFORMATION SYSTEM

What Are Existing N.A. User Needs and Ability:

Each particular handicapping condition level is broken down into the four major biologic systems. In order to perform any task we rely upon our biologic systems and subsystems for biochemical, biomechanic and neurosensory support. The biochemical subsystems in task performance have the responsibility to insure that the entire system has enough metabolic or chemical energy (balance) and respiratory oxygen supply balance to initiate and sustain physical activity and to power the neurosensory. The biomechanic subsystems are the largest users of the energy, as their major responsibility is to provide the necessary static and dynamic forces in combination with structure to carry out the physical activity demand. The neural sensory systems have the responsibility of coordinating and equating the efforts of the entire system with regards to its internal state, balance external influences and mental voluntary and automatic task demands.

The corresponding psychosocial character of the condition level is also given. The total needs of the particular condition level alone are provided. From this information and its given sources it also is possible to determine the particular level of the condition plus its existing performance ability. Thus, we are able to quickly review the total condition requirements which can be further broken down into their respective biologic subsystem categories for further examination.

Determining the Overall User Requirements

In order to determine the total requirements for existing user needs and ability, all condition levels of biologic deficiency and their associated variables below the highest involvement level are to be taken into account. The subsequent needs and ability of each level are added up (cumulative) with the others, below the level of involvement.

This is when the overall existing user needs and ability can be formulated. Next we must determine the advantageous user requirements which are independent in nature and will vary a great deal. The advantageous user requirements that are given, primarily came from clinical (psychiatric and medical care) work with the N.A. Most of what is considered to be advantageous is based on the current medical practice, state of the art and past clinical experience. What's considered advantageous today clinically will thus be subject to change.

The Physiologically Advantageous User Requirements

To date there are primarily three artificial means in which to physiologically attempt to rehabilitate, aid or restore the non-ambulatory organism (N.A.). Two of these means which have not been discussed include the application of physical treatment, or care and therapy. Both physical therapy and care are concerned about prevention and correction of organic deficiency.

Care is typically aimed at reducing and eliminating the effects of complications while trying to control and avoid new and old reoccurrences. The typical objectives of care are to first increase the organisms movement potential and use of hands.

Ultimately, care treatment is most advantageous if it can allow the individual independent self-care maintenance. Prevention and correction of contracturing and pressure sores are the most common, and rate the highest in care priorities.

Probably physical therapy and its means of application have developed more rapidly than the means of care. Therapeutic treatment is normally applied in order to minimize the resultant affects of handicapping deficiencies. Both therapy and care needs and requirements are closely related. But therapy is more directly involved with the biomechanic portion of deficiencies, while care is directed more towards the biochemical deficiencies and integrity of the organism as a whole. Therapy, as its means of treatment, is primarily concerned with moving body mass segments that are unable to move and range by themselves. Therapy in a sense is reinforcement for the care. Because in physical therapy there is a daily priority to keep the N.A. organisms as physically active as possible and to passively guide and stretch out the mass segments. Therapy is thus concerned with passively maintaining as normally as possible body mass extension while trying to increase muscle fiber strength, endurance, and energy reserves and attempting to maintain old or stimulate the development of new neural pathways.

A systematic approach to therapeutic activity is normally taken, due to the minimal energy capacities of most N.A.'s. A great amount of dedication, time and effort go into this care and therapy treatment, but only a certain percent of the N.A.'s will ever respond to it. Both care and therapy personnel are understandably overworked and are unable to give full attention, or sometimes even meet the patient's minimal treatment needs. This, of course, increases both the mental and physiologic pressures placed upon the patients, who in turn have that much less of a potential to rehabilitate.

Advantageous Aids

The amount of potential physiological advantages that could be derived from the development and proper interfacing of new aids are unlimited. But first care and therapy personnel need to be relieved of the burden of having to manually assist nearly all N.A. patients. A great deal of artificial aid is needed in this area. Non-ambulatory individuals often leave the care and therapy wards with a certain amount of self-care and performance ability, but within weeks outside the ward they lose it. Artificial aids for home care, therapy, and recreation are needed. In general, artificial aid is needed to support what can't be naturally supported by the organism and provide the N.A. with an independent and new way of controlling and using their bodies.

RANDOM FACTORS CHECKLIST

What is Physiologically Advantageous

Physiological advantages or beneficial care for the N.A. can be broken down into categories of: biomechanical advantages, therapeutic and artificial aids that are stimulating to the organism and its neurosensory mechanisms. Biochemical advantages from therapeutic care that are potentially beneficial can also be classified.

It is therapeutically advantageous and biomechanically beneficial to:

- Control and maintain a symmetrical pelvic base
- Encourage proximal to distal recovery
- Strengthen and control proximal body segments first before the distal ones
- Control the entire leg by controlling the ankles
- Control extraneous or low muscle tension
- Maintain proper ligament and tendon muscle fiber lengths so bones don't contract and deform
- Control reflex activity in the body
- Move or be as physically active as possible
- Engage in gross physical activities
- Have maximum daily (physical) activity level
- Strengthen all trunk musculature
- Prevent any deforming forces in the body
- Keep joints in their natural alignment
- Put stress and weight bearing on bones in the affected areas
- Stand and decrease bone brittleness by returning calcium to the body
- Restore missing or altered balance mechanisms
- Substitute for damaged or missing action components
- Substitute for any missing, damaged, or altered (shifted) parts of the gravitational axis
- Substitute for any missing support under the shoulders
- Put traction or stretch on the low spine
- Rest low spine on the illium (pelvic girdle)
- Maintain full pelvic extension and flexion ability

Alignment is beneficial if it:

- Reinforces bilateral orientation to anticipated manipulations
- Reinforces visual resolution (localization)
- Maintains freedom of trunk to align, change alignment, and freely return to alignment

Passive ranging is beneficial if it:

- Maintains or increases a stable range of limb motion
- Increase weight put on body segments being ranged as ranging repetitions increase
- Extends and/or stretches body parts and limbs as much as possible
- Is kept up for a minimum of two to three hours daily
- Is kept up for more than three hours if hypermuscular tension exists
- Extend the hips, knees, and toes first; then chest muscles, upper shoulders and upper extremities
- Passively ranges limbs that are not fully ranged thru daily use
- Increases joint mobility and aids circulation

Movement patterns are beneficial if they:

- Stimulate gross rhythmic movement of body parts first
- Move thru and mimic natural spiral and diagonal counter-balance motions
- Promote smooth, cyclical repetitious activity
- First develop bilateral balance and counterbalance
- Help rebalance peripheral neuromuscular imbalances
- Stimulate repetitive body action
- Use reflex points for quick movement or support of desired patterns
- Increase the involvement of trunk action and movement in patterns
- Keep reflex arcs active and use them
- Safely increase participation potential in active recreation
- Stimulate and increase the amount of movement ability
- Enhances the organism's health
- Can be developed into controlled performance activity
- Reinforce good head control and balance
- Help channel energy (strength) from above in unaffected body areas to the affected areas

Sensory stimulation is beneficial if it:

- Increases the sense of alertness
- Increases awareness of performance ability
- Substitutes for any missing sensory feedback losses
- Helps regain basic peripheral sensitivity to position and direction of body parts
- Enhances or sharpens the remaining sensor functionings and vision or audition
- Enhances any existing vertebral reflex responses

<u>It Is Advantageous and Biochemically Beneficial To Provide Therapeutic Care</u>

Hard and soft body tissue and fiber care is beneficial if it:

- Prevents pressure sores or any skin infection
- Stops demineralization and subsequent bone brittleness by returning calcium to bones
- Increases hard tissue strength
- Increases muscle fiber strength and endurance
- Can protect the skin from abrupt changes in force or energy
- Can protect tissue from any strong or abrupt stimuli
- Keep the soft tissue healthy, dry, but not flakey
- Protects the feet
- Stops or decreases neurogenic atrophy
- Stops muscle fiber atrophy
- Protects weak muscles from stress or overstretch
- Increases muscle tone in the vertebral musculature
- Avoids abrupt body twisting or turning and lifting strain
- Can be frequently inspected (particularly in anal and groin areas
- Protects prominent bones of the hip and pelvic girdle
- Protects already infected body tissue
- Can stop atrophying before the first four to six months of deficiency pass by
- Maintains the proper skin moisture and thus body surface elasticity

Respiratory care is beneficial if it:

- Helps to regain lost respiratory capacity and eventually increase endurance
- Can support above chest to uplift diaphragm, in sedentary postures
- Helps muscles to regain their oxygen debt
- Provides chest uplifting and stretching thru manual and positive pressure

Circulatory care is beneficial if it:

- Can slow down circulation in legs and feet
- Can decrease sudden pressure changes in legs and feet
- Increase veins and capillaries strength by increasing their use thru exercise
- Maintains proper blood supply to the spinal cord at all times
- Decreases stress on the cardio vascular system
- Can keep heart rate below a maximum of 120-130 beats per minute

Thermal care is beneficial if it:

- Does not allow the deficient human organism to become hot or cold
- Externally can control localized or borderline perspiration
- Can be maintained slightly lower than normal internal body temperature, to decrease oxygen requirements of the living tissue

Metabolic care is beneficial if it:

- Can keep the metabolic rate below five calories per minute
- Is accompanied with a controlled pattern of urinary output, bowel consistency, fluid intake
- Can properly cope with abrupt situations or climatic changes
- Can vary with daily activity changes and environmental changes

Bowel and bladder care is beneficial if it:

- Can maintain clear urinary and bowel tracts
- Can help the human organism adapt to new ways of controlling and using the body
- Maintain an infection and bacterial-free state
- Can decrease sedimentation within the body
- Keep urinal fluids diluted
- Can assist overworked kidney functioning
- Can initiate and maintain a pattern of voiding, evacuation and eating
- Can help decrease the body's requirements for water
- Can assist bowel and bladder functioning by allowing stretch and exercise of low back and abdominal musculature

REQUIREMENT CHECKLIST

Therapeutic Potentials of Artificial Aids

- Should be usable in a graduated rehabilitation program
- Should be able to adjust or graduate the system's range to some degree
- Should be usable each day in order to maintain a daily activity schedule
- Should allow user to independently stand for prolonged periods of time without fatigue
- Should provide user with a limited locomotor (movement) capacity without any fatigue
- Should sense, amplify or reinforce weak neural signals
- Should stimulate muscles into patterns of action with electrical impulses or vibration
- Should move and support body segments in accordance with natural timing
- Should support and reinforce reciprocal segment motions first
- Should provide extra protection around existing pressure sores and/or around common pressure sore locations
- Should protect all bony points and bony ridges that are in affected area, particularly along exterior surface along the vertebral column
- Should automatically support, move and guide limbs thru daily ranging exercise requirements beyond the daily movement pattern
- Should provide spiral and diagonal (natural) patterns of body segment ranging for it is most effective (Knott and Voss 1966)
- Should use electrical energy transfer (impulses) to control, guide and obtain its feedback
- Must provide even pressure about the entire involved body segments

Therapeutic Potentials of Artificial Aids (Continued)

- Should allow limbs to engage in 8-12 hours of daily activity or cyclical stimulation
- Should allow user to extend and abduct their legs (straight leg ranging)
- Should stimulate extensor reflex at sole of the foot
- Should allow N.A. to extend or stretch the hips daily
- Should help to increase the capability to swim and participate in water sports
- Should integrate with or use existing skeletal framework, if remaining
- Should only help maintain the beneficial range that is required daily
- Should allow more asymmetrical ranging of one part or area in order to oppose forces of imbalance
- Should provide carry over value in any support aids, as well as diversification (flexible usage)
- Should first support and insure good posture and respiration

Overall Therapeutic Aid, Care Constraints and Precautions

- Must move body segments that are involved or affected passively or not at all
- Should avoid any tightness or continuous rubbing on affected areas
- Should not allow two skin surfaces to rub against each other
- Must avoid any rubbing, etc., around any bony prominences
- Must evenly distribute and minimize pressure on any major bony areas
- Must protect against any incidental stress or pressure on body
- Should be able to adjust to take into account varying degrees of individual condition variance within the set condition levels

Overall Therapeutic Aid, Care Constraints and Precautions (Continued)

- Should have a certain degree of condition flexibility
- Should have a certain degree or flexibility in controlling amount of range and/or movement capacity within the set condition level
- Should require a minimum amount of physical effort to use
- Should not provide those with moderate to acute cardiovascular or kidney complications with movement or locomotor support
- Should not provide N.A. with degenerative conditions any full locomotor, support aid
- Should protect against hot or cold surface contact
- Should not depend upon surgical fusing, etc., of vertebral column to insure proper balance and stability
- Should not cause or stimulate any swelling in foot or leg
- Should not cause or stimulate pain
- Should minimize use of straps in unaffected areas
- Should not use straps in (nonsensitive) or affected areas
- Should minimize the use of any artificial electrical stimulation
- Should not introduce aids until condition stabilizes and individuals are fully able to use
- Should not require any static (stable) corsets on chest area
- Should help minimized chances of embarrassment due to lack of bowel or bladder control
- Should not cause feelings of confinement
- Should minimize compression of abdominal viscera and lower back areas
- Should not allow limbs to be ranged to normal extremes
- Should not allow joints to become rigid from disuse

Overall Therapeutic Aid, Care Constraints and Precautions (Continued)

- Should not allow quick or compressive twisting or bending of vertebral column
- Must protect vertebral column from any outside pressures or impact

Designing for N.A. Children and Aged

"Growing bodies are influenced by their surrounding energies and forces." (D. B. Harmon 1965) This is evident and important if we understand the biologic differences and demands of the varying growth and development stages of the normal human organism are more than anatomical in character. This, I believe, is true and more important when concerned with the non-ambulatory organism's growth and development

Clinically, it has been found that handicapped children, or those who are still in a period of biologic development, will usually have the greatest potential to maintain and/or restore some of their lost capacities which minimizes their deficiencies. This potential is there and should be capitalized. What is advantageously done for them at an early age will influence their functional existence the rest of their life. However, this potential is rarely met, particularly by those who can determine their life style. In fact, a great many handicapping conditions are at first not a non-ambulatory condition, but only become so thru time and lack of proper support. Because their already sensitive growing bodies are unable to cope as well with the deficiencies brought about by the condition and they soon become increasingly deficient.

This study has not been able to go into these particular problems, but there are some major design criteria emphasis changes that should be made clear.

If we are concerned with designing for the growing handicapped organism and developing specific information which can be readily used to make valid design decisions, then we must understand what need changes occur and how they correspond to the varying stages of growth.

I believe there is an intimate correlation and yet difference between at what age of the growth development period the condition strikes with its initial handicapping affects, and how, thru time the affects change in character, increasing the deficiency.

Literature emphasizes that non-ambulatory children are more than anything else, threatened and often grow up with a progressively acute and later permanent deformities. Bad childhood postures are leading them into being multiply involved handicap conditions. The slowing down and disruption of the natural bone growth and development are attributing factors. They usually are found to have extremely underdeveloped, tender and weak trunk, spinal and pelvic musculatures that are more sensitive to imbalances, and less stable or strong than should be at a normal development stage. Also during the bone development stage the center of gravity is higher and the pelvic girdle tends to tilt forward, increasing deformity and spinal collapse even further. The shorter the non-ambulatory's adolescent growth or development delay period is, the less biological makeup is required to catch up. "Providing it is still done during the development stage of the mechanism." (D. B. Harmon 1971) Thus, it seems the sooner optimal aid and support can be given after initial onset the greater the chances of positive rehabilitative response. We can only go on the fact that any delay in growth during the organism's growth stage due to disability, will alter the body segments and mechanic growth character. The younger this occurs, the greater and more severe the alterations. The length and cause of delay will determine how great these affects will be.

This study was not able to study the influences of onset age, condition nature, potentials and cause, and what affects and correlations, if any, they make on developing non-ambulatory design guidelines.

There will be a need in the future for further investigation into the particular needs of N.A. children and the aged both. Aged, for example, have more structural instability in the spine. Their lumbar spinal columns often flatten out and fix, while their centers of gravity tend to move forward with increasing age.

Here is how needs for new support, sensory aid and stimulation, flexible kinds and amount could change and/or alter the amount of time required to make up for the growth delays and affects in such biologically deficient bodies.

What is Psychosocially Advantageous to the N.A.

Physical manipulation of the deficient body that is psychosocially advantageous, will benefit and aid the N.A.'s ability to adjust to their involuntary imposed life style. Life style is primarily concerned with how one lives, performs and behaves, and in what manner desires can be met. An individual life style is characterized by a continuous series of events that are determined by innate drives, desires and perceptual motivations.

Basic survival drives are in all individuals. There may be many desire variables, however, drives are quite consistent among individuals. Basically, the N.A. and the healthy individual have similar survival drives, although priority of desires may differ. Natural drives are sought first before essential and unessential desires. The less performance ability the N.A. finds he has, the greater his desires are likely to be. The degree to which they can physically adapt to their deficiency, to a great extent, will determine the amount of psychological and social support they need.

Primarily there are four categories in which to approach the N.A. psychologic and social desires, or needs. The N.A.'s daily living, personal acceptance, norm group acceptance and occupational needs are all very closely related. But in all four cases some sort of adjustment on the N.A.'s part must be made, if they are to find living worthwhile.

Daily living adjustments are primarily concerned with self-care independence. The unmatured or adolescent aged N.A.'s, are most frequently found, yet ironically least emotionally ready to meet the massive demands of dependency. All of the adolescent, age groups, independent desires will often conflict with the dependency adjustment demands. Increased emotional stress at this age is the result. The problems of being unable to independently meet daily living needs are correlated to the emotional problems of self-acceptance.

How someone feels about never walking again is an unanswerable question! The perspective in which the N.A. individual views himself and feels about himself are going to result from how well he can manipulate within his physical surrounds. Their feelings of how others view them and respond, will also affect the acceptance behavior. Their self-image is often destroyed, or never developed. There is a loss of important sensory input to their individual ego. Ego or personal acceptance is quickly diminished as their visual appearance and social integrating capacities are upset. If preservation and personal advantages are threatened, adjustment becomes more difficult.

Factors concerning personal and norm group acceptance are complexly interwoven. The N.A.'s role in the family can take an unfavorable turn, in many aspects, and can greatly influence their behavior and minimize their possible ability to cope with their deficiency. Individual, sexual and occupational role factors are majorly involved in personal and norm group acceptance. Sexual inadequacy is more often found to disturb the males than females. The loss of sexual identity is a major fear which accompanies many N.A. conditions. A great deal of personal bitterness, and in marital cases, family conflict often arises due to this problem. The loss of occupational potential is also a cause of family conflicts. Overall increasing the N.A.'s occupational potential is one means in which they can decrease both their personal and norm group acceptance difficulties. Extensive emotional adjustment problems and conflicts occur because of their inability to meet the minimal living needs and roles in the home and in society. If not minimized, the problems will often affect and diminish later life potentials and interests.

How can the N.A. individual change their way of thinking and doing in order to cope with a deficient life style? Those unable to adjust will tend to emotionally avoid or accept the reality of their condition, by not working actively to rehabilitate or increase their life style potentials. As the facing of reality is held back, an unfavorable progression of behavior change often occurs. Personal isolation is likely to increase. Psychological acceptance by the N.A., of his disability condition is needed, before any behavior change improvement can occur. Without psychological acceptance, serious and permanently harmful events can affect their life. The sooner the individual can perceive themselves as they really exist, and clearly understand the extent of their disability condition, the less the possibilities are of undesirable behavioral change. Overall personal adjustment to limited life style will tend to vary depending upon past experiences, length of disability, degree and cause of the biologic deficiency.

Social or norm group acceptance is closely related to the degree in which the N.A. will be able to take part or interact in interpersonal events. Cultural background, life experiences, personal home, and social relationships with people will often affect the N.A.'s social adjustment more than the handicapping condition itself. There is reason to believe that psychological differences in the N.A. and social reactions to the N.A. disability condition will vary with the amount of biologic deficiency or severity of the handicapping condition, however, not necessarily the kind of N.A. condition. The severity of the condition will directly influence how much the N.A.'s life style must depend upon other individuals for daily existence.

I believe the capacity to meet the simplest tasks of life is minimally, yet most essential to the N.A. Thus, it is more psychologically advantageous to provide the N.A. with the means to beneficially regain and redevelop a new norm group and personal role in life. The amount of performance independence that the N.A. can redevelop is most important, for it directly influences what roles and extent to which desires can be achieved.

Adjustment to the handicapping condition is achieved, when the N.A. can turn from their situations at hand, to the social surround to test his performance capacities, while feeling socially accepted. Full adjustment is marked, only when the N.A. can turn from self-concern or introversion to extroversion without fear of outside acceptance.

> ...the biggest problem of adjustment is of shyness, or of coming back to the real world, overcoming the fear of everyone looking at you, and of associating with people that weren't disabled. (Steve Kayes 1971)

Once extroversion is achieved, adjustments are easier and more rapidly made. While it is unlikely that anything can be socially advantageous until psychologically beneficial to the N.A. individual first. Aid which is psychologically beneficial allows the N.A. to perform. Aid socially beneficial enhances the ability to interact within their physical surround. The problem is in preventing introversion and motivating extroversion within the N.A. individual. It is unlikely that anything can be motivating without being first psychosocially advantageous also.

SUBJECTIVE REQUIREMENT CHECKLIST

Overall Psychosocially Advantageous

- Should take into account that there is often a direct correspondence between body build and mean temperament or behavior
- Should maintain or regain individual masculine (or feminine) identity
- Should stimulate motivation and desires from within
- Should decrease everyday tension and fears accompanying disability
- Should minimize or eliminate any continuously unconscious fears or threats on survival
- Should increase self-independence, both occupation and self-care
- Should increase discharge and utilization of individual's aggressive energies to master surround and situations
- Should help to regain as much of their past self-identity and image as possible
- Should help speed up the emotional adjustment period of acceptability
- Should try to ease or lessen adaptability demands
- Should increase desirability of their visual image and appearance to themselves and then to their companions
- Increase and speed up their potentials or ability to socially interact and communicate
- Should help minimize or eliminate isolationism behavior
- Should help make the body image change less shocking and more acceptable to the disabled and others
- Should be able to dress, bathe, and use toilet facilities by themselves
- Should help them return to a purposeful and meaningful life style in the community

Overall, Psychosocially Advantageous (Continued)

- Should maintain a high level of daily activity and personal involvement
- Should help to minimize any daily dependency requirements and behavior patterns
- Should help minimize and eliminate concern and worry for themselves (introversion)
- Should increase their ability to engage in constructive action, purposeful activity and to be and feel involved
- Should help soften the impact of first facing reality
- Should try to provide N.A. with functional aid as soon as possible (after onset)
- Should help them overcome their feelings of helplessness
- Should help them minimize and eliminate as many denying restrictions of the disability as soon as possible
- Should help to continuously re-experience and reprove his capacity to utilize his limited abilities
- Should help them to continually understand the extent of his disability and his potential
- Should help them regain or retain their individuality and original character
- Should help extend and stimulate their occupational potentials, responsibilities and ability
- Should help them perceive special equipment and aids unemotionally
- Should attempt to prevent, lessen or eliminate any maladjusted behavior patterns
- Should stimulate and provide positive encouragement and hope
- Should help stimulate and increase the N.A.'s desire or motivation to improve their physical condition
- Should stimulate them into seeking new experiences

Overall, Psychosocially Advantageous (Continued)

- Should attempt to enhance the appearance of their bodies to help change their attitude
- Should help minimize frustration, frustrating experiences and maximize motivation
- Should help maintain ability to think clearly (constructively) plan, and make decisions for themselves
- Should help to ease the stress of their altered sexual role
- Should help them accept themselves and be socially acceptable
- Should increase their ability to use existing public facilities and transit systems
- Should help them make social and interpersonal adjustments more easily
- Should help them return to as much of an original life style and plan as possible
- Should help stimulate and make physical activity recreative and fun
- Should aid and help the N.A. to be as physically normal in performance, as those he lives with
- Should increase to a maximum (within his physiologic limits) his ability to travel or get around independently
- Should help to become ambulatory in a functional way (move in vertical posture at will)
- Should increase their ability to move in natural patterns
- Should minimize and not cause any feelings of disinterest or boredom when N.A. engage in social or mental activities
- Should help them to realistically understand their new relationship to others
- Should help to maintain or have a secure and happy family relationship after onset.
- Should help to reach the highest level of constructive adaptation as possible

Overall, Psychosocially Advantageous (Continued)

- Should first help to manage their own daily activities and then worry about social appearance
- Should minimize the amount of motivational effort required to use artificial aid
- Should be able to perform with others in their physical surround that are ambulatory
- Should not stimulate users into any unfavorable correlations or comparisons

What is Psychobiologically Advantageous

To be psychobiologically advantageous, any physical aid provided for the N.A. must maximally attempt to enhance, support and sustain their biologic state at a productive yet worry-free level of functioning. Sensory and biochemical support are of first necessity, before biomechanic performance and a beneficial psychologic attitude can be developed and sustained.

Biological advantages are based upon what can be done to minimize and control the N.A.'s permanent biologic deficiency condition characteristics. Psychological advantages are based primarily upon what can be done to ease and minimize the emotional problems which have resulted from varying levels of performance deficiency. Thus, anything which can be done to help the N.A. to reach and maintain their full performance potentials in a safe and meaningful manner, is psychobiologically advantageous.

However, it is not advantageous to push their artificially supported performance capacity beyond their limited biologic thresholds. Also, it is not advantageous to reinforce a performance capacity which has no productive usefulness. Reaching a task performance level is one thing, but being able to sustain the level daily in order to meet a specific task goal or living need is just as important. Thus, the need by the N.A. to control or adapt to situations that they are confronted with becomes more essential as performance abilities or potentials increase. The more we can enhance the N.A.'s performance ability to manipulate, control themselves and the surrounds about them, the more advantageous it will be.

With any perceived changes in performance ability there will be an accompanying emotion boost. If we can aid the N.A.'s to meet their potential task performance ability, we will in affect be determining what events and thus, life styles they have. A great many of their psychosocial problems will be resolved at the same time.

Beneficial Task Performance Potential

The individual N.A.'s overall psychobiologic potentials are seemingly dependent upon whether or not they can biologically and psychosocially adjust and accept their imposed and deficient life style. Adjustment and acceptance are greatly dependent on the extent to which they can care for themselves. While the factors influencing self-care, emotional adjustment and acceptance all are a result of the level of condition involvement, with its complications and variable nature. A beneficial level of potential can be determined for each involvement level and also for each kind and type of handicapping condition. Psychobiologic potential is said to exist in nearly all of the N.A.'s except those unable to perceive.

> As long as they are able to perceive or have meaningful awareness to some degree, they have more undamaged physiological equipment, than damaged. (D. B. Harmon 1971)

Foreseeable chances of restoration, or potential can be calculated by taking the existing psychobiologic state of the N.A. and eliminating all but its permanent biologic deficiencies that are unchangeable and ultimately only controllable.

There is a difference between what's optimally advantageous and what's beneficial. Example of this is, optimally all N.A.'s should be able to run and recreate, but many if made to do so, no matter how well supported, would fall over dead. Thus, there are certain limits to which many of the N.A.'s can foreseeably ever perform, because of their permanent biologic deficiencies nature. But it is beneficial that the N.A. psychobiologically reach their highest beneficial potential, in order to maintain the most desirable comfortable and productive life style.

Physiological constraints will increase as the level of the condition involvement does. For example, respiratory constraints from the (3.1) biologic condition level on up will be deficient to some degree, no matter how long or well it is aided. The respiratory capacity will always drop when the aid is removed. So much respiratory aid will consistently be required in order to meet their beneficial performance level. Thus, the unchangeable deficiencies are the constraints of which a handicapping condition will use to set the maximum for their beneficial performance and ultimately life style. What the N.A.'s physiologic potential is and how well it can be achieved will to a great extent determine their psychosocial performance goals.

Physiological advantages become the how or means to, and the psychosocial advantages are the why or reason for what beneficial task performance level should be met.

Selecting the Task Performance Range or Level

The selection of a desirable task performance level or range is based on the found psychobiologic performance parameters. The physiological parameters and corresponding psychosocial task goals will determine what performance goals the N.A. can reach and maintain within the safety and comfort thresholds of their present biologic states.

Having a functional performance ability range is the N.A.'s means of meeting their performance goals, purpose and needs.

There is a hierarchy of performance levels and performance ability requirements which will vary as the level of performance ability increases or decreases. Usually, the greater the need or purpose, the greater the performance level and the more biologic ability and effort required to perform it.

Hierarchy of Task Performance Ability, Goals and Objectives

Levels of task performance are determined primarily by the complexity of an activity and its subsequent surround condition, with regards to the amount of biologic demand and artificial support required to productively reach and maintain the performance goals.

TASK PERFORMANCE LEVELS	PERFORMANCE OBJECTIVES	PERFORMANCE GOALS
T1.1 LYING-LIFT HEAD	.Use eyes, observe, eat and aid in breathing	
T1.2 LYING-ROLL OVER	.Relieve boredom, bedsore problems, and minimal physical activity	TASK LEVEL 1 to have full lying freedom despite physiologic condition
T1.3 LYING-SITTING	.Maintain minimal trunk activity, aid circulation	
		TASK LEVELS 1-2 to have full access to and use of wheelchair
T2.1 SITTING-TRANSFER (ROTATE DIRECTION)	.Have full private transport access (auto or whatever) and to be able to move in and out of bed at will	
T2.2 SITTING-MANIPULATE	.Be able to have full-time potentials (passive, recreative and occupational)	TASK LEVEL 2 to have full sedentary freedom
T2.3 SITTING-STANDING	.Meet minimum daily vertical posture requirements	
		TASK LEVELS 2-3 to independently move in and out of desired sitting and standing location to perform

(Continued)
Hierarchy of Task Performance Ability, Goals and Objectives

T3.1 STANDING-MANIPULATE	.Increase activity range potentials, enhance occupational and physical condition potentials	
T3.2 STANDING-BEND (TOUCH TOES)	.Necessary for full self-care independence	TASK LEVEL 3 to have full standing or vertical posture freedom
T3.3 STANDING-LYING	.Necessary in case of fall for ability will allow one to live completely alone	
T3.4 STANDING-MOVE	.Enhance vertical posture security, full freedom to get in and out of standing and sitting positions and have full to moderate occupational potentials with wheelchair	
		TASK LEVELS 3-4 to move independent of wheelchair, to and from tasks in public facilities and outdoors
T4.1 MOVING-MANIPULATE (Limited*)	.Move within indoor environments at will, and full public transit access	
T4.2 MOVING-LOCOMOTION (Unlimited gross) ability	.Limited movement capacity thru outdoor environments	TASK LEVEL 4 to have full body movement capability and freedom
T4.3 LOCOMOTION-NTL.PACE (Unlimited fine)	.Unlimited normal pace movement capacity outdoors	

(Continued)
Hierarchy of Task Performance Ability, Goals and Objectives

T4.4 FULL LOCOMOTION-MOTOR SKILLS (Unlimited activity)	.Have full body usage and motor capabilities (skill to run, jump, skip, etc.)

HIERARCHY OF THE N.A.'s BENEFICIAL TASK PERFORMANCE GOALS

1.1 Level T2.2 or Sitting and Manipulate

1.2 Level T3.1 or Standing and Manipulate

2.1 Level T4.1 or Moving and Manipulate

3.1 Level T4.2 or Gross Moving and Locomotion

4.1 Level T4.2 or Gross Locomotion

5.1 Level T4.3 or Natural Pace Locomotion

6.1 Level T4.4 or Full Locomotor Skills

*see hierarchy of Task performance levels

What is Task Analysis and How Can it Best Be Used

Task analysis is a means of examining human activities. It is a means or way of pulling apart, identifying and understanding a particular existing activity or desirable performance (work situation) factors and variables.

Whether the activity being examined exists or is to be created, there is a need to clearly establish the purpose, performance involvement and intent (objectives) of the activity. An attempt to clearly establish what is the desired and beneficial level of performance begins, in hopes of later finding what biologic support will correspond and be required.

Task analysis is first concerned in an occupational sense in determining the real needs or purposes for the activity. The concern of analyzing a task or activity is to establish and identify the performance factors which exist or should exist, how long, where, and why is this activity occurring or going to occur. Next it is necessary to determine what would be or is biologically advantageous for the organism performing this activity with regard to the known influencing performance factors. Finally, it is important and necessary, in analyzing a task, to identify the intensity at which the activity is to be performed. For the quantitative changes in demand on the biological systems are derived from the task intensity, and will influence the biologic constant and variable requirements needed. If the analysis of a task or activity is properly executed, it should indicate what is being performed, why, who is involved (what kinds) where and at what physiological expense or for what biologic demands must they perform.

Guidelines from requirements to optimally support and direct the organism's activity and performance (sequence of events) can be established and rank ordered. Most important are the requirements and guidelines which evolve from the analysis that determine what is artificially needed to optimally support and position the human organism freely in the vertical and horizontal planes of space while performing. The analyzed information should then be used to ideally indicate and determine how, and with what equipment, the organism should be able to perform, what the performancesposition is, and what artificial support requirements are necessary to maintain the organism in the activity. In the end all requirements, factors and guidelines established are applicable only if they can be translated into two kinds of physical expression.

Thus, the ideal energy, force and support criteria and requirements must be physically expressed and directed in the design, to provide the human organism with the necessary biologic support to sustain and perform in a dynamic manner.

Task Analysis

The need for task or activity analyzing has been sensed for quite some time. It has been approached in many ways, such as examining the task's sequence and progression of events, by determining the event's feedback, control and performance patterns, by studying with cameras, drawings or computers, the anatomical position changes of the body in space, and more recently by attempting to record indicators of energy output, strain or physiological changes. In all cases the investigators are breaking down the many components of a task to develop greater insight as to what actually occurs during human activity.

Task analysis is not as important as the informational results derived can be. As creators of form, we need to perform task analyzed to insure that form and those who experience it will homeogeneously interact together.

I believe that full analysis of human performance is a key in developing a universal rationale for a psychobiologic approach to design. If we optimally design for mankind, we must take into account all the activities in which man participates and performs. This is necessary before valid biologic design decision making can take place.

T.1
Level of Task Performance Ability

A Task Analysis of Lying and Moving (Lifting) the Head Includes:

Time Demands:

- Seconds to less than a second
- Dependent upon purpose and whether action was reflex, fully involuntary or whether it was partially voluntary
- Speed of trunk rotation doesn't need to be fast normally

Biomechanic Demands:

- Requires the gross performance capacity indicated in (PA1)
- Head and neck rotation thru the second cervical vertebrae
- 30°-50° of easy head extension and flexion movement
- 45°-60° of easy head rotational movement
- Requires contractional force from anterior of shoulder girdle to back of the neck
- Requires fore and aft shoulder girdle tilt
- Need a thrust or support behind the back of the neck to initiate and then to maintain the movement

Biochemical Demands:

- Very minimal to zero effect
- Requires more effort to lift up and maintain than to rotate
- Unable to maintain without support
- Easiest when it is dynamic

Mental Demands:

- Little to no effort to rotate versus minimal to lift head up or down
- Usually very much of a automatic response controlled by mechanisms of occular scanning, etc

Sensory Demands:

- Eye, head and neck sequenced coordination and rotation
- Eye scan and head movement
- Minimal dynamic alignment and balance is required

Physical Support and Environmental Surround Demands:

.Usually is on a bed or sofa
.Support surface approximately two feet from the floor
.Sponge like to very firm surface
.Indoors usually

*and all constant biologic requirements

T1.2
Level of Task Performance Ability

A Task Analysis of Lying and Rolling Over Includes:

Time Demands:

.Usually between 1-3 seconds
.Can vary a great deal depending upon purpose and reason for rolling over
.Increase in speed of movement helps momentum of this twisting action

Biomechanic Demands:

.Strong shoulder and upper trunk rotation required
.Coordinated head, neck and shoulder rotation
.Is a 180° position change
.Once pelvic base is rolled beyond 90° no force is required
.Proper bone alignment important
.Strong vertebral column twisting action takes place
.Is a coordinated twisting action between the shoulders and pelvic base
.Is an asymmetric back-abdominal muscular pull
.Alternating directions of pull

Biochemical Demands:

.Nearly the same as (T1.1) except is probably less demanding because normal rolling over can take place very slowly because one's total body mass never has to be fully lifted off the supporting surface

T1.2 (Continued)

Mental Demands:

- Requires sometimes a bit more conscious thought or desire than lifting head, etc., or moving from sitting to lying position
- Very common activity during sleeping period, most partially roll 30-50 times a night

Sensory Demands:

- Reflex action
- Head and neck, upper trunk and pelvic girdle asymmetric, reciprocal coordination

Physical Support and Environmental Surround Demands:

- 3x6-1/2 ft bed or sofa
- Bed coverings and sheets
- Springiness and/or firmness of mattress
- Location on bed after rolling over
- Space it takes to roll over
- Must support upper trunk and natural vertebral column rotation

T1.3
Level of Task Performance Ability

A Task Analysis of Moving From a Lying to Sitting Position Includes:

Time Demands:

- Very short normally, 1-3 seconds
- Dependent upon voluntary desires and urgency
- Can be slower if large degrees of trunk rotation are available

T1.3 (Continued)

Biomechanic Demands:

- Requires the gross performance capacity indicated in (PA2)
- Shoulder-upper trunk rotation of 6-10°
- Bending forward of head-neck and the waist (shoulder-thigh flexion (min. of 96°)
- Optional aid from pushing upper extremities against support surface
- Primarily a movement requiring first a strong lower back pull and then a longer period of abdominal muscular pull
- Freedom of hands in task isn't necessary
- Need to provide first a strong head-shoulder lift and then a forward push under the lower back

Biochemical Demands:

- Minimal amount exertion or oxygen and glucose demand
- No reserves required

Mental Demands:

- Little to zero conscious thought required
- Must subconsciously make command to perform action

Sensory Demands:

- Head-neck-upper trunk bilateral coordination and control
- Primarily a reflex action
- Requires MINIMAL dynamic alignment and balance
- Minimal pressure and position sense

Physical Support and Environmental Surround Demand:

- Same as T1.1 and T1.2

T2.1
Level of Task Performance Ability

A Task Analysis of Sitting Transfer Includes:

Time Demands:

- Normally a few seconds or less, varies with purpose and urgency
- Quicker movements are more difficult to maintain and control but amount of control available will determine max. of how fast one can safely horizontally shift their body mass

Biomechanic Demands:

- Require some sort of lateral (horizontal force)
- Requires support and forces to horizontally rotate thru one's vertical axis and/or base of support
- Requires minimum vertical force and a great deal of horizontal force
- Purpose to horizontally shift or slide the body mass from one position to another (one seated location to another)
- Move from a sitting in bed position to sitting on the edge of bed (ready to stand)
- Degrees of movement:
    - Normally requires lower trunk-pelvic girdle action and counteraction
    - Usually will roll to one side of the pelvic girdle and swing legs out or across to the anticipated support base location
    - Use arms a great deal to help balance and provide vertical force

Biochemical Demands:

- Greater than any lying activity
- However quite minimal
- Little to no energy or respiratory reserve required

Mental Demands:

- Greater than in any lying activity
- Minimal conscious effort
- Requires subconscious desire

T2.1 (Continued)

Sensory Demands:

.Increase in position sense requirements
.Min. increase in pressure sense requirements
.Min. direction sense required
.Requires dynamic alignment and mod. dynamic balance min.
.Need to control thighs and have head and full trunk coordination

Physical Support and Environmental Surround Demands:

.May be the same as in T1
.Or varying seating device ht., shape and contour (design)
.Varying degree of support device, slide from lateral force contact

T2.2
Level of Task Performance Ability

A Task Analysis of Productive Sitting Includes:

Time Demands:

.Normally less than one hour
.Usually can be measured in minutes
.May last from minutes to several hours
.Prolonged sitting is one hour or more

Biomechanic Demands:

.Two-dimensional near task (example reading and writing)
  .Requires forward body tilt
  .Arm suspension and that legs and feet shift back
  .Work surface with a 20° angle
  .Full lumbar and buttock support
  .Knee joint should be held higher than the hip joint
  .Elbows have freedom to lie slightly over edge of the work surface

T2.2 (Continued)

- Three-dimensional near task (example modeling, manipulative action as eating, etc)
  - Requires back and forth freedom
  - A minimum of 27" are spread freedom
  - Full arm activity, lumbar and buttock support and flexion of the legs
- Three and two-dimensional far tasks (example, spectator, T.V. watching, recreation, etc)
  - Requires full back support
  - Extension of legs, greater thigh shoulder extension or minimum of 110°
  - Relaxed position, tilted back, with maximum visual angle
  - Should require the least amount of physiological effort to maintain
- Two and three-dimensional near tasks will change with varying heights of work surfaces
- Minute body oscillations occur and are necessary
- Oscillation effort varies with differences in support surface contours
- More substantial body shifts occur during periods of prolonged seating (dependent upon degree of comfort or amount of circulation interference)
- Demand placed on antigravity muscles to stabilize the trunk over the pelvic base
- Paraspinal, low back, abdominal and neck muscles are all active (lateral obliques included)
- Feet usually lie flat on the floor

Biochemical Demands:

- Changes in circulation rate will be less as compared to active movement or standing rates
- Will begin to fatigue within a two to three minute period without proper support
- Surface can make seating uncomfortable without movement
- Normally there is a general increase in fatigue thru time
- Approx. 50-60 minutes of uninterrupted positioning a supportive surface (device) without movement is supposedly ideal (D.B.Harmon 1970)
- Prolonged periods of seating in less than ideal seating support requires increasing amounts of effort to maintain attention
- Extremely fatiguing during prolonged periods if the freedom to properly shift position and maintain minute oscillations is interferred with
- More oxygen and energy required to maintain attention attitude in seating than in relaxed seating posture
- Need greater body trunk support as length of seating time increases

T2.2 (Continued)

Mental Demands:

- Normally it takes no conscious effort to maintain posture
- No command to make or hold action or change from position
- To continually maintain proper circulation flow (positioning oscillations)

Sensory Demands:

- Autonomic reflex (automatic)
- Neuromuscular action is providing control over activity
- Great deal of sensory control and adaptation is required to maintain and keep organism in coordination with visual performance
- (Must be free to balance trunk and/or body with 2D and 3D near task activity)
- Wt. bearing pressure sense

Physical Support and Environmental Surround Demands:

- Very hard to very soft depending on surfaces to be seated on
- Hardness or softness directly influences circulation flow and subsequent amount of restlessness or comfort
- Influences bony linkage, part positioning, and alignment
- Shape and contour of supporting device (and its forces) affects comfort and ultimately desire to remain seated
- Shape of supporting surfaces will directly affect degrees of angulation of skeletal linkage and increase or decrease muscle tone (pressure sense)
- Varying mtls, will increase or decrease, stimulate or not thermal sensations (sticky-cold and/or hot)

Environmental Surround Demands:

- Indoor environment variables
- Seating dimension variables
- Number of components making up support surface (seating device)
- How strong seating device is
- How stable it is on floor surface
- How secure it is on the floor surface
- Ht., depth, width and angles of seat pan and back
- Varying ht. and angle of surface working off of

T2.3
Level of Task Performance Ability

A Task Analysis of Moving From a Sitting to Standing Position Includes:

Time Demands:

- Approximately one to two seconds
- Normally very short, in fact it is more energy consuming to transfer slowly than fast
- Varies depending on the level of seated posture and standing position one desires to achieve
- Depth of seat, its distance from the ground, all influence the speed of action

Biomechanic Demands:

- Requires the gross performance capacity indicated in (PA4)
- Center of gravity must move forward and be swung and stabilized above a stationary support base
- Vertical and horizontal forces are required to move center of gravity
- Short term dynamic act of transferring body wt. support from end of the tailbone (buttocks) to the organism's feet (overall support base)
- Need to rise without flattening out the lumbar curve
- Should maintain feet beneath the center of gravity at all times
- Aid lateral stability with arms or hands as mass rises (transfer movement takes place) is optional but common
- Greater displacement of the center of gravity in low sitting-standing transfer, requires greater muscular force (vertical force)
- Need to increase balance forces with increase displacement of the center of gravit
- Needs to maintain balanc between center of gravity and center of pressure
- Need counterbalancing action of trunk-pelvic-support base

Biochemical Demands:

- Requires a short term and small expense of muscular energy
- Requires a minimal oxygen demand on respiratory reserve
- Little overall expense, however will vary on distance of movement
- Proper circulatory support, circulatory mechanism control of pressure becomes very important

T2.3 (Continued)

Mental Demands:

- Mental desire has to be there either voluntarily or involuntarily
- Usually a subconscious effort primarily unless there is some degree of abnormality about the position in or going to reach

Sensory Demands:

- Must control center of gravity fluctuations first in front and then behind the line of gravity
- Line of gravity smoothly moves forward in front of support base until buttock lifts off the chair
- More backward and forward fluctuations of c.p. than lateral
- Ascending increase in upward head tilt descending decrease eye-head tilt
- Eyes (visual axis remain fixed on near space balance pt.
- Must keep center of gravity over or within base of support
- as weight is being transformed or shifted from sitting to standing or vice a versa

Physical and Environmental Surround Demands:

- Indoor environment variations (usually)
- Varying floor surfaces and mtls. (vinyl, carpeting, wood, etc)
- Varying kinds of indoor seating equipment
- Occupational seating devices and relaxation seating
- Varying degrees support surface hardness-softness
- Varying degrees of frictional quality
- How secured seating device is with supporting surface

T3.1
Level of Task Performance Ability

<u>A Task Analysis of Productive Standing Includes:</u>

Time Demands:

- Seconds to hours
- Varies according to need and type ^ ^ activity involved in
- Usually under an hour unless its occupational task requiring prolonged standing 4-10 hours
- Prolonged standing is 1-3 hours or more

T3.1 (Continued)

Sensory Demands:

- Erector reflex responses
- Minimal position sense
- Maximal pressure sense (hip, sole of foot)
- Zero - minimal direction sense
- Normally maintained with ease and without conscious effort
- Continuous low intensity tension and compression activity on structural frame of body
- Maintain in standing, access to all 3 fields of vision (near, intermediate and far)

Physical Support and Environmental Surround Demands:

- Required is some sort of stable supporting surface to be under supportive base of the body mass
- Supportive base requires, certain degree of a resistive counter force response from supporting surface (should be equal forces to mas
- Supporting surfaces may vary greatly from very hard to moderately soft or from slippery to sticky
- Energy forces of surround can influence tension and compression forces within body (its tensive alignment)
- Varying grades and elevations
- Energy forces will influence visual mechanisms and auditory mechanism's performance
- Free standing vertical posture has a maximum ability to adapt to changes in physical environment and to its energies
- Frictional coefficient will vary between supporting surfaces and support base
- Correlation between necessary support base size and type of surface on
- There are a large variation in structural elements vertical protruding and taking up space in the surrounds that can be used to assist standing

T3.1 (Continued)

Sensory Demands:

- Erector reflex responses
- Minimal position sense
- Maximal pressure sense (hip, sole of foot)
- Zero - minimal direction sense
- Normally maintained with ease and without conscious effort
- Continuous low intensity tension and compression activity on structural frame of body
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- Correlation between necessary support base size and type of surface on
- There are a large variation in structural elements vertical protruding and taking up space in the surrounds that can be used to assist standing

T4.1 and T4.2
Levels of Task Performance Ability

A Task Analysis of Bipedal Locomotion (walking) Includes:

Time Demands:

- Normally is approx. 5-15 minutes
- Normal distance is approx. 1/4 a mile or 3 blocks
- Varies however from minutes to hours
- Varies with individual needs and purposes for activity
- Normal speed is 2.85
- Normal stride length 28"
- Speed 107 steps per minute
- 20-30 min. to walk a mile

Biomechanic Demands:

- Requires gross performance capacity indicated from (PA5) to (PA7)
- Continuous oscillations (larger than in sitting or standing) in all planes of space (particularly sagittal)
- Vary with environmental surround's size (outdoor vs indoor)
- Reciprocal counterbalancing of forces
- Bilateral balancing on the 4-dimensions of space (three coordinate planes and time)
- Bone and muscle elasticity
- Requires a smaller support base than static vertical action
- Motor sequence:
  1 one ankle relaxes (flexes)
  2 center of gravity moves in front of ankle joint
  3 other foot lifts and moves forward to receive body wt
  4 forward swinging limbs heel and then foot is placed on the walking surface
  5 created momentum and push from rear foot carries c.g. over support again
  6 sequence continues as each new foot contact is made,*joint adjustments occur to utilize momentum

Biochemical Demands:

- Normally requires 2.5-3 calories per min (metabolic rate and equivalent heat output)
- 120 to 180 calories per hour
- Circulation flow extremely important
- Increase in blood flow compared to standing
- Less demand than maintenance of prolonged stance

T4.1 and T4.2 (Continued)

Mental Demands:

- Subconscious activity
- Conscious only when placed in a stressful situation or base of support is insecure
- Requires greater mental effort with increases in fatigue

Sensory Demands:

- Requires primary coordinated patterns of input and output to stimulate, maintain and control
- Requires more involuntary than voluntary sensory activity
- Requires moderate to full reflex patterns of motion
- Is not neurologically demanding
- Is a primary yet skilled motor pattern
- Maximal direction sensory equipment
- Maximal position sensory equipment
- Moderate pressure sensory activity
- Full body mass activity integration

Physical Support and Environmental Surround Demands:

- Outdoor exposure to energies and obstacles
- Indoor exposure to energies and obstacles
- Thermal range (climate) -30 to +100 deg. F
- Air resistance (wind currents)
- Radio waves (60 cycle artifact or static)
- Northern light (environment light spectrum or character)
- Radiant heat gain or loss
- Metal and magnetic surfaces
- Surfaces to counteract forces produced by the body (mass thrusts, gravel, grass, tar, cement, etc)
- 30" doorways, elevators, stairs, inclines, esculators, curbs 4"-6", steps 6-10"
- Static electricity
- Rain, snow (water)
- Dirt particles, air quality
- Opening doors
- Moving sidewalks
- Moving vehicles and devices
- Protruding objects in space
- Electromagnetic fields

Factors and Variables of Task Performance

In order for man to resolve his needs or answer his desires he must be able to prepare and readily engage himself in physical activity. In most instances the objectives or purpose of the activity will determine why he performs in a particular manner. Despite his character all activities are primarily influenced in three ways. The level or difficulty of performance ability required, environmental conditions of the activity and duration of the activity are influencing variables.

The environment or physical surrounds of a task are typically made up of physical energies and supportive forces. These energies and forces can either reinforce the ease in which the biologic mechanisms are able to meet and sustain the activity or they can increase the demands on the biologic mechanisms by not optimally reinforcing its processes. The physical surrounds can directly influence and increase the effort and thus increase the productivity of the performance. As the level of performance ability of the activity or task to be engaged becomes more or less difficult and involved so do the demands on the biologic mechanisms of the human organism.

Duration or amount of time during which an activity is performed will change the influence of all other task variables. All tasks despite the level of performance demand and requirements will be performed in a quantity of time and under certain surrounding conditions. Together time and environmental conditions will determine the overall biologic demands and constraints on the tasks productivity and ultimate success. How well the required, overall biologic demands can be met and sustained, will greatly depend on the biologic system's performance capacity and endurance.

There are many intensity variables which exist, and must also be taken into account when analyzing tasks, that directly influence the task's biologic demands. The variables of intensity at a particular performance ability and situation are quantitative in character. These variables of performance intensity are indirect and can't be measured by changes in performance, speed, force, distance, frequency and timing. As variable qualities of performance, changes in performance intensities will change the amount of motor skill, endurance and mental effort requirements of the task performance. Motor skill demands will depend on primarily on how fine or gross the sensory and biomechanic mechanisms of the body must perform. Endurance demands will vary, depending on the metabolic and respiratory rates or energy and oxygen consumption levels of the activity, both of which are directly dependent upon support from the biochemical processes of the body. Mental demands of a task vary depending upon the amount of subconscious vs. conscious effort that is required to sustain the activity. While mental effort will depend upon sensory and biochemical support from the body.

How well the biologic mechanisms and processes of the body are able to meet the overall requirements of a task will determine its success. Performance requirements demanded of the body to reach the level of performance ability must first be met. How efficiently this is met or how well performance ability can be sustained and maintained at a particular intensity and within a physical surround will vary as the overall demands and biological requirements to productively perform.

Requirements of Task Performance

Particular task support requirements, as discussed, are derived from the task's initial performance variables, which determine the performance intensity, and together make up the total biologic demand. The total performance ability demands of a task can thus be divided into constant and variable requirements. The constant demands and subsequent requirements on the biologic systems will vary, only as the overall nature of the activity, which will be either sationary or dynamic. These constant requirements will need to be optimally met to ready the body for performance. The variable demands, motor skill, mental and endurance capacity of the task can be divided and placed in their respective biologic support system categories, and be referred to as variable biologic system requirements.

Altogether, all tasks will have a particular set of constant static or dynamic biologic system requirements and a particular set of variable, biologic system requirements which must be met. Thus we are able to break down and determine any tasks total performance demands into requirements on a biologic basis. By using such a method any task can be analyzed as the categories of biologic performance variables, demands and requirements are identified.

Constant and Variable Requirements of Task Performance

All tasks can be broken down into set of constant and variable requirements. The constant requirements primarily referring to the essentials of maintaining meaningful visual localization and orientation as dynamic or stationary alignment criteria.

Constant alignment criteria breaks down into criteria of gravitational and visual balance, base of support and directionality. Together constant requirements will determine the task performance total support requirements.

The variable sets of task performance requirements are all affected by the performance factors and variable dimensions of time, space and intensity. Task performance factors and variables thus will change with changes in the level or kind of performance engaged. Thus, they become additive or subtractive depending on the total character of the performance required, and the kind of constant support requirements.

The constant requirements of performance are to be met first. For the human organism must first meet its support requirements or be ready to perform before it can act in a manner, depending on the variable requirements, which will successfully resolve its performance needs.

CONSTANT REQUIREMENTS OF STATIC STATIONARY PERFORMANCE

Static Visual Balance

1 Need to maintain neutral cantelever of vertebral column

2 Need to pick out clearly vertical and horizontal planes in space (visual localization)

3 Need to maintain proper visual localization and acuity

4 Need to maintain proper visual awareness or perception

5 Need to maintain proper occular convergence, capability

6 Need to maintain its hyperbolic field of view

7 Need to maintain visual axis's that fall off the tip of the nose, 20 ft or 6 meters out in space to an imaginary point on the ground

8 Required is full head and neck support and control

9 Requires full postural support and comfort

10 Requires slightly foreward head tilt

11 Maintain a productive eye-hand, eye-ear and eye-body coordination

Static Gravitational Support and Balance

1 Neutral vertebral column cantelever, with a natural lumbar curve is required in which the line of gravity falls thru the 7th cervical vertebrae and hip joints pivot center

2 Anatomically correct body segment; mass, bone, and joint alignment, stabilizing and compression is required

3 Vertical trunk support resulting from vertical spinal tension and interlacing is needed

4 Vertical trunk balance resulting from diagonally interlaced and equally distributed tension and compression elements is required

5 Suspension of the thoracic trunk or rib cage is necessary

Static Gravitational Support and Balance (Continued)

6 Steady and firm shoulder base for neck and head is a must

7 Provide horizontal tension across the pelvic girdle and a steady and firm pelvic base for the trunk

8 Diagonally reciprocal action and counteraction of the four body sides is necessary

9 Two mirror-like bilateral halves that reciprocally communicate and act together as a whole is needed.

10 Integrated body leveling and head neck leveling systems that can match or equate differences between gravitational orientation to visual or head-neck leveling is needed

11 Integration and equating of external and internal forces into body leveling system is required

12 Need body leveling awareness of body part, mass, and segment position and movement direction

13 Shoulder-thigh gross extension ability is necessary

14 Need to control and balance the interaction and changes between the:
(a) base of supports size, location and equalize wt. distribution between changing support bases, (b) center of gravities height and oscillation and (c) action line of forces or center of pressure acting the total mass weight

*Static Gravitational Support for Standing

1 Need a neutral vertebral column cantelever with the line of gravity falling thru the 7th cervical and center of hips joints pivot center, support of the natural lumbar curve and maintenance of frontal and sagittal plane alignment of vertebral column beneath the thorax and head

2 Need full body vertical support with: erect suspension of one mass segment upon another, control of extension and flexion of the segments, shoulder-thigh-foot gross extension and thoracic trunk suspension

3 Need fully body diagonal patterns of diagonally interlaced vertical suspension and/or stretch, overall resistance to bending or collapse, horizontal and vertical forces holding in the mass and rotational trunk torsion

4 Need bilateral symmetric and asymmetric reciprocal balance, counterbalance and coordination of body mass segments using diagonal opposing see-saw force patterns and not unilateral rotational patterns

5 Need slight sagittal sway through ankles, (maximum between 1.5° to 3°) to aid and stimulate circulation flow, minimal lateral and posterior sway and rigidly control heel-ankle movement with regards to the legs

6 Need to maintain thru prolonged durations erect vertical posture with efficiency, ease and comfort and a minimal amount of physical force

7 Need full body mirror like, bilateral halves that reciprocally communicate, equate and act together as a whole and diagonal action and counteraction of the four body sides.

8 Need anatomically correct body part, bone, joint alignment and compression, with steady and firm bases for the head and neck, the trunk and lower extremities. Also required is proper ankle alignment and 10° inward angulation, which is critical to the success of any static and/or dynamic support

9 Need same requirements as in static alignment constants of: 10, 11, 12, 14

Static Support Base

1 Need to stabilize the mass and support structure, holding it steady in all directions of the horizontal base

2 Need to maintain a secure and sure base in which center of mass above can stabilize itself, in other words vertical support structure must be integrated with the overall support base

3 Increase its size or move, with shifting center of mass from the original base

4 Required is an asymmetric rather than symmetric overall mass base (triangular support)

5 Need to evenly support and distribute mass above it

6 Must allow body segment masses to freely return via the easiest lazy route to keep its center of gravity within its base of support (unconsciously)

CONSTANT REQUIREMENTS OF DYNAMIC PERFORMANCE

Dynamic Visual Balance

1 Must allow the visual system and its mechanisms once in proper alignment, to lead body thru space; for the eyes seem to lead the neck-shoulder, shoulder leads the pelvic girdle and pelvic girdle leads the base or partial base of support

2 Must maintain freedom to freely shift occular mechanisms from near, intermediate, neutral and far visual space and scan to the sides

3 Need steady and stable head, body support bases, despite any body oscillation incurred

4 Need to maintain head and eyes in a vertical position with forward neutral tilt

5 Needs to maintain feedback information as to horizontal or gravitational balance, body balance and head balance

6 Needs movement to help maintain its own visual orientation mechanisms proper functioning

7 Need to maintain neutral vertebral column cantelever

8 Need slightly forward head tilt

9 Occular axis falling 6 meters out into space when moving forward

Dynamic Gravitational Support and Balance

1 Need to maintain requirements one and two of static balance

2 Need to increase vertical support, strength and collapse resistance

3 Need increased vertical balance resistance to bending and lateral instability; with increases in diagonal tension, balance control proceeding from the distal ends, inward to the proximal

Dynamic Gravitational Support and Balance (Continued)

4 Need is for rotational transfer of balance to and around changing line of gravity pattern, with (A) diagonally coordinated balance-counterbalance sequencing, (B) correlated balance patterns to rotational freedom, (C) automatically adjust to changes in center of gravity both vertically and horizontally, (D) maintain smooth shifting line of gravity and (E) increase the reciprocal action of the rotating body segments. (Need good hip control and support)

5 Need to control the patterns or direction and position sequences of the shifting support bases and:
a. control size of support base, movement and location of center of gravity
b. balance mass on alternating, full or partial support bases
c. rhythmically time and sequence balance patterns to shifting gravity patterns
d. increase forward lean, proportional to speed of shifting base
e. support base to quickly sift and follow pattern of moving line of gravity
f. shift base of support as soon as line of gravity leaves base
g. control direction and the amount of mass beyond the base

6 Sequentially correspond pattern of line of gravity, center of pressure, center gravity and support base to one another

7 Need to maintain a neutral gravitational balance pt. that corresponds to visual balance orientation mechanisms

8 Need to coordinate changing or moving body position feedback to body leveling system and:
a. body leveling mechanisms are aware of sequential shifts in the support base
b. gravitational orientation, feedback to head balance system is maintained
c. increase timing and sequencing of balance control and feedback
d. increase sensitivity to shorter time allowances for instability and forward and downward pull of gravity

9 Need to maintain listed constraints requirements (7) and (8) of static gravitational support

10 Required is diagonally opposite extremity action and opposing rotation of adjacent mass segments

11 Required is diagonal counterbalance signal (control and feedback) between lower extremities and trunk (thru the hip)

12 Required are equal diagonally shifting thrusts of force thru the body's invariant vertical axis to maintain dynamic balance

13 Need is for synchronized, reciprocal and reflex counter counterbalancing

14 Dynamic movement is to occur with a forward lean to start spiral, reciprocal counterbalancing action

Dynamic Support Base

1 Need a support base to quickly elicit or relay information as to its position and direction of shift

2 Need to maintain its own internal integrity under conditions or instances of incidental stress

3 Needs to absorb shock

4 Needs to react quickly to changing contact surface conditions

5 Needs segmental support ability and strength as well as whole mass

6 Needs to control direction in which forces will act upon supported body mass

7 Needs to shift or move first in order to naturally move the body mass thru space

8 It is required to vertically and horizontally support and propel the entire mass

9 It is to receive, support and transfer the moving body mass

10 It is able to evenly distribute the mass on only a portion (1/4 of its entire base structure for short periods of time)

Overall Hierarchy of Task Performance Requirements:

With regards to maintaining and optimally providing support for the human organism in a task, provide:

.ADEQUATE AND PRODUCTIVE VISUAL ALIGNMENT AND BALANCE

.ADEQUATE AND PRODUCTIVE GRAVITATIONAL ALIGNMENT AND BALANCE

.ADEQUATE DIRECTIONALITY OR OVERLAPPING OF (1) AND (2) FOR LEVELING AND MOVING SENSE

.ADEQUATE KINESTHETIC REFERENCES OR BODY POSITION AND MOVEMENT AWARENESS

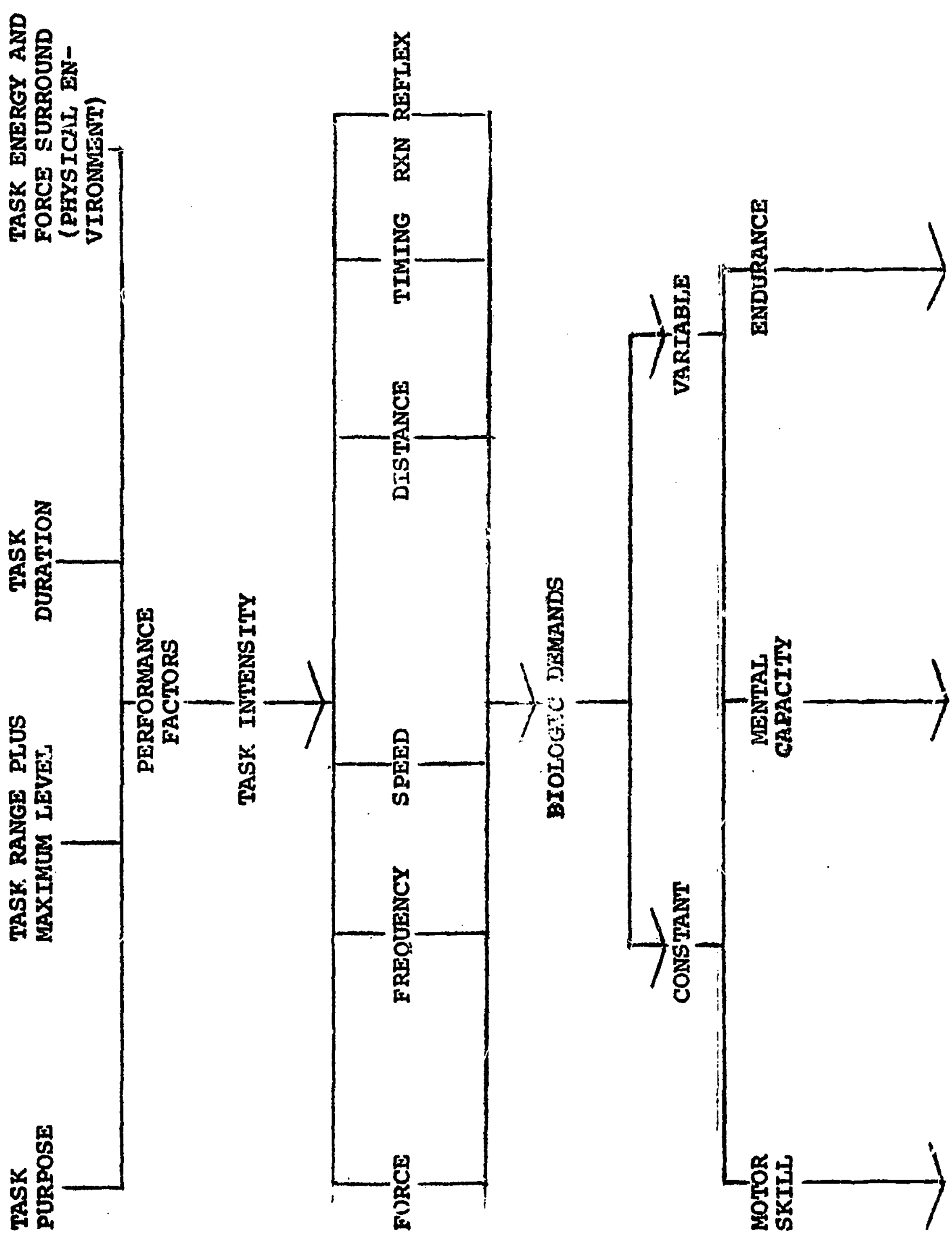
.ADEQUATE SUPPORT BASES, BILATERAL AND UNILATERAL

.VERTICAL SUPPORT AND BALANCE

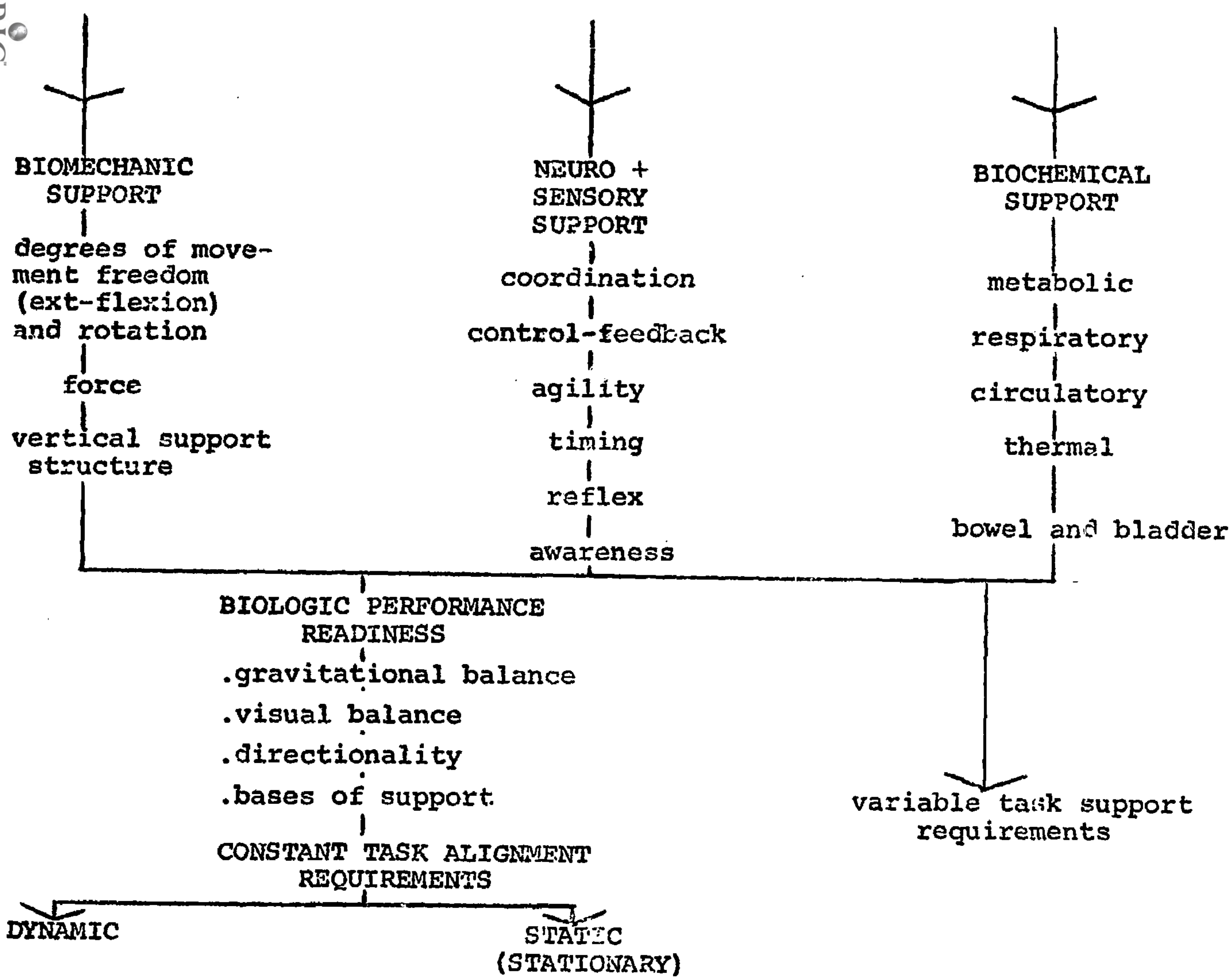
.ADEQUATE MOTOR OR MOVEMENT ABILITY

Total Task Performance Requirements

In order to properly perform a task there are certain constant and varying variable factors which must be met. The performance of a task can be broken down into the following requirement sets to analyze the task.



(Continued)
Total Task Performance Requirements



Determining the N.A.'s Task Performance Requirements

As determined there is an important hierarchy of task performance ability levels which vary depending on how much biologic support is required. Along with this there is a correlation between the amount of performance ability required and the amount of biologic support normally demanded of the human organism in order to meet those requirements.

In the case of the N.A. the overall psychobiologic problems and needs are the determinors of both existing performance and beneficial performance. As the amount of deficiency increases the beneficial performance potential range will decrease and vice a versa. The N.A.'s level of biologic deficiency thus determines just how great a difference there is between what they can do and what they need to do. These correlations, along with the fact that all N.A. can't and don't need to perform at a full, gross performance level because of the varying levels of biologic deficiency led to a very interesting rationale.

Simply by determining the biologic differences between the N.A.'s existing ability and their potential level of task performance, this rationale can be used to determine what needs to be artificially substituted for the N.A. An N.A., for example at a (2.1) level of biologic deficiency will have a particular performance ability range that requires only so much trunk support. By determining the difference between how much trunk support is known to exist at the deficiency level, and knowing what is needed, we can now determine theoretically how much and what kind of support the N.A. needs. A means of expressing and following all the elements of the rationale in their proper perspective is necessary to further understand the correlations which exist.

Normal Performance Ability (-) Required Task Ability Range (+) Required Surrounding Conditions (=) REQUIRED RANGE OF PERFORMANCE ABILITY

Required Range of Ability (-) Existing Biologic Ability (+) Existing Psychosocial Ability (+) Psychobiological Advantages (=) POTENTIAL ABILITY DIFFERENCE

Potential Ability Difference (=) Required Ability Level (-) Existing Psychobiologic Ability and Potential (=) NEEDS OF PARTICULAR N.A. GROUP

Potential Ability Difference (=) What Has To Be Artificially Substituted or Replaced (=) N.A.'s OVERALL NEEDS

By lowering the level of task performance and conditions under which the task is performed, will decrease the total performance demands or requirements of the task, and more importantly narrow the difference to be artificially replaced between N.A. ability and the normal performance requirements. The use of this rationale will make designing for the N.A. much more practical and easier to understand and accomplish.

HIERARCHY OF N.A.'s UNAFFECTED AND EXISTING GROSS PERFORMANCE ABILITY

1.1 Partial PA1

1.2 Partial to Moderate PA1 and Partial to Zero PA2

2.1 Moderate PA1 and Partial PA2

3.1 Moderate to Full PA1 and Partial to Moderate PA2

4.1 Full PA1 and Moderate PA2

5.1 Moderate to Full PA2 and Partial PA3

6.1 Full PA2 and Partial to Moderate PA3

*see hierarchy of gross body performance ability requirements

A Model for Man, the Dynamic Action-Reaction Structure

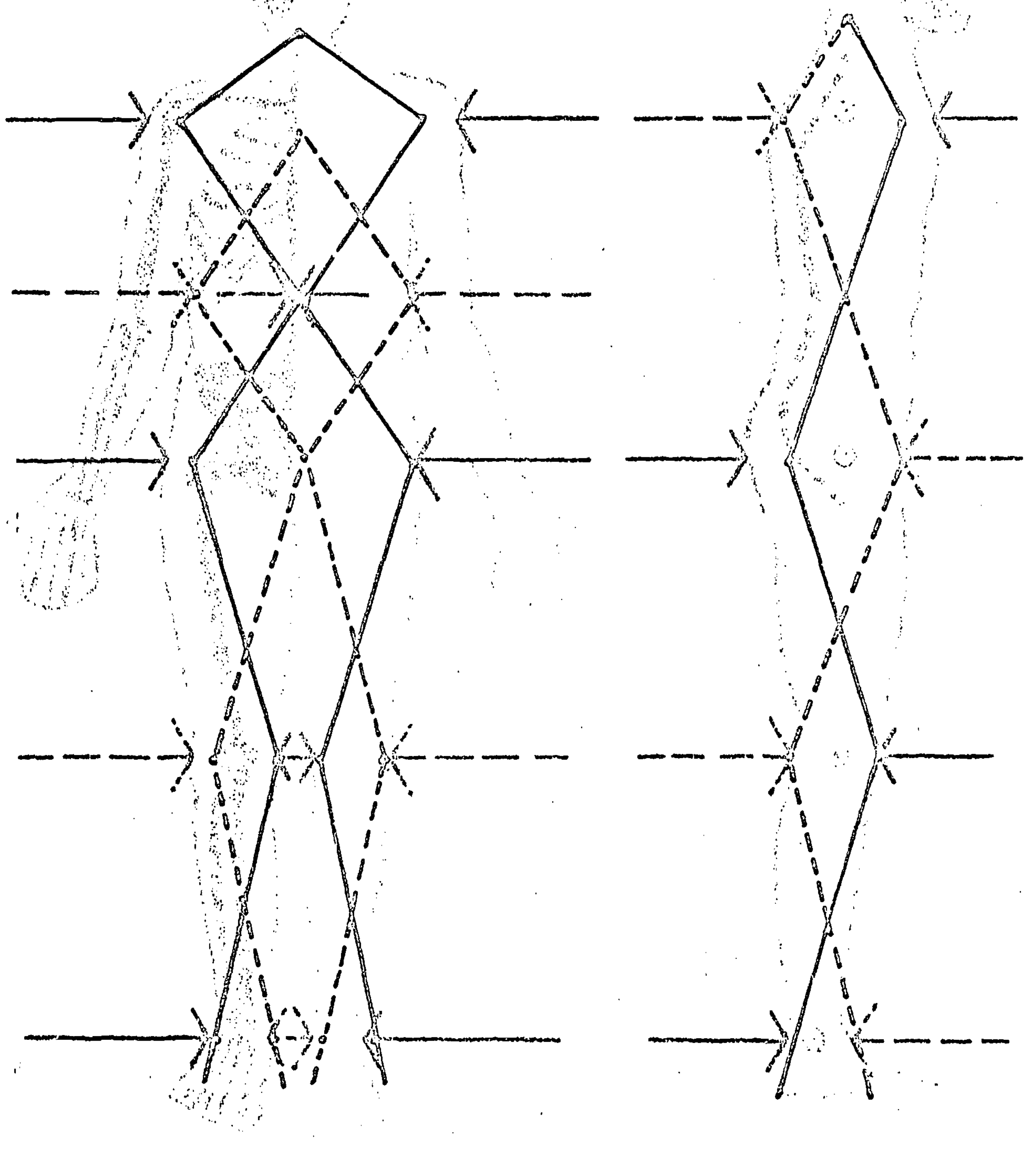
Before we can artificially substitute for any deficient mechanisms of performance or action, there is a need to understand in a simplistic way how the total muscular skeletal system of man normally works to perform. Thus a schematic model and rationale has been developed to identify only the TOTAL AFFECT of the otherwise complex, action and reaction structure of man.

The interpretation for this model has been developed from clinical observations reported by Dr. Pat Murray, Margaret Voss and Dr. Darell B. Harmon. Although their works are substantiated on earlier works of Rudolph Magnus and Raymond Dart and others. It is said that body movement and locomotion is a change of place and position which occurs due to spiral rotation and forward motion. Dr. Harmon postulates that locomotion is an interplay between forces of gravity and the body's control of its forces. He suggests that because the body is made up of quadrants of muscular tension and subquadrants in which parallelograms of forces act, a diagonally reciprocal total action-reaction movement structure results.

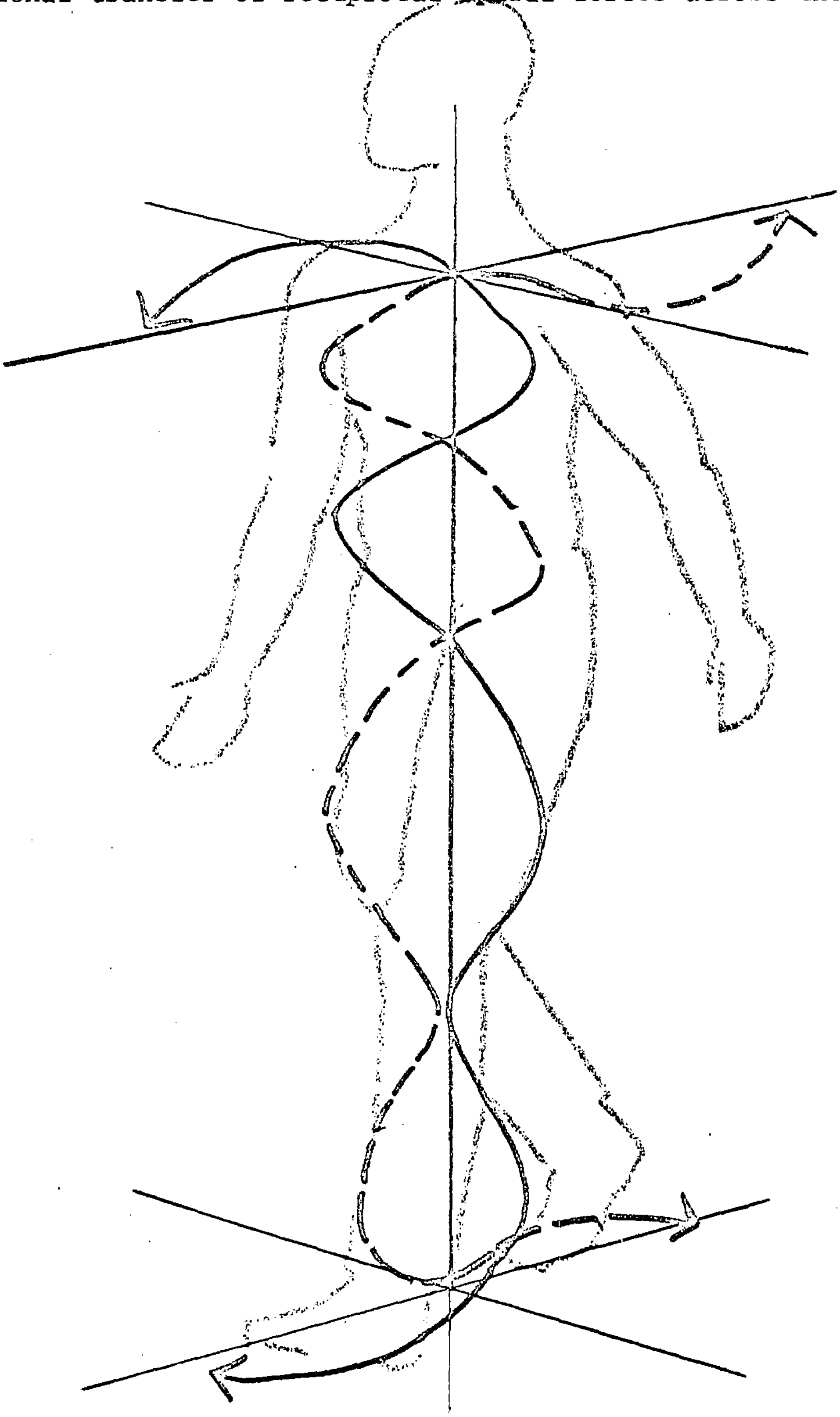
It is my belief that internal thrust of force and balance occurs at the body's structural joints due to primary diagonally opposed lines of muscular tension around the body's structure and thus control the body's mass segments about their joints. I must emphasize that the body is not structurally or neurally integrated as a diagonally reciprocal system but only performs as though it were. Because the two bilaterally opposite halves of the body are controlled by a complex simultaneous patterning of neural command such a movement behavior results. Thus the total mass performs a diagonally shifting structure due to its alternate body segment spiral rotations.

Obviously the muscular skeletal system is integrated to perform in a spiral manner. And overall is specifically arranged with its simultaneous neural control not only to provide forces to move the mass segments but the spiral action helps maintain both static as well as dynamic balance at all times with least effort.

The following schematic diagram indicates only the major lines of muscular pull or tension and compression about the body's structure. The subsequent action and counteraction forces which result. These forces are minimally required to maintain vertical support. The solid arrows indicate the positive thrust resulting from the positive (solid lines) line of pull and the dotted arrows indicate the counter thrust resulting from the negative (dotted lines) line of pull.



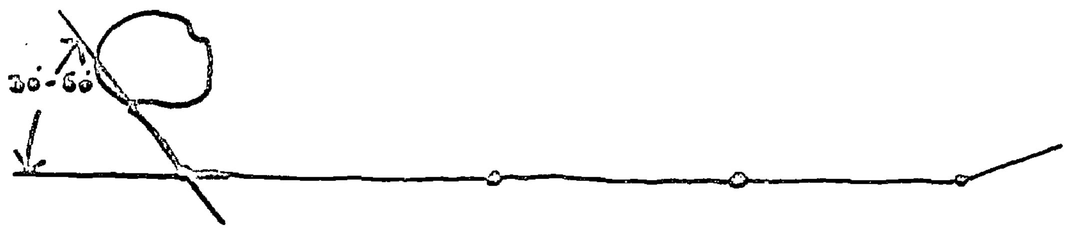
Overall, the schematic diagram of frontal and sagittal plane lines of pull and resulting forces must be thought of in three dimension. Due to simultaneous neural commands from high motor cortex. Locomotion can be thought of as a three dimensional transfer of reciprocal spiral forces across the body.



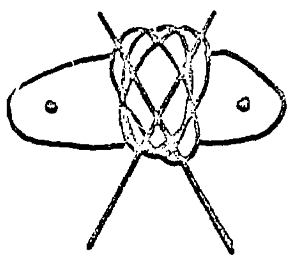
Hierarchy of Gross Performance Ability Requirements

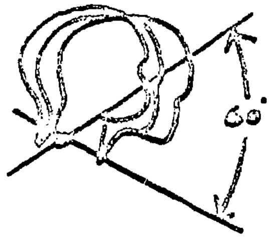
The following is a schematic hierarchial representation of the minimally required needs of the human body in order to reach a dynamic locomotor performance capacity. With each added degree of freedom it is believed that four other simultaneous functions need to occur to have a natural pattern of performance including: force, vertical support, balance and coordination.

Performance Ability One (PA1)

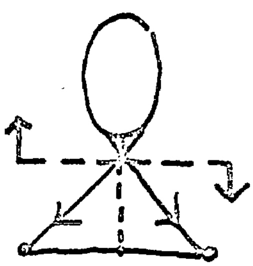


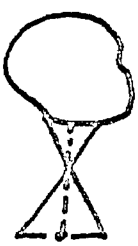
Degree of free movement need is for head-trunk extension and flexion



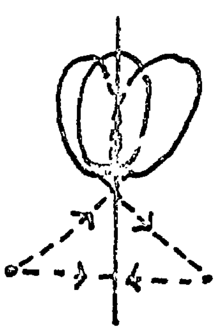


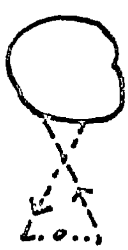
Simultaneously there is a need for horizontal and sagittal plane head-neck rotation on the shoulders





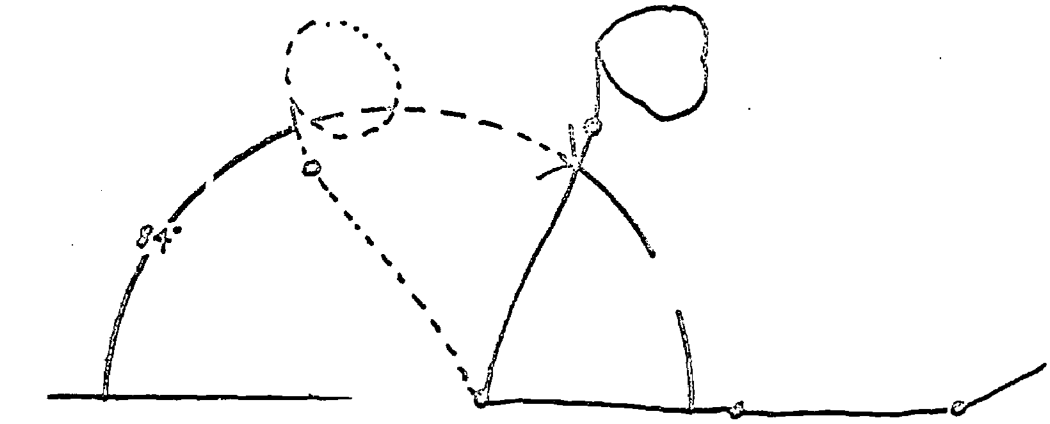
Simultaneously there is a need for structure and forces in the head-neck and upper shoulder to provide vertical suspension and balance



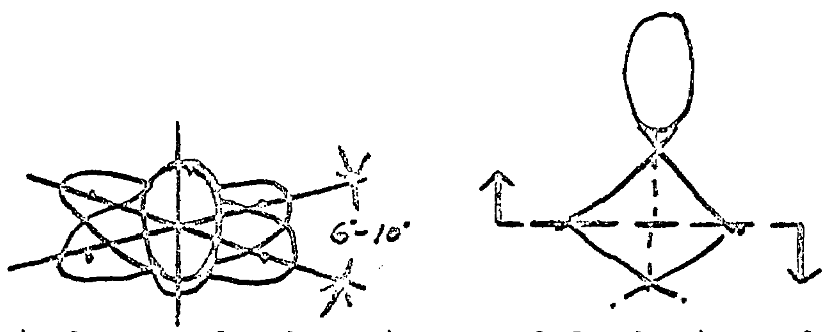


Simultaneously there is a need for eye-ear and head-neck control and feedback coordination or sensory tonic reflex control

Performance Ability Two (PA2)

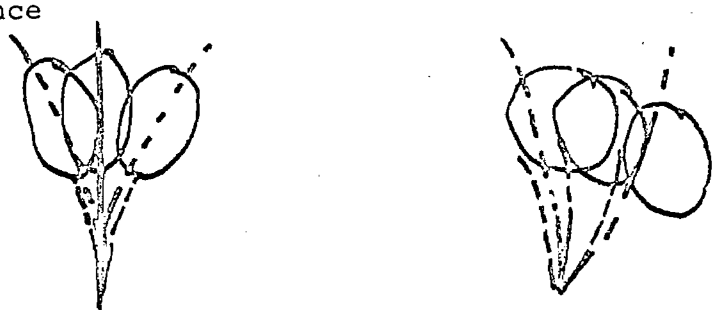


Degree of free movement is for shoulder-thigh extension and flexion



Simultaneously there is a need for horizontal shoulder-upper trunk rotation

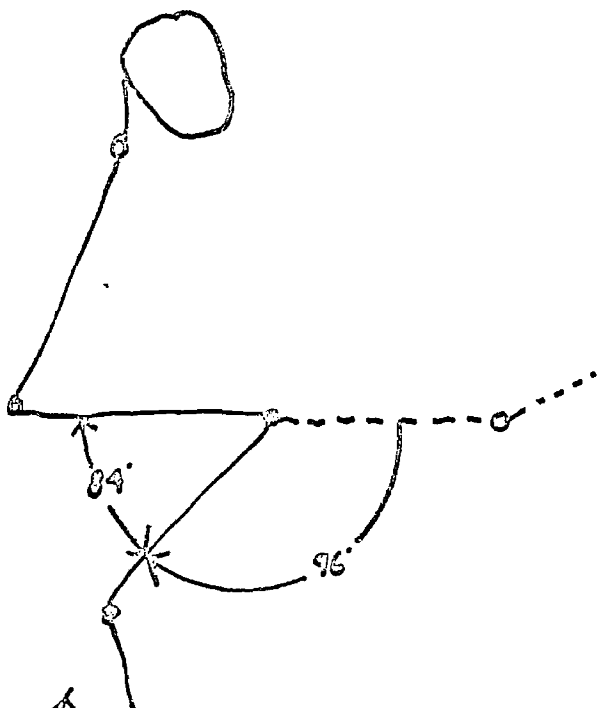
Simultaneously there is a need for full shoulder, upper chest and back structure and forces to provide vertical support and balance



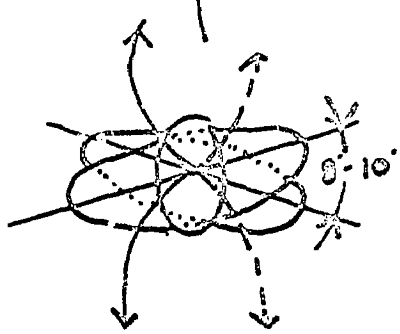
Simultaneously there is a need for head-neck and upper (high shoulder, chest and back) trunk coordination is particularily needed in the frontal or lateral plane

Hierarchy of Performance Ability (Continued)

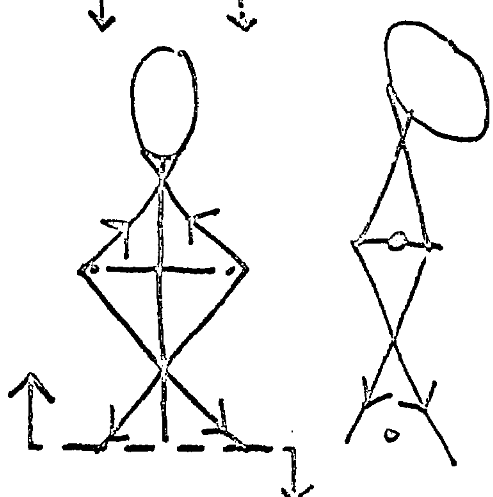
Performance Ability Three (PA3)



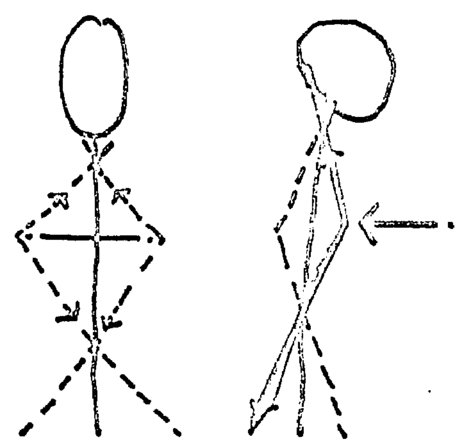
Degree of free movement is for thigh-leg extension and flexion which is minimal in order to sustain sitting posture or transfer.



Simultaneously there is a need for horizontal, shoulder and upper trunk rotation and lower trunk counter rotation. Lower trunk-pelvic rotation allows full trunk pelvis stability and enables body to twist over the pelvic base



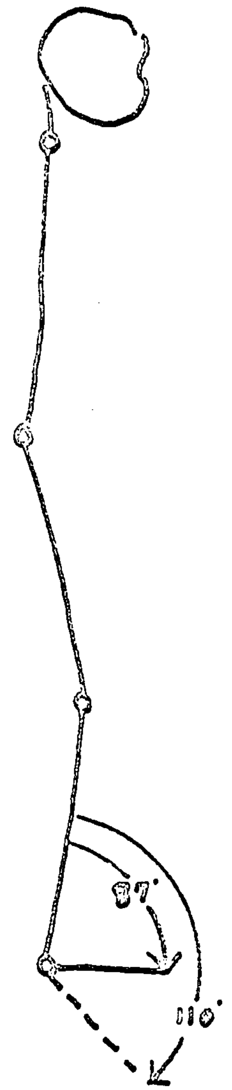
Simultaneously there is a need for lower trunk (abdomen and low back) vertical support and structural balance. A stable and integrated trunk and pelvic girdle is required



Simultaneously there is a need for full head-trunk orientation and alignment feedback and control. Position sense is necessary particularly in the sagittal plane

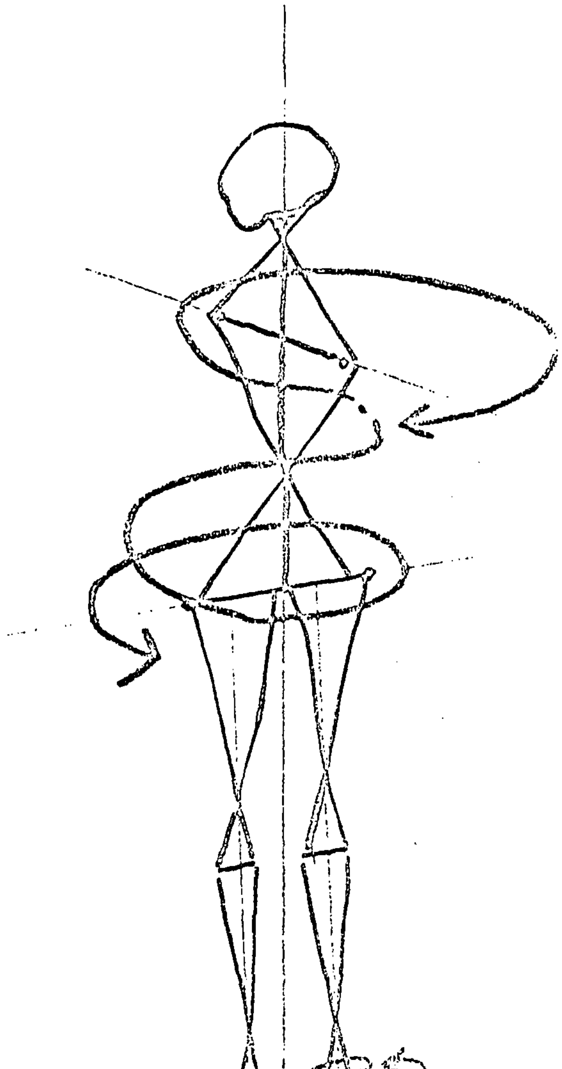
Hierarchy of Performance Ability (Continued)

Performance Ability Four (PA4)



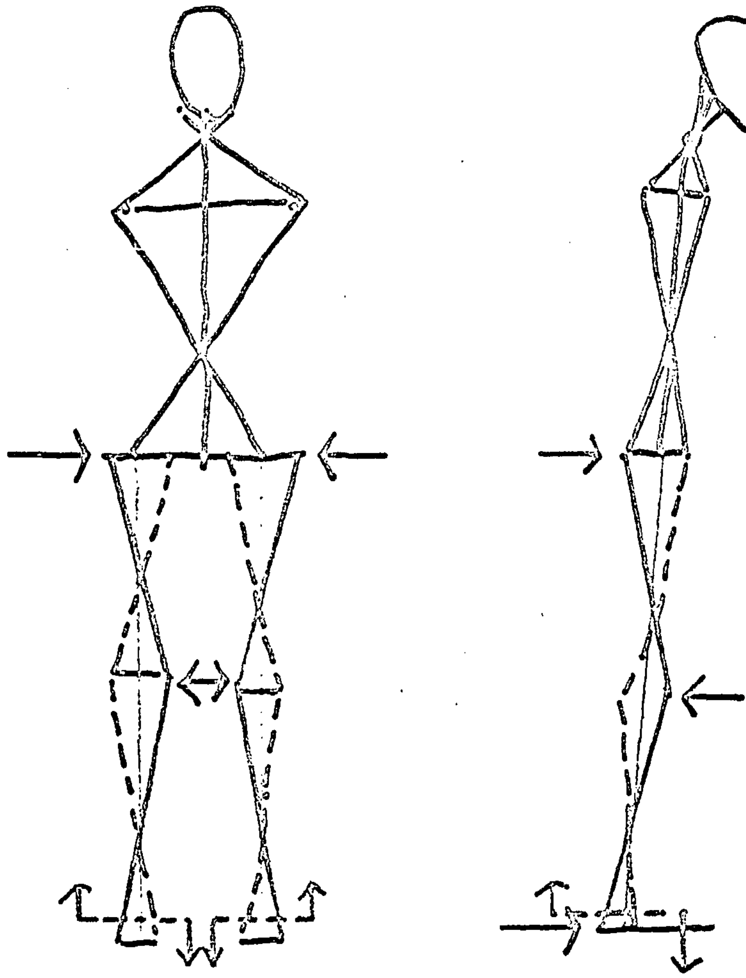
Degree of free movement required is a minimum of 87° of leg-foot extension and flexion, which allows the body to minimally reach an erect vertical posture, although being unstable and probably insecure

Performance Ability Four (PA4.2)(Continued)



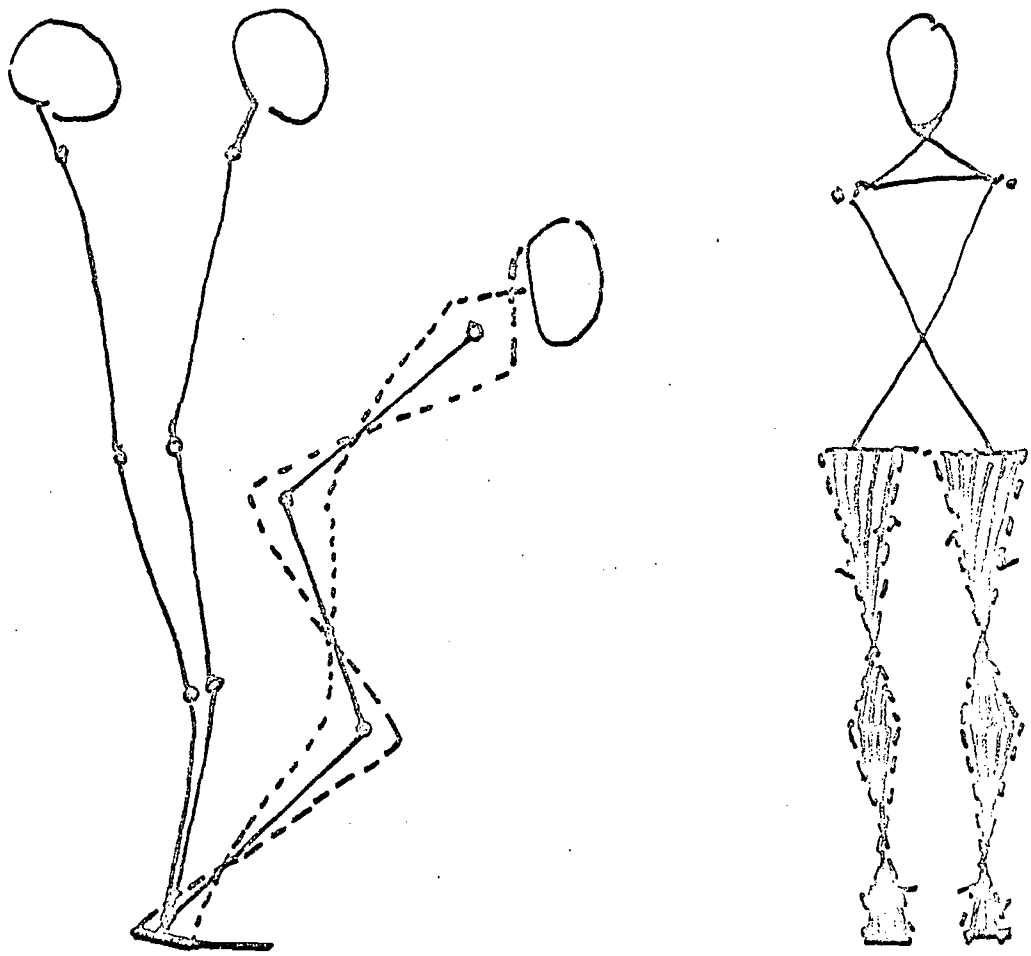
Simultaneously there is a need for pelvic rotation onto the ankles and the total mass support base. This provides and allows the body with a full twisting action over its static base or ensure vertical balance. Without such simultaneous rotation about the support bases the body is unable to functionally slide the base of support due to frictional and gravitational forces. The body now has all necessary structural elements for full body counterbalance in vertical space

Performance Ability Four (PA4.3) (Continued)



Simultaneously there is a need for minimal lower extremity vertical support, structuring and balancing components. There is a necessity to structurally interconnect trunk and lower extremities thru the pelvic girdle while ensuring sagittal plane stability in the lower extremities particularly.

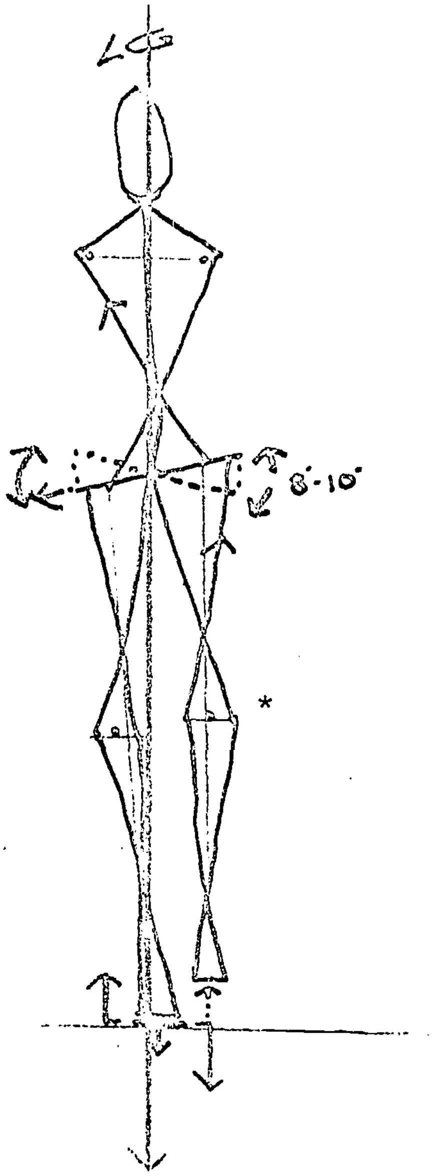
Performance Ability Four (PA4.4) (Continued)



Simultaneously there is a need for full body mass position sensing, which allows for full static vertical posture. Minimal head-trunk trunk-lower extremity neural interaction is needed. Interaction is provided to keep the mass from collapsing and falling. The head-orientation, center of gravity and base of support feedback give and maintain the full static mass control.

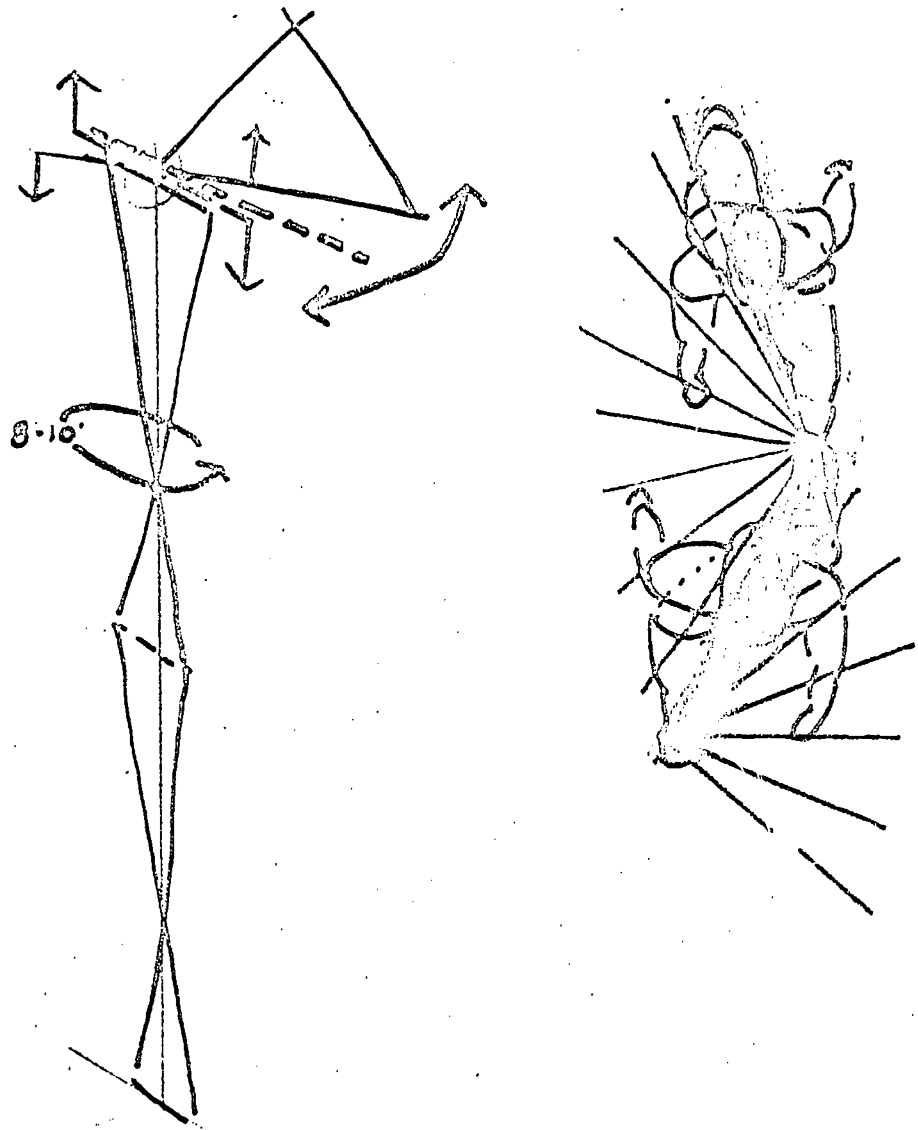
Hierarchy of Performance Ability (Continued)

Performance Ability Five (PA5)



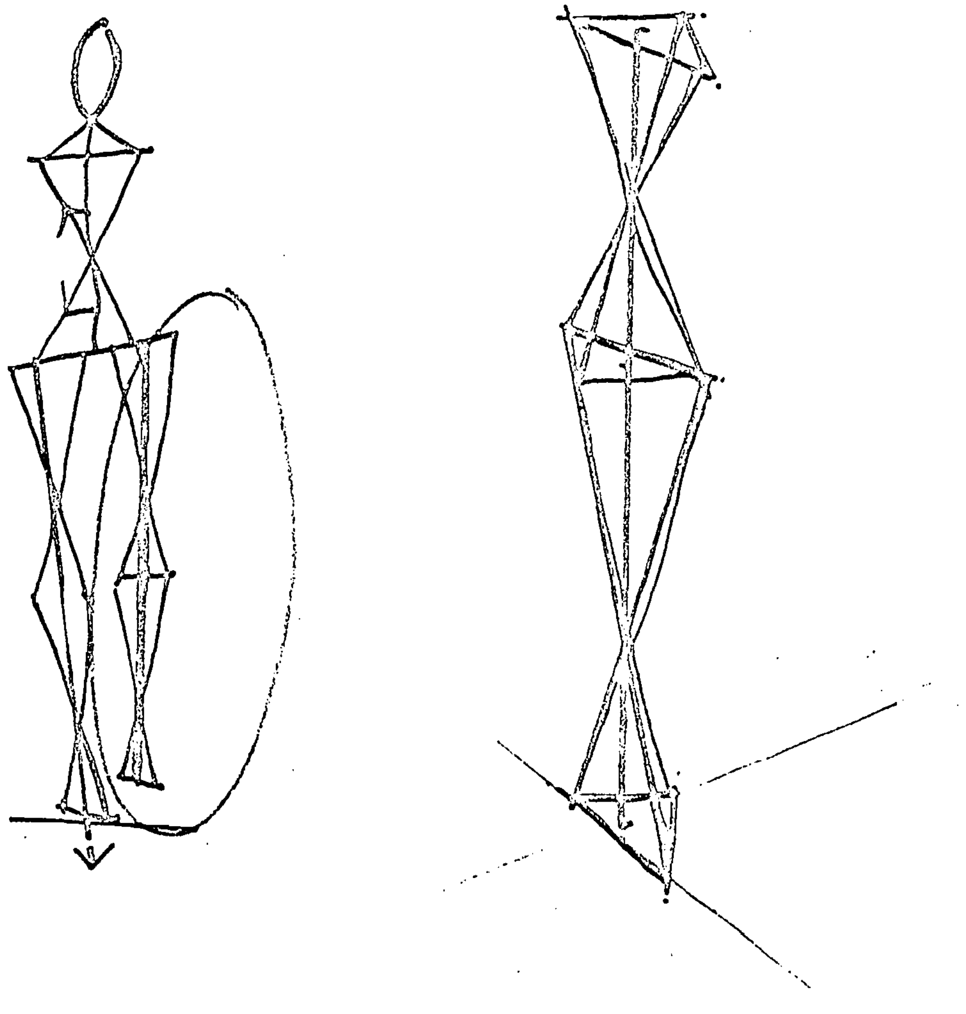
Degree of free movement required is for an alternating pelvic girdle, leg lift and rotation. (Pelvic tilting and rotation) Ability to alternately lift and rotate the pelvic girdle will minimally allow the body mass to be dynamically transferred thru space, although slowly and possibly for short distances only. *Slight knee flexion will aid in smoothing out such movement.

Performance Ability Five (PA5.2) (Continued)



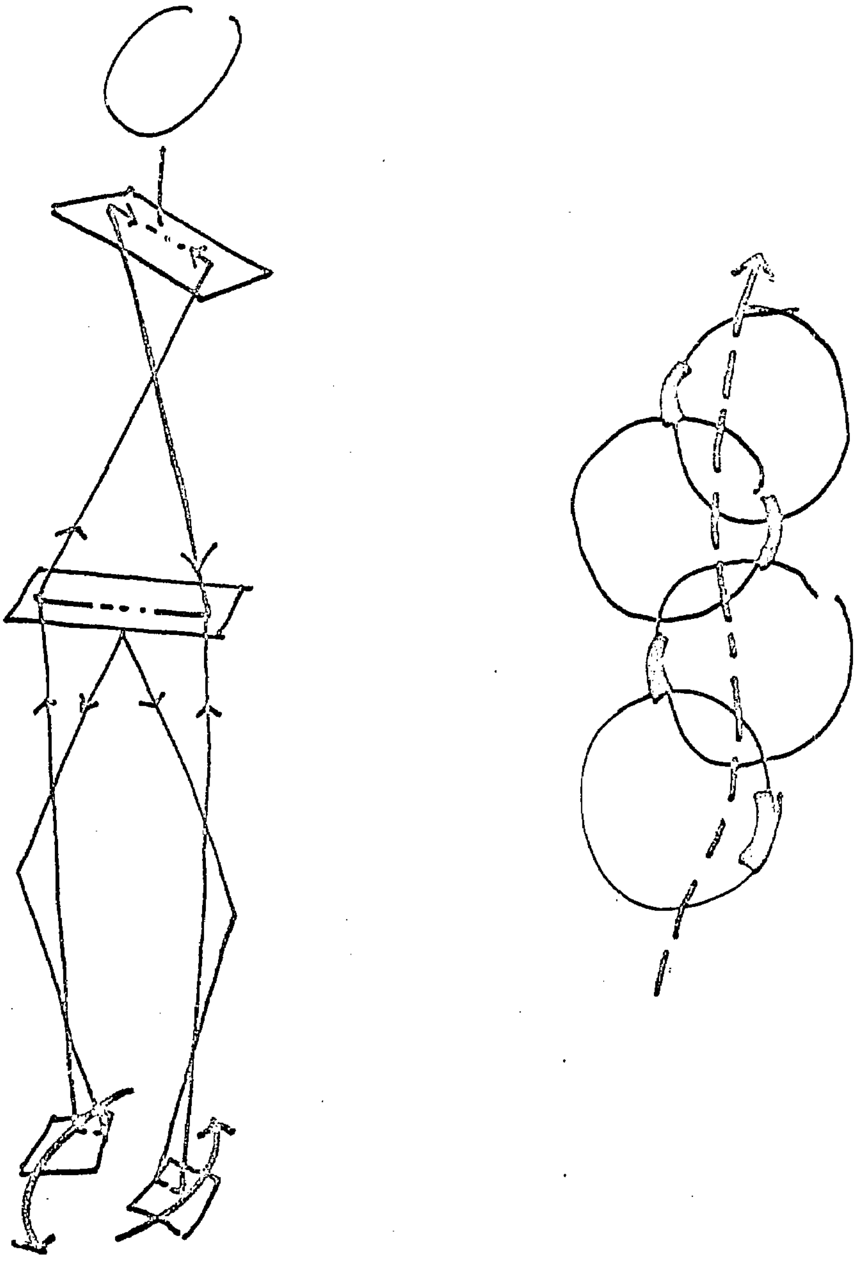
Simultaneously there is a need for rotation thru one leg and alternately over its adjoined one-half total mass base of support 8-10° of rotation occurs between the pelvic girdle and femur in the hip joint.

Performance Ability Five (PA5.3) (Continued)



Simultaneously there is a need for full dynamic lower extremity and foot (overall support base) structural force, support and balance.

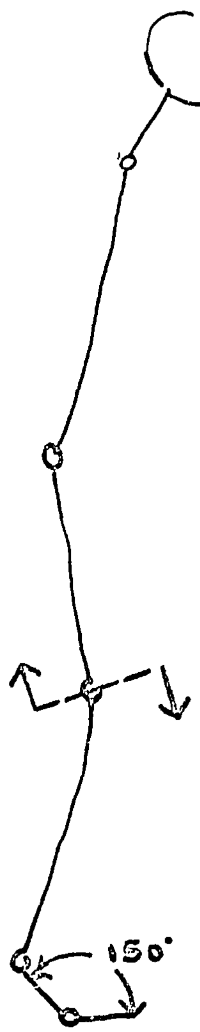
Performance Ability Five (PA5.4) (Continued)

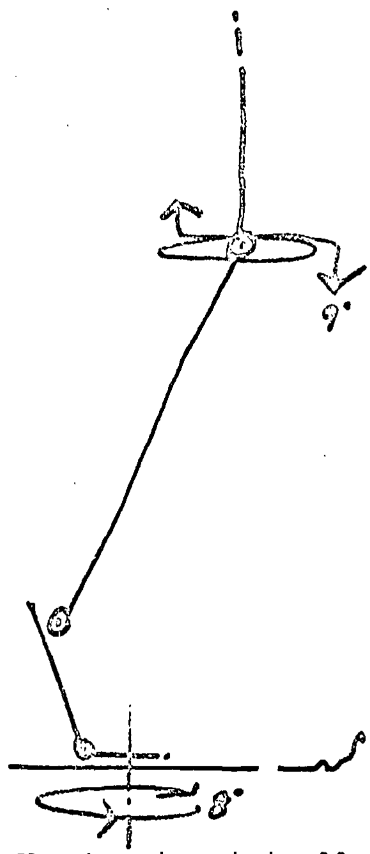


Simultaneously there is a need for dynamic body coordination which can: alternately rotate swing and lift total mass over and about one-half a base of support, simultaneously sequence and control the shoulder, pelvic and one-half support bases as one, coordinate from the center of gravity, one-half mass base support and center of pressure.

Hierarchy of Performance Ability (Continued)

Performance Ability Six (PA6) and (PA6.2)

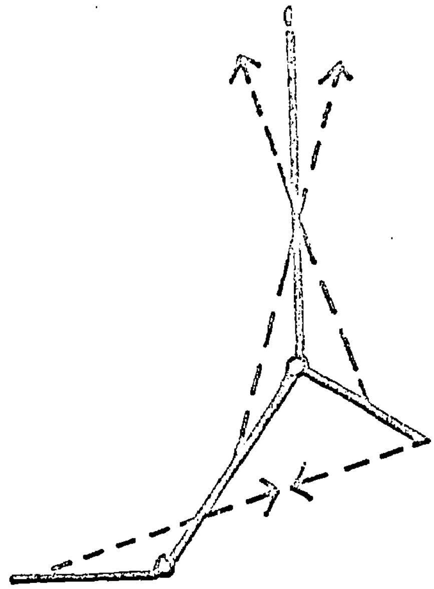


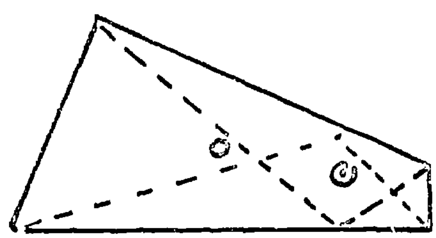


Free movement of 150°, toe-foot flexion is minimally required to provide and aid leg and pelvic lift. Required is foot force or one-half support base horizontal force helps propel mass forward in a more smooth and momentus manner. Movement freedom allows mass to easily change force directions, pivot or follow thru and change speeds (stop and go) while providing full dynamic support base action.

Simultaneously required is mass rotation on the toes and thru the knee joint. Required are toes that can momentarily support entire body mass as it rotates over and thru one-third of one-half mass base of support. Required is 6-9° of horizontal rotation thru the knee joint to facilitate the necessary torsional balance required to support mass on its small momentary base. Toė rotation 2° internal and 6° external is required as support base rotates horizontally with the alternating action.

Performance Ability Six (PA6.3) and (PA6.4) (Continued)





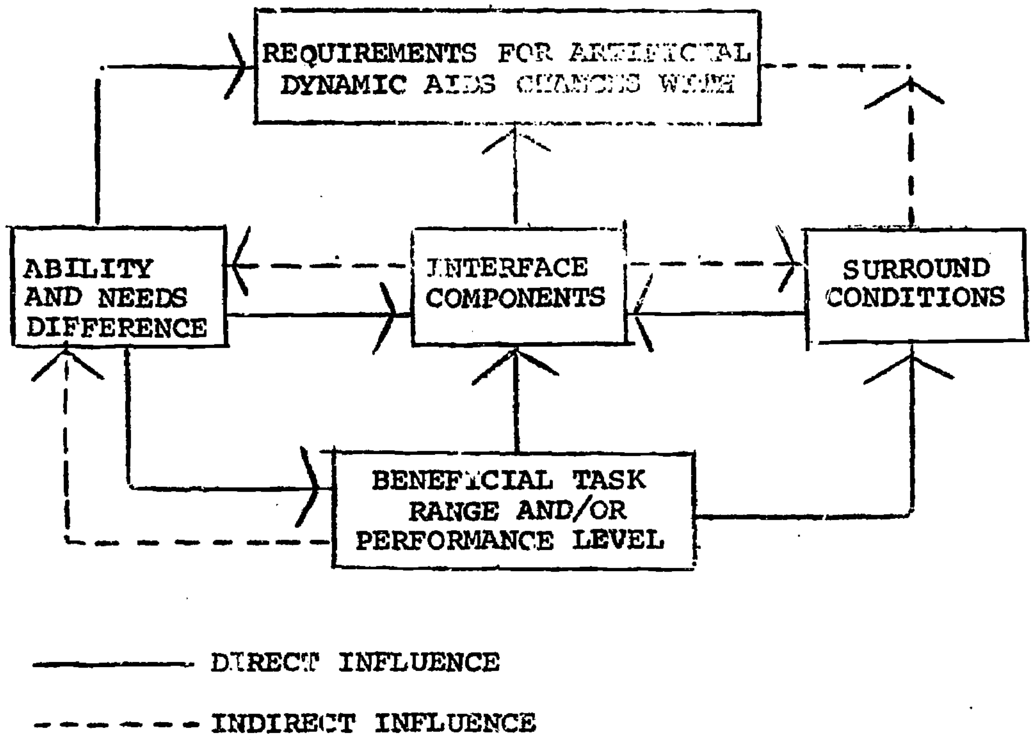
Simultaneously required is full foot structural integration balance and support.
Required is full dynamic body and base of support coordination and integration, which provides full center of gravity base of support control and feedback. Foot-leg-pelvis-shoulder head and (visual orientation) feedback and control is to act and respond together. *If body masses forward momentum is to be increased synchronized arm swing needs to be provided.

INTERFACING THE N.A. WITH ARTIFICIAL DYNAMIC SYSTEMS

Through rank ordering and determining of requirement priorities it is clear that the success or failure of any N.A. system depends on how well it interacts with its intended user. A close and delicate interaction of the two is necessary before any performance ability can be restored.

With the information system the difference between beneficial task performance range and user needs (ability) will determine what artificial aid should be provided. The artificial aid needs, plus user's needs will determine what overall integrating criteria must be met. The task performance range will determine how long, etc., the physical system minimally needs to be integrated. The amount of deficiency will determine where and how much of body needs to be reinforced and integrated with. While the extent of condition variables, complications, etc., will determine what particular precautions and kind of reinforcement is required.

Because of biologic deficiency in a N.A. organism, there is a particular need to carefully determine how a dynamic physical (artificial) aid will be integrated with the remaining body mass. Both the body's external and internal ability to control, balance or bilaterally equate the differences in its response to its physical surrounds is lacking. The integrity or homeostatic balancing processes are lacking, and the body no longer can properly act or respond to energies and forces that continue to influence it.



*Interface components are indirectly determined by the range and/or level of task performance and its corresponding condition or environmental surround range and level.

*Interface component must equate the three other variable elements, no matter at what level we are designing at.

Successful Interfacing With the N.A.

If we can develop the most sophisticated artificial, dynamic aid in the world, it will be unusable unless it first accounts for the integrating needs of the N.A. organism. The artificially provided aid and the user's capacity to perform as one is dependent on optimal interfacing for success. The success of the interaction will be determined by how well a balance can be achieved between normal task demands, and how the body internally and then externally reacts to the artificial aid. How well the artificial aid absorbs, insulates and can compensate impacts, forces and affects of energy on the total mass, will become a measure of its success. A complimentary interaction and contact between user and the artificial aid, despite the body's size or amount of body mass remaining is required.

An exchange of affect and influence between the artificially provided and the organism must be controlled if we are to support the biochemical or internal processes, responsible for biomechanic actions. How well the biomechanic mechanisms of orientation are supported in turn will influence the glandular processes balance. The activities of the central nervous system will normally respond and attempt to equate changes and differences in internal or external balance. However, the deficient N.A. organism's inability to send or receive and act to compensate for imbalances must be artificially replaced. Deficient organisms will adapt to any stress, strain and tension on muscles, the biomechanic, or on glandular (biochemical) processes due to their lack of proper neural feedback and control. As the amount of biologic deficiency increases the degree of internal and external support requirements increases. Thus, integrating requirements for any artificial aid directly increases as the amount of body area involved increases which indirectly increases in task performance ability ranges.

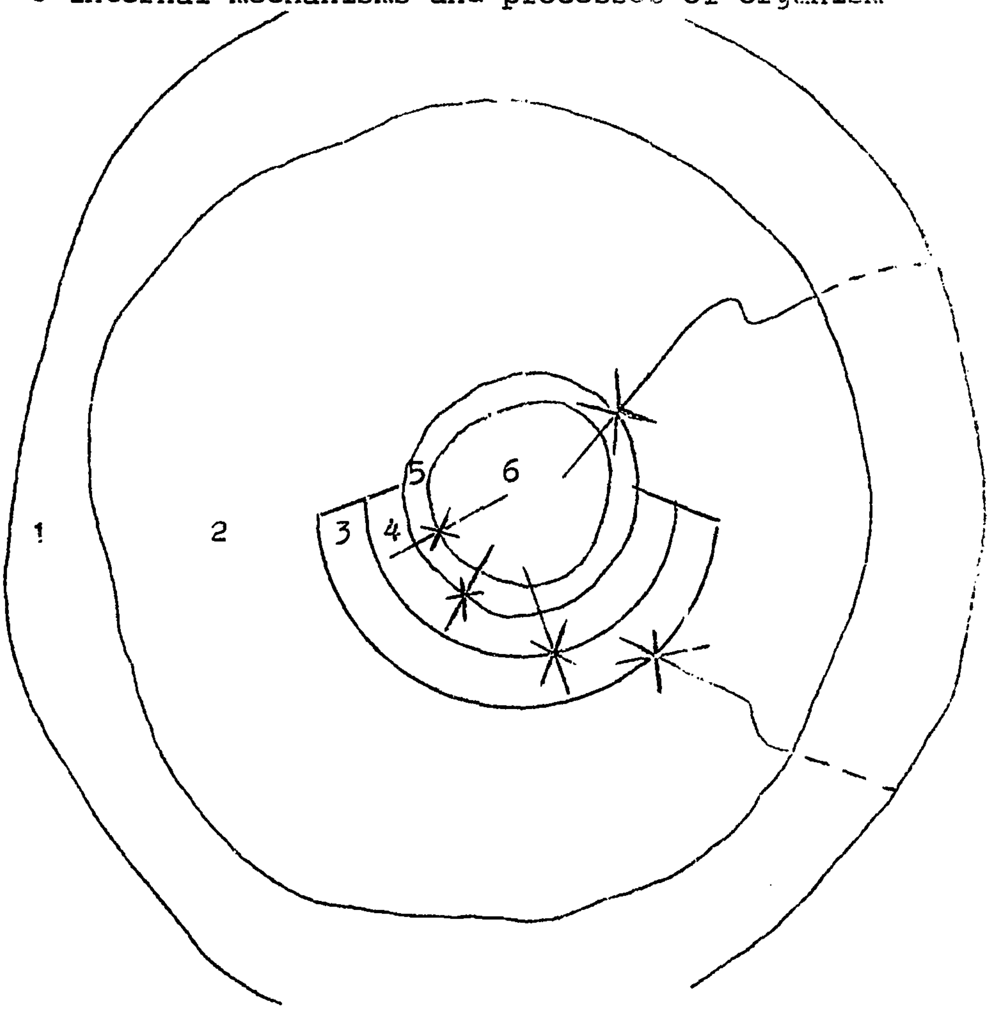
Any dynamic artificial aid for the N.A. will obviously require some sort of support, balance, movement energy, forces and structure along with sensory control mechanisms to tie it together. The artificial aid or system will have a definite shape rigidness, component action, location and materials interacting directly with the remaining body mass. The kind or type and amount of component will depend on what is beneficial to the organism and its performance potential as a whole. The components of an artificial, dynamic aid will determine how the overall body mass is supported and moved. Kind and amount of materials used will affect heat, air exchange and surface contact responses. While influences of forces or pressures from the artificial aid and the physical surrounds must be properly anticipated and cushioned. All energies and forces which may possibly be present or given off in or during the anticipated use of any dynamic artificial aid must be accounted for, including radiant energies frictional heat, magnetic forces, sixty cycle energy waves, etc.

Any dynamic artificial aid requires an interfacing media that must continually balance, protect and maintain a stress-free biologic condition. The interfacing media must continually equate or make up for differences in biochemical and biomechanic imbalances due to both direct and indirect condition changes resulting from activity being performed.

There is a complex interaction of energies and forces between the environmental surrounds, the deficient N.A. organism and the physical system provided. Both indirect and direct cycle of stimuli will affect the external and internal integrity of the organism. Whether or not a stress-free situation will be maintained, will depend on how well the interfacing or integrating media of the physical system can control the stimuli and equate the response of the organism.

Diagrams symbols

1 natural environment (outdoor)
2 artificial environment (indoor)
3 physical system (substitute for deficient biomechanic mechanisms
4 interface media (substitute for biochemical mechanisms of control
5 external mechanisms and processes of organism
6 internal mechanisms and processes of organism



A continuous cycle of varying levels of interaction (action + RXN) occurs, with the interfacing media probably will become the most important part of any artificial dynamic aid on system.

(1) or (2) affects (3) ——→ (4) ←----→ (5) ←----→ (6)

There is a three-way interaction between the environment condition required and its affects, physical system's affects and the N.A. organism's biochemical and biomechanic needs. The level of success of the interface will determine the level of performance and compatible usage possible with the dynamic artificial aid.

There seems to be three basic interaction variations possible
1) static interacting, when both physical system and organism are relatively at rest where readiness to perform is being maintained,
2) dynamic interaction when a change in organism's internal and/or external state overtly acts on physical system, and
3) dynamic interacting, when physical system components and materials are dynamically acting on the N.A.'s organic mass. Any interfacing media must allow the user to perform at his peak performance level without inducing biologic stress.

Despite the level at which one finds most ideal to design for the N.A., minimal or optimal, the degree of integration or permanency of interface is another factor to account for. Logic indicates that there needs to be a proportionate increase in component and material sophistication along with an increase in the amount of permanency as the amount of biologic deficiency increases. The kind and amount of use provided and required from any artificial dynamic aid and amount of value ultimately provided are key factors as to warranting of permanent attachments and thus increasing the aid's sophistication. I feel there is a correlation between how permanently artificial dynamic aid is interfaced or attached and how optimal and sophisticated it ultimately becomes. Ideally the artificially provided aid should never be taken off and permanently attached. However, it can be semipermanently attached to the N.A.'s body with only portions taken off daily or the aid can be nonpermanent with all components removed daily. The greater the permanency the more sophisticated any artificial dynamic aid will probably tend to perform.

Improper and/or poor interfacing of a artificial, dynamic aid with a biologically deficient N.A. organism could be disastrous. Success or failure of interfaced artificial aid must be carefully weighed through pre-evaluations as well as post-evaluations. Any measurement of abnormal changes in muscular, peripheral biomechanic stress, and/or chemical stress will indicate unsuccessful interaction. Avoidant behavior and/or sudden changes in emotional attitude will also be indicative or poor integration between the N.A. and the artificially provided dynamic aid. Such observation for indicators and measures will be necessary before real comfort and compatability of any artificial dynamic aid can be assured. "A minimum of two years of field observation and testing," is suggested by Dr. Harmon and others. Subjective reports of comfort are often inaccurate. It must be emphasized that if not overt, stressful situations can be easily disguised in the N.A. by overwillingness, improper neural response capacity and/or possibly habituation. The N.A. organism is likely to habituate naturally or inadvertently to induced stress. Either way, the N.A. as in nondeficient organisms will not be able to shut off the harmful physiologic responses to stressful situations but only its awareness.

CONCLUSION

Unfortunately, because of time I must leave this study just as the "exciting" part begins. However, I sincerely hope to do follow up work with this study and see that the information potential is put to a complete test. I hope to carry on with the preliminary design results obtained from a preliminary study to test the information system. I sincerely hope that others will attempt to use this study and further extract pertinent performance characteristics for all levels of non-ambulation. At best, additional research appears warranted in many areas as implied throughout this study.

To resolve the problems of the N.A. we will need a more future understanding. Overall we need to increase and clarify knowledge concerning the N.A. while we fill in the information gaps in literature. There is a particular need to clarify how the human organism's biologic system functions in correlation to each other, and as a whole. We need to determine what are the parameters or biologic demands of performance and interaction between the human organism and his supportive surrounds. The need to learn more about the correlation of neurophysiology and determine how visual orientation may be the biologic basis to design integration. There has been little, to no advance in literature particularly for those with interdisciplinary background and concerns. We need to develop better means of information storage, communication symbolism, and retrieval world wide. A world "bank" of N.A. information accessible via electronic media is seemingly the ideal.

Most people today will agree that the technological means and ability to do just about anything exists. How we habitually make use of this potential is indeed sad. In fact, it may be possible that medical research will find remedies, cures, etc. to eliminate congenital deficiencies in the body and may be able to artificially replace deficient body parts. At the same time it is possible that society will eliminate all infections, wars, and accidents. Eliminating the causes of handicapping conditions is, of course, the ideal. However, until this happens, the dilemma of the physically handicapped and the N.A. must become a topic of social and humanistic importance, as the number of biologically deficient human beings is growing.

The psychosocial aspects of the N.A. disabilities need the most research. To insure that future design applications will relate and carefully meet the N.A.'s emotional and behavior needs. Interdisciplinary design groups must continue to systematically develop criteria for the N.A. environments and supportive devices, with an underlying aim, being to understand and improve the quality of physical surrounds for the nonhandicapped as well as the N.A.

In no way do I wish to have made anyone feel that their expertise have been discounted by this study, or its usage of data. It has been necessary in this study to generalize and yet try to provide data that is applicable to individual cases. Dr. Bruce Archer of the Royal Academy of Art, London, states: "Most information is empirical, reliably true only for a given situation at a given time." I hope I have been able to develop some principles out of research for use by designers and have suggested how they can apply it without distortion.

In review of the study's conclusions, certain direct correlations tended to exist between the level or amount of biologic deficiency and amount of inability or the N.A.'s deviation from the norm, the extent of inabilities and amount of accompanying complications, the complications and the overall level of resulting biologic deficiency, the amount of inabilities and the minimum required or user's needs to support a beneficial range of task performance, and what the specific performance range requirements are and the level of design sophistication. Some of the results of this study other than criteria regularities, priorities and turning points in requirements for N.A. design need to be expressed.

I believe this study reinforces the belief that a psycho-biologic approach to design is more than ideal, it is also possible. As the deficiencies of the N.A. increase the greater is the need of understanding the efficient organism. A biologic breakdown of factors and requirements is a potential means of getting at all complex design problems of man.

In all, it has been found that the N.A.'s needs cannot be taken for granted. The N.A. were found to have the same needs and desires as anyone, but usually in a more complex sequence and with a different priority. This study proves that there is a viable way of simplifying design requirements by determining what the N.A. minimally need.

Design of dynamic artificial aids for the N.A. is self-defeating unless developers first account for the N.A.'s biochemical needs. Without doing so life for many of the N.A. conditions is not much more than vegetative. The N.A.'s organisms neurosensory needs, biomechanic needs and their psychic demands are to be accounted for. Without support of the first, the others are deficient. I believe that the biomechanic cannot be efficient as a performance mechanism unless there is first proper reinforcement by the neurosensory, and an awareness of what, where, and how the organism relates to the physical surrounds. The biomechanic or activity performance needs are third because without performance ability the psychic could not be readily satisfied. Those who are confined to a wheelchair, can support this claim! Designers using this information system must take into account requirements with this sort of importance scale.

In conclusion it is my belief that to provide any N.A. organism with the kind of mobility independence they need, at the varying degrees required, we as determiners of form must be able to minimally replace the N.A.'s deficient mechanisms of dynamic structure and orientation (balance) while controlling and protecting biologic integrity. To move the N.A. daily thru the vertical planes of space in a productive manner, they will need a minimal yet successful action, reaction structure...along with a dual reciprocal functioning of parts throughout. I believe a key factor to such design success will depend on using gravity to an advantage and as a positive force, so only the counterforce will have to be supplied artificially. Secondly, success will depend on how well we can artificially integrate and reunite mechanisms of visual orientation and thus the coordination of the overall body's action through the head and shoulders.

A final qualification I believe for any successful dynamic artificial aid, will come only thru repeated success of the aids use, and only after the N.A.'s handicapping deficiencies are no longer acknowledgeable!

APPENDIX

A case study (CS1) to test the validity and strategy of the information system was conducted. A portion of its results needs to be included with this study to indicate the sort of design criteria and requirements that can develop from this system with use.

The case study chosen concerns the high thoracic group of N.A. at the 2.1 level of biologic deficiency. Each of the listed phases of the strategy were followed and gone thru, up to and including the design alternative stage. Further preliminary findings and early design conceptualization is only available at this time. However, the case study was able to test the interacting of the three major criteria sets developed. The following will provide an overview of those sets of criteria pertaining to physical aid, interfacing, overall design and subjective and objective design requirements. Preliminary findings and results along with an attempted development of alternatives based the major conflicts and crucial issues which developed from integrating the requirements will be disclosed. Up to this point I believe that the informational system has worked for the case study and that additional outgrowth of the following will need to be pursued.

Appendix (Continued)

To use the data and subsequent criteria that comes out of this information system it must be synthesized or interacted to determine the conflicts and crucial issues. Only by attempting to resolve these conflicts and issues, can design solutions develop. Decisions as to size, shape and materials and component action can be made from the provided data if this is done. Performance requirements which come out of this system need to be taken into account in the given orders of importance. I believe anyone who is to design for the N.A. must consult the provided data. They must use the easy to identify level of deficiency they are concerning themselves with and data related to it, in order to understand what performance structure and biologic processes need to be substituted for, corrected and/or ultimately protected. Without using the data provided, designers will be unable to clearly compare deficient needs with what is minimally required to perform.

Primarily the given information source can be used to determine what kind of characteristics dynamic artificial aids, components and materials are needed, and in what relationship and quantity, to minimally answer the N.A. needs. Later the given data can be used to continually check back and evaluate design decisions as to their validity as they are made. How ideal components and material substitutes need to be organized into design solutions is to be based on the biologic analogies provided, and only after crucial issues and conflicts which result from the interacting requirements are resolved there is a need to look back at the many analogies that are made throughout this study concerned with normal performance if we are to design in a technically feasible and most ideal way for the N.A. Listed requirements are to be substituted as to their normal functions and total interaction as a whole system.

I feel that there are three design premises or ways to look at designing dynamic artificial aids for the N.A. Two of which I believe should be discounted according to the found data. The given information is presented in light of returning a gross yet some level of natural performance capacity back to the N.A. However, the data can be used to develop movement systems that move body parts only thru their necessary degrees of motion without the simultaneous actions that normally occur. At best such design would result in a therapeuticially nonbeneficial and robot type movement. Or the provided data can be used in the development of even less ideal and beneficial systems which would move the deficient body as though it were a stiff mass without movement of its deficient parts.

In no way is this study conclusive as to design solutions. However, the following is presented to indicate the type of reasoning which needs to be followed to develop design solutions when using the data provided.

CS1

User, Task Performance Ability Differences and Resulting Physical Aid Criteria

Criteria is based upon difference found between user's ability and beneficial task performance required, thus a comparison of user's needs and task requirements resulted in:

- Must minimally provide and allow user to properly maintain a 2D and 3D near productive posture position (capability and freedom)

- Should provide user with a minimal sedentary tolerance of 4 hrs per sitting period

- Must minimally be able to ascend onto and descend from a standard size or type of seating device with the following approximate dimensions, etc
  - a) Minimum seat pan width of 16-18"
  - b) 16-19" seat pan ht
  - c) 90-95° seat back angle
  - d) 8-18" of solid or semisolid seat back support surface
  - e) Wood, metal or plastic
  - f) Has rubber skids on each of its legs, however, not permanently attached to floor surface
  - g) Partial-moderately contoured seat pan and back
  - h) Minimum seating device, base of support of 17-20"
  - i) Semiopen seating device bottom

- Must minimally be able to move thru a standard size 36" doorway width

- Must minimally be able to move mass across carpeting, varying flat and relatively hard surfaces despite water or dirt particles

- Must be able to move and carry user across slopes max. of 10°

- Must provide unlimited indoor use (except for long flights of stairs)

- Must be able to carry user over or down curb minimal of ht. 4-6" (min. stepping capacity) with railing or arm support

- Should compensate and not be influenced by poor supporting device contours or deficient supportive forces or pressures

CS1 (Continued)

- Should be able to move user from standard bed surface ht. between 16-24" to a standing position despite following conditions:
  1)With firm to soft mattress surface
  2)With wrinkled blankets and sheets, etc
  3)With moderate to firm bed, support base (no casters)

- Should be able to minimally maintain a safe and comfortable 3 hours of standing per day

- Must not allow support device contour, etc. disrupt or interfere with user's circulatory flow

- Should operate or function within a temperate climate zone and/or geographic location

- Should be operative and fully functional within 0-100° F. and 0-100% humidity

- Should allow user when standing to freely bend thru the waist and voluntarily maintain any position within a 115° shoulder to thigh flexion range for a minimum of 5 minutes

- Should provide user with a means to voluntarily override and control all of system's automatic movement patterns or dynamic functions

- Should provide both a manual and automatic stop, start and change of system movement functioning

- Should provide user with a minimum direction control (components)

- Should provide user with a minimum force control range

- Should allow user to turn around or make a 360° direction change

- Must minimally provide total mass with approximately a 20x14" base of support area

- Must minimally provide total mass with a 10-14" one-half base of support area

- Should not move one total base of support area (leg and foot) horizontally farther than 28" at a time (one stride length)

- Should be able to come to a very quick and sure stop

CS1 (Continued)

- Should have or provide a small but quick responding acceleration range to quickly increase or decrease speed for duration (1 minute bursts)
- Should automatically control movement base so that feet fall no more than 4" apart or no less than 1" along or from the midline of progression or static balance at any time
- Should automatically control support base halves so feet don't out toe beyond 8° or less than 2° of intoe
- Should provide an asymmetric static support base, one half maximum stride length of 14" and with feet approx. at a 25° angle (1-4" separation)
- Should evenly transfer most of the mass wt. to the support about the ankles and feet (support base halves)
- Should automatically control support base size with regards to the mass speed, displacement location of its center of gravity
- Must be able to smoothly move and control the masses center of gravity in and out of its support base
- Should move body from sitting to standing posture without flattening out the back and maintain the proper postural balance
- Must be able to vertically and horizontally transfer c.g. and at all times be able to bring it back to a stabilized position above the acting support base
- Must keep c.g. within support base at all times or quickly return it to within
- Should coordinate or balance the c.g. position and the application of forces (center of pressure)
- Must control c.g. fluctuations sagittally and laterally above the support base
- Should allow more sagittal c.g. sway than lateral
- Must hold erect in a vertical position the remaining and/or deficient muscular skeletal parts (MASS)
- Must hold total body mass erect over a changing and moving support base

CS1 (Continued)

- Should have its forces that are holding the mass erect, respond to changes in the pull of the forces of gravity

- Should alternately and slightly shift body wt. bearing oscillate wt. bearing between the two base of support halfs

- Should support and control a sedentary respiratory and metabolic rate approx. between 100-110 cal. per hr., despite length of standing period (min. of 3 hrs)

- Should automatically allow user to safely maintain a standing posture without having conscious effort make to manually control

- Should require only a minimal amount of control or conscious effort for user to move in and out of a standing position

- Should protect body parts in case of accidental fall

- Should protect user from any sharp and/or blunt forces from protruding objects

- Should protect and not break down upon short term contact with very hot or cold surfaces

- Should hold body trunk without conscious effort for as long as user desires (2D,3D near task)

- Should hold body trunk erect without conscious effort in a 125 (55° flexion) 2D,3D intermediate and far seated posture

- Should support and control a dynamic movement respiratory and metabolic rate between 120-180 cal/hr or (2.5-3 cal/min)

- Should provide the user minimally with a 1 mile (12 block and/or 30 min) daily locomotor capacity

- Should progress forward the total mass at a rate between 2.5-3 mph (ideal)

- Should require maximum only minimal voluntary control and conscious effort to move thru space in a productive locomotor pattern

CS1
Major Physical Aid Design Requirements

One hundred and forty-six initial physical aid requirements were developed, identified and then found to relate in the following manner to comprise twenty-eight requirement categories.

Constant Requirements (A,B,C, 1-16) determined

Category (1)
- Reinforce, stabilize and protect existing visual and gravitational orientation mechanisms functioning and freedom to respond between head, neck and shoulders

Category (2)
- Rebalance, maintain and protect neutral visual axis

Category (3)
- Coordinate artificially supplied position and direction feedback and control to existing coordinate head-shoulder and trunk-pelvic actions
- Integrate artificially supplied support balance and structure with existing structure and balance mechanisms

Category (4)
- Rebalance, maintain and protect neutral vertebral column balance with the center of gravity (c.g.)

Sensory Requirements (E, 17-58)

Category (5)
- Provide internal condition feedback, control and warning system sensors

Category (6)
- Provide graduated coordination, control and adjustment

Category (7)
- Provide insulated, static free dependable and safe control system
- Electrical energy transmission circuitry to coordinate parts and stimulate action

CS1 (Continued)

Category (8)
- Automatic support base movement and size control maintaining: 8° outward, 2° of inward foot rotation
- 1-4" parallel foot separation along line of progression or stance
- Continuous asymmetric base
- Automatically control and coordinate total mass to rotate over transforming 1/2 mass base or over full static base
- Maintain center of gravity within and evenly over the transforming mass base

Category (9)
- Provide automatic mass support structure and balance element control and feedback coordination evenly about the bilateral quadrants of the natural invariant vertical axis
- Position and direction integration of mass base and parts

Category (10)
- Provide automatic diagonally reciprocal element coordination
- Stimulate, guide and sequence desired element movement mimicking gross patterns
- Resist all uneven mass balance and undersired mass segment movement

Category (11)
- Simultaneous coordinate trunk flexion and shoulder-pelvic rotation, pattern of movement or simultaneously coordinate leg flexion and pelvic-mass base rotation
- Sequence and time structurally integrated mass bases movement and balance action

Category (12)
- Automatically lift and swing one pelvic girdle end about 1/2 mass base
- Provide vertical balance feedback to equate mass weight distribution differences over mass base and about the vertical axis

Category (13)
- Provide automatic balance feedback for both dynamic and static activity: 1) provide semimanual directional control over the transforming mass base 2) provide automatic proximal-distal feedback to stabilize and distal to prosimal control to transfer mass 3) provide automatic (reflex) stop and go response and manual control (energy power) 4) provide manual override over dynamic force speed and reflex response mechanisms

CS1 (Continued)

Force Requirements (H, 59-78)

Category (14)
- Anchor support forces to mass bases
- Pelvic girdle is overall structure force anchor area

Category (15)
- Horizontal and vertical transfer forces action on mass base
- Alternate pelvic girdle lift and swing force for dynamic transfer of one-half mass base

Category (16)
- Forces to simultaneously extend flex reinforce mass segments rotation and counterrotation

Category (17)
- Corrective and supportive external thrust forces replacing missing internal forces
Active forces in three planes of space holding mass and structure erect 1) 2 active forces per one-half mass base 2) 3 active, two point forces in mass sagittal plane 3) 8 active, one point forces in masses frontal plane

Category (18)
- Force efficiency, mass momentum and emergency reserve
- Optimal utilization of forces and energy
- Provide 30-60 minutes of dynamic locomotor power with a 2.5 to 3 mph speed and 1-1/2 mile distance limits
- Daily provide 15 hours postural transfer and sedentary, standing oscillation and internal maintenance power
- Daily provide 4 hours unlimited standing capacity, support energy and forces

Degrees of Freedom Requirements (I, 79-112)

Category (19)
- Protect and maintain full to moderate arm usage and range
- Protect and guide a minimal of existing 30° of head extension and flexion and 55° of rotation
- Reinforce 115° thigh-shoulder with three minute limited hold anywhere between 96-115°
- Reinforce and provide unlimited hold at 6°, 55° and 96° of flexion (starting from 0 or lying flat)

CS1 (Continued)

Category (20)
- Protect existing 8-10° shoulder rotation while reinforcing 8-10° pelvic girdle rotation and lift
- Reinforce 93° of thigh-leg extension and flexion from 177° of extension
- Reinforce 43° of foot-leg extension-flexion from 67° of extension
- Reinforce 10° of ankle-rotation starting from 2° inward

Category (21)
- Allow a maximum of 1-3° of sagittal sway and only minute lateral sway thru ankles
- Maintain smooth cyclical spiral patterns of mass segment transfer
- Simultaneously bend, rotate and flex thigh-leg

Category (22)
- Daily provide 2-3 hours full passive ranging
- Graduated range and range speed program
- Graduate extension and stretch passive capacity

Provide and Insure Inhibited Movement Freedom

Category (23)
- Transfer to and from common seating devices, beds, and thru 30" doorways
- Noninhibited movement freedom indoors or in artificial surround
- Maximally provide 10° slope, 6" curb, and 360° turn around within 40" performance capacity
- Optimally integrates and does not disturb (pollute, break, knock down or injure) in common physical surrounds in which it is to be used (despite duration of use)

Bases of support and Vertical Support and Balance Requirements (D,G,F, 113-146)

Category (24)
- Smooth alternating one-half total mass base with a 10x14 surface area
- Maintain base transfer and surface frictional contact

CS1 (Continued)

Category (25)
- Provide a minimal total mass base with 20x14" surface area
- Evenly distribute mass weight over mass bases
- Provide an asymmetric total mass base with cengers 14" apart at 25° angle

Category (26)
- Integrate vertical balance and vertical suspension to mass structure to maintain overall vertical mass support

Category (27)
- Integrate pelvic-shoulder and pelvic base action
- Always provide neutral vertical support and alignment
- Maintain homeogeneous interaction of mass and structural segments as a whole

Category (28)
- Provide simultaneous interaction and rotation of adjacent mass segments

CS1

Physical Aid Design Requirement (Req.) Categories

Twenty-eight requirement categories were identified, interacted and then found related in the following manner to comprise physical aid requirement group:

GROUP (8) Req. Categories 2,4
- Optimally maintain and reinforce an neutral visual balance axis
- Optimally balance and control neutral vertical axis

GROUP (7) Req. Categories 5,7
- Optimally provide automatic internal balance control
- Optimally provide a fail proof electrical energy transmission system to coordinate and integrate artificially provided

GROUP (5) Req. Categories 17,26,27,28,11,14,21
- Optimally provide external forces of thrust to rebalance and hold up the natural mass and its structure
- Optimally integrate artificial components and forces of vertical balance to vertical support
- Optimally integrate the two distal mass bases (and their structural components and forces) to the pelvic mass base
- Optimally integrate all artificial and natural components and mass to minimally maintain an overall homeogeneous mass action
- Optimally coordinate and provide simultaneous mass extension-flexion with rotation-counterrotation movement forces
- Optimally anchor artificial support forces and structure
- Optimally reinforce and guid simultaneously spiral patterns of extension-flexion and rotational mass movement

GROUP (4) Req. Categories 1,3
- Optimally rebalance and reinforce existing sensory mechanisms
- Optimally integrate and coordinate existing balance, movement and force control directionality, structure and action ontc artificially supplied

GROUP (3) Req. Categories 22,23,6
- Optimally provide graduated movement freedom duration and range
- Optimally insure that beneficial movement freedom supported by artificial system is practical and nonconflicting in common physical surrounds
- Optimally provide a minimal graduated movement range, speed, and coordination, fineness adjustment

CS1 (Continued)

GROUP (2) Req. Categories 9,10,16
- Optimally provide diagonally-reciprocal automatic balancing of mass wt, horizontally thru the quadrants of the mass (coordinates)
- Optimally provide diagonally-reciproeal automatic balancing of mass wt vertically across the quadrants of the mass
- Optimally provide diagonally reciproeal total mass stabilization and balance forces

GROUP (1) Req. Categories 8,12,13,15,25,24
- Optimally provide automatic mass base, size, direction and/or transfer control
- Optimally coordinate and integrate pelvic girdle lift and rotation control (forward swing) with 1/2 base transfer
- Optimally provide artificial structure with mass support: wt. balancing position, direction and reflex response for automatic stabilization and leveling
- Optimally provide horizontal and vertical forces to transfer the mass wt
- Optimally reinforce and add on to natural pelvic and overall mass bases
- Optimally provide a smooth and sure contact alternat 'y, 1/2 mass base transfer

GROUP (0) Req. Categories 18,19,20
- Optimally use, apply and maintain force and movement efficiency regards to necessary duration magnitude required
- Optimally protect and reinforce existing movement freedom and ranges
- Optimally guide and reinforce only necessary mass segment movement

CS1

A Rank Ordering of Physical Aid Design Requirement Groups

Eight physical aid requirement groupings were interacted, then weighed and given the following order of priority value:

(8) OPTIMALLY REINFORCE AND MAINTAIN A NEUTRAL VISUAL AXIS AND COORDINATE IT WITH THE BALANCE AND REINFORCEMENT OF A NEUTRAL, VERTICAL GRAVITATIONAL AXIS

CS1 (Continued)

(7) OPTIMALLY PROVIDE A FAIL PROOF COORDINATION AND INTEGRATING SUBSYSTEM, PARTICULARLY TO PROTECT AND BALANCE INTERNAL TISSUE MAINTENANCE AND ACTIVITY

(5) HOMEOGENEOUSLY COORDINATE, (WITH CONTROL AND FEEDBACK) AND STRUCTURALLY INTEGRATE HORIZONTAL AND VERTICAL MASS SUPPORT-BALANCE BETWEEN SHOULDER-PELVIC BASE AND PELVIC-MASS BASES DIAGONALLY RECIPROCATING ACTION (SIMULTANEOUS EXT-FLEXION AND ROTATION-COUNTERROTATION)

(4) OPTIMALLY USE EXISTING REBALANCED AND REINFORCED MASS BY INTERACTING REMAINING 1) ORIENTATION-CONTROL (LEVELING AND DIRECTIONALITY) 2) STRENGTH 3) STRUCTURE, WITH ARTIFICIALLY PROVIDED 1) POSITION SENSE, CONTROL PATTERN 2) FORCES AND 3) EXTERNAL MASS STRUCTURE

(3) OPTIMALLY INSURE DESIRABLE USER-SYSTEM INTERACTION WITH GRADUATED ADJUSTMENT AND GRADUATED SYSTEM CAPACITY AND FULL SYSTEM-PHYSICAL SURROUND ACCEPTABLE INTERACTION

(2) OPTIMALLY REINFORCE AND GUIDE SIMULTANEOUS PATTERNS OF MASS MOVEMENT: WITH VERTICAL AND HORIZONTAL, DIAGONALLY RECIPROCAL STRUCTURAL-FORCE CONTROL

(1) OPTIMALLY AND AUTOMATICALLY CONTROL AND STRUCTURALLY COORDINATE 1/2 MASS BASE TRANSFER, WITH PELVIC GIRDLE LIFT AND ROTATION (FORWARD SWING) ABOUT THE OTHER 1/2 MASS BASE WHILE MAINTAINING A MASS BASE SIZE, WT. DISTRIBUTION AND EMERGENCY REFLEX RESPONSE, AND RELYING ON ALTERNATE VERTICAL AND THEN HORIZONTALLY APPLICATION OF FORCE INTERACTION BETWEEN THE MASS BASES

(0) OPTIMALLY MAINTAIN AND EFFICIENTLY GUIDE AND REINFORCE ONLY NECESSARY MASS SEGMENT MOVEMENT, RANGE AND FORCES

CS1

<u>Physical Aid Subjective(Sub) and Objective (Obj) Requirements</u>

Fifty-one initial subjective and objective requirements were developed, identified and then found to relate in the following manner, to comprise categories of Sub. and Obj. requirements.

Category (15)
- Provides user safety at all times and under any and all extreme circumstances of anticipated use
- Safe for others to move and work about the dynamic aid provided
- Complimentary to conventional physical surrounds

Category (12)
- Protect, correct and then maintain an infection or complication free mass, full self-care support, and help meet and provide, full indoor use, and minimal outside occupational and social involvement potential to meet minimal access desires

Category (9)
- Restore minimally the survival freedom to adjust to situations or make change, and control one's own body form in time and space
- Adjusts and is flexible in meeting individual N.A. group user characteristics, fit of remaining body mass and volume

Category (8)
- Easy to control and use, can independently use and get on or off, train and prepare for use
- Restore and adjust to normal emotional and behavioral state, eliminate depressive, and introversion feeling fears, and social withdrawal
- Provide user with worry free operation and usage, that's dependable and trouble free

Category (7)
- Made up of a minimal amount of components and hardware
- Easy to set up, install, service and daily maintain
- Provides N.A. group with corresponding performance range capacity, ease of use, safety and visual acceptance

Category (6)
- Provides a beneficial level of N.A. task performance ability that's unattainable in any other form or way, increases their daily physical activity level in a natural pattern of performance, increases performance motivations and desire to be active, while it is satisfying and has user carry over value

Category (5)
- Practical availability to all who need and could benefit from use
- For financial attainability price should be kept aprox. below $3,000
- Safely use and keep on for 16 hours a day, without having to use a wheelchair

Category (3)

- Providing necessary 16 hours of daily operation power mostly for sedentary and indoor operation, along with emergency support, and back up power
- Light weight, not bulky and yet strong
- Force pressure, heat and cold, shock absorption durability and ruggedness are all necessary qualities
- Properly anticipate material stress and strains (tensile qualities)

CS1
A Rank Ordering of Subjective and Objective Physical Aid Design Requirement Categories

Seventeen subjective and objective requirement categories were interacted, then weighed and given the following order of priority value:

(15) OPTIMUM USER, USAGE SAFETY AND PHYSICAL SURROUND INTERACTION OR INTERFACING

(12) OPTIMUM BIOLOGIC MAINTENANCE, AID AND SUPPORT OF A STRESS FREE CONDITION

(9) OPTIMUM RESTORATION OF THE N.A.'S INDIVIDUAL SURVIVAL FREEDOM

(9) OPTIMUM INDIVIDUAL USER, USAGE FLEXIBILITY AND INTERACTION

(8) OPTIMUM EASE TO LEARN TO USE AND OF USAGE

(8) OPTIMUM INDEPENDENT USAGE

(8) OPTIMUM AID IN ADJUSTING OR RESTORING PSYCHOSOCIAL, OCCUPATIONAL STATE

(7) OPTIMUM USE OF AND SELECTION OF MATERIALS FOR SYSTEM COMPONENTS WITH REGARDS TO DURABILITY, EASE OF CLEANING, ETC

(7) OPTIMUM EASE IN MEETING DAILY MAINTENANCE AND/OR OPERATING COSTS

(7) OPTIMUM USAGE SATISFACTION AND AID ACCEPTANCE (VISUAL)

(6) OPTIMUM USER OR N.A. GROUP PERFORMANCE GOAL CAPACITY PROVIDED

(5) OPTIMUM EASE OF MAINTENANCE, SERVICE, INSTALLATION AND DEPENDABILITY

(5) OPTIMUM VALUE FOR MODERATE MANUFACTURING, BUYER PRICE AND COST

(5) OPTIMUM AVAILABILITY OR ATTAINABILITY FOR ALL ELIGIBLE USERS

(5) OPTIMUM DAILY USAGE FREEDOM

(3) OPTIMUM MINIMIZATION AND SIMPLIFICATION OF COMPONENTRY AND SYSTEM SOPHISTICATION

(3) OPTIMUM SELECTION OF COMPONENT MATERIALS FOR EASE OF MANUFACTURING

CS1
Physical Aid Interfacing Design Requirements

One hundred and twenty-one initial interface (INT) requirements were developed, identified and then found to relate in the following manner to comprise categories of interfacing requirements.

Category (10) INT 73,75 & 87
- Stimulate and promote an infection-free state
- Stringently control permanent conditions in order to eliminate or minimize their variable influence on the organism's health
- Increase the N.A.'s overall physical health

Category (7) INT 1-16
- Increase, balance and control, oxygen inhaling-exhaling capacity and oxygen reserve
- Provide portable respiratory aids, rhythmic positive chest pressure lifting and lateral range, rhythmic abdominal lift and support and diaphragmic weights
- Develop and maintain normal breathing pattern and pace
- Provide and maintain respiratory passage, chest musculature and neck with nonstatic uneven rhythmic pressure and irritation protection

Category (6) INT 65,68,69,70,71,72,87,99,103,104,105,117, 118,119,120 & 121
- Apply artificial pressure and forces as:
  1) Compound curves of forces
  2) Evenly distributed over as large surface area as possible
  3) Greater forces and pressure in safe bony contact or nonvascular areas
  4) Minimal forces and pressures in fleshy and bony prominences
  5) Perfectly integrate artificially applied support pressure and forces

Category (6) INT 38-47
- Provide zero-ninety five degree F., thermal protection for mass
- Automatically equate (feedback and control) of supplied thermal energy (heat and coolness) with regards to continually maintaining a 34-35° C peripheral mass temperature
- Measure difference between circulating water temperature and the desired surface temperature
- Thermal control of perspiration, heat dissipation or metabolic heat output
- Skin moisture and odor maintenance

CS1 (Continued)

- Provide body temperature danger warning sensor-signal after 180 cal. per hour of heat output
- Provide thermal cooling and ventilation system due to hyperthermic character and insulation requirements, moving coolants from proximal to distal ends of mass

Category (5) 27-37 & 93
- Provide circulatory and abdominal pressure danger warning signal
- Stimulate proper circulatory flow and venous contraction
- Increase capillary pressure capacity
- Control circulatory flow to the legs and feet

Category (5) INT 48-56 & 86
- Bowel-bladder care and cleanliness maintenance, pressure and irritation protection
- Evacuation and urinary appliance access freedom
- Urinary appliance installation, care and protection
- Maintain clear waste evacuation tracts

Category (5) INT 56,62,73,78,79,80,81,82,83,91,96,100, 102,107 & 109
- Protect and maintain entire natural remaining mass and its frame from falls and/or from abrupt incidental external and/or internal, hypertensive reflex forces
- Provide continuous minute surface tissue vibration and pressure change, to stimulate capillary circulation particularly in sedentary wt. bearing areas of mass
- Provide full pressure sore protection against any skin or surface tissue irritation, rubbing or uneven pressure which may disrupt capillary circulation

Category (4) INT 61,63,64,84,85,110
- Protect natural mass from any abrupt or extreme external contact with hot or cold surfaces
- Provide and maintain minimal all year around usage in temperate climatic zone
- Provide safe, climatic functioning in: 0-95° F weather range, 25 mph winds, 0-100% humidity, moderate rain and/or snowfalls

Category (4) INT 16-26
.Decrease, then balance and control their gastrointestinal activity, metabolic heat rate, by controlling their 02 intake and their body temperature

CS1 (Continued)

- Develop, maintain and balance a minimal 30-60 min. 120-180 cal/hr energy reserve and corresponding respiratory capacity
- Maintain a maximum metabolic heat rate of three cal/min or a dynamic activity heat rate between 120-180 cal/hour and a sedentary rate of 100-110 cal/hr

Category (2) INT 57,58,59,89,112,113,114,115,117 & 118
- Optimally minimize the mental perceptual concentration and physical effort
- Minimize the physiologic expense to perform

Category (2) INT 74,94,97,98,106,116
- Protect existing mental capacity and sensory equipment
- Maintain meaningful awareness, performance readiness
- Guard against overelectrical stimulation nerve ending pressure, or near brain wave oscillation and neural annoyance
- Reinforce, protect the spinal cord, and vertebral column, from external forces and internal compression, yet move it in its natural homeogenous way

CS1

A Rank Ordering of Physical Aid Interfacing Design Requirement Categories

Eleven interfacing requirement categories were interacted, then weighed and given the following order of priority value:

(10) OPTIMALLY RESTORE OR CORRECT AND THEN MAINTAIN OR PROTECT (PREVENT) BIOLOGIC DEFICIENCIES

(7) OPTIMAL RESPIRATORY (02) AID, SUPPORT AND CONTROL ABOUT THE CHEST AND ABDOMINAL AREAS

(6) OPTIMALLY INTEGRATE (CONTACT) EXTERNAL FORCES AND PRESSURES TO SUPPORT THE ORGANIC MASS

(6) OPTIMAL INTERNAL BODY TEMPERATURE AND PERSPIRATION BALANCE AND CONTROL

(5) OPTIMAL CIRCULATORY FLOW AID, SUPPORT AND CONTROL, IN ABDOMINAL AND LOWER EXTREMITY AREAS

(5) OPTIMAL BOWEL-BLADDER (EVACUATION) PROTECTION, REINFORCEMENT AND CONTROL OF GENITO-ANAL, LOW BACK AND ABDOMINAL AREAS

(5) OPTIMAL NATURAL MASS, SKIN TISSUE PROTECTION AND STIMULATION OVER THE ENTIRE AFFECTED MASS

(4) OPTIMAL EXTERNAL BODY TEMPERATURE PROTECTION, EXCHANGE AND BALANCING CONTROL, OVER ENTIRE AFFECTED MASS

(4) OPTIMAL METABOLIC BALANCE, SUPPORT AND HEAR RATE CONTROL OVER ENTIRE AFFECTED MASS

(2) OPTIMAL PHYSICAL AND MENTAL EFFORT EFFICIENCY

(2) OPTIMAL MENTAL AND SENSORY PROTECTION AND STIMULATION

CS1
Major Physical Aid Requirement Conflicts

The conflicts were determined by interacting the requirements of each of the three major criteria listings with and within each other with the following as only an example of conflicts between:

A,B,C, 1 & 10
.Optimally require head and back of neck reinforcement, yet require that center of gravity be maintained at all times and at its natural level of height or lower

A,B,C, 1 & 15
.Optimally require head and neck reinforcement, yet require existing sensory mechanism response freedom and mental alertness

F 136, Sub. 38 & G 125
.Require homeogenou body and physical aid mass, structure action and integrat on, yet require rigid support and minimal number of joints in physical aid for a moderate cost

E 50,49 & INT 117
.Require minimal conscious effort to operate and minimal visual concentration to use...yet require semimanual directional and pace control

H 59,78, R8 & INT 66
.Require rigid yet flexible forces of mass balance-correction and firm well fitting forces of mass support and alignment correction, yet require nonstatic or irritating pressure action in thoracic area and even external pressure distribution for respiratory support

E 36,29,26 & INT 58, H 76
.Require force and mass transfer efficiency, yet require that one-half of the mass base is alternately lifted and swung forward with a smooth impact action

I 97,79,84
.Require user to stretch, extend and hyperextend in a prone positioning, yet require only 115° of shoulder-thigh extension necessary and that extreme extension of limbs is dangerous

I 93,98
.Require necessary 2-3 hours of passive ranging daily, for N.A. level, yet require only 30-60 minutes of limited locomotor range action as beneficial (and the rest of time in standing and sedentary postural changes)

CS1 (Continued)

I 106, INT 106, I 101 & INT 108
•Require total mass postural change transfer and standard seating and supportive device usage, yet require full buttock, low-high back and vertebral column protection and external reinforcement

I 103, R 7, E 58, H 73 & 75
•Require unlimited indoor, user and dynamic physical aid transfer, freedom and usage, yet require a great deal of respiratory component aid, portable outdoor power sources

CS1
Major Subjective (SUB) and Objective (OBJ) Physical Aid Requirement Conflicts Between:

SUB 22,17 & INT 13
•Optimally require that the physical aid is safe to use for 16 hours per day and require that approx. two-thirds of the typical user's natural body mass is artificially supported, yet require that no confinement feeling should be prompted in users

SUB 17,52,48
•Optimally require full 16 hr. daily usage, yet require only 30-60 min. (1/16th) of that time to necessary, dynamic locomotor activity and minimal system components (energy, structural, coordination elements)

SUB and OBJ 46,48,49 & 36
•Require that N.A. group variance flexibility and adjustment be built in, yet require minimal number of components, sophistication and set up time, etc

SUB-OBJ 45,52,26 & 48
•Require that it provide graduated performance adjustment and be usable for graduated therapy, ranging and rehabilitation programs (at home and in hospitals), yet require minimal number of components joints etc. and only what's necessary to meet N.A. group beneficial task performance range

SUB-OBJ 43,45 & 42
•Require that the physical aid be designed for and used only after typical N.A. group user's condition stabilizes and only for a daily beneficial performance range, yet require that it be usable as soon as possible and in a graduated program of rehabilitation

CS1
Major Interface Requirement Conflicts Between:

INT 8 & 4
.Require nonstatic rhythmic, positive chest musculature pressure while we require full neck musculature freedom and not chest or neck surface irritation

INT 64 & 45
.Require a 0-95° F. thermal surround access, while requiring that system must stringently maintain and preserve a 34-35°C peripheral body temperature

INT 42, 26 & 43
.Require thermal insulation protection of atrophied areas, yet desirably need to enhance vascular contraction and/or support lower extremity circulation

INT 41,42,13 & 44
.Require full thermal protection insulation and mass support, yet need to maintain full peripheral surface breathing and control, excessive perspiration flow

INT 42 & 47
.Require full thermal control, insulation and protection about the affected mass, yet require decrease in excessive heat output (metabolic rate)

INT 51 & 53
.Require abdominal, low back and pelvic area supportive pressure and forces, yet require full excretatory, self-care freedom, and urinary appliance usage when it's necessary

INT 69 & 73
.Require evenly distributed mass support pressures and forces over as large an area as possible, yet require no pressure application in fleshy mass areas

INT 69 & 89
.Require evenly distributed mass support pressures and forces, yet requiring that system help alleviate or prevent abnormal internal cavity pressures, at all times

INT 71 & 91
.Require the application of support forces and thrusts in safe locations, yet require that organic mass must be protected from all external forces and/or irritations

CS1 (Continued)

INT 69 & 36
.Require that system optimally prevent vascular constriction and hard and soft tissue atrophy and try to restore mass size and strength, yet require that we provide evenly distributed support pressure and forces about the same tissue areas

INT 13 & 22
.Require the system to optimally maintain clean-dry skin and protect tissue from irritation and/or external forces, while requiring full affected area surface and mass enclosure and pressure

INT 95 & 103
.Require that system help control blood pressure flow into legs,yet require no irritating tissue or applying local mass tightening or pressure

INT 97 & 102
.Require without the use of straps, well fitting mass support (nonstatic) in the high thoracic area, yet require that the support in this area does not rub,irritate or ride away from the mass surface at any time (provides even pressure)

INT 100 & 106
.Require that system optimally suspend in a vertical manner the vertebral column, yet require that the vertebral column is optimally protected from external forces and/or internal compression abrupt twisting

INT 106 & 113
.Require optimal lumbar, sacral mass area support, yet require that no abnormal or uneven internal cavity pressure be produced

INT 121 & 107
.Require that the system daily provide full and beneficial mass segment ranging beyond what's required for daily performance needs, yet require minimal system cost and/or system sophistication that's necessary to meet beneficial N.A. group performance with the least number of components

INT 81,82,18 & 37
.Optimally require protection of bony prominences and weight bearing mass areas, from any abrupt forces or tissue break-down, y t require, even mass pressure and well fitting surface contact, that provides continuous minute pressure changes or vibration

CS1 (Continued)

INT 81 & 82
.Optimally require well fitting, wrinkle-free and even supportive pressure and surface contact, yet require continuous minute mass surface pressure vibration

INT 81,69 & H 66,60
.Optimally require that each N.A. group user has well fitting, wrinkle-free and even supportive surface pressure, yet require the mass support be rigid enough to move and guide body segment masses

INT 81,76 & 92
.Optimally require that each individual has perfectly fitting mass support and pressure for their particular mass character and condition (size, shape and texture), yet require and hope that the mass rebalances and restores itself (increases fiber size and increases in vascular contraction capacity, etc)

INT 107 & 115
.Optimally require that system must not restrict existing movement range or performance capacity (upper extremities, shoulders, neck and head), yet require that the neck-back of head and shoulder girdle be reinforced vertically and that the deficient mass is integrated with existing head and shoulder movement

INT 113,48 & H 96,91
.Optimally require full lumbar-sacral area support without causing abnormal pressure internally, yet require that the individual bend thru their waistline and stretch low back and abdominal musculature daily, if possible

INT 105,8,108 & I 89
.Optimally require nonstatic, thoracic area support, and respiratory musculature aid, yet require full vertebral column protection, and 8-10° shoulder-pelvic rotation and counterrotation

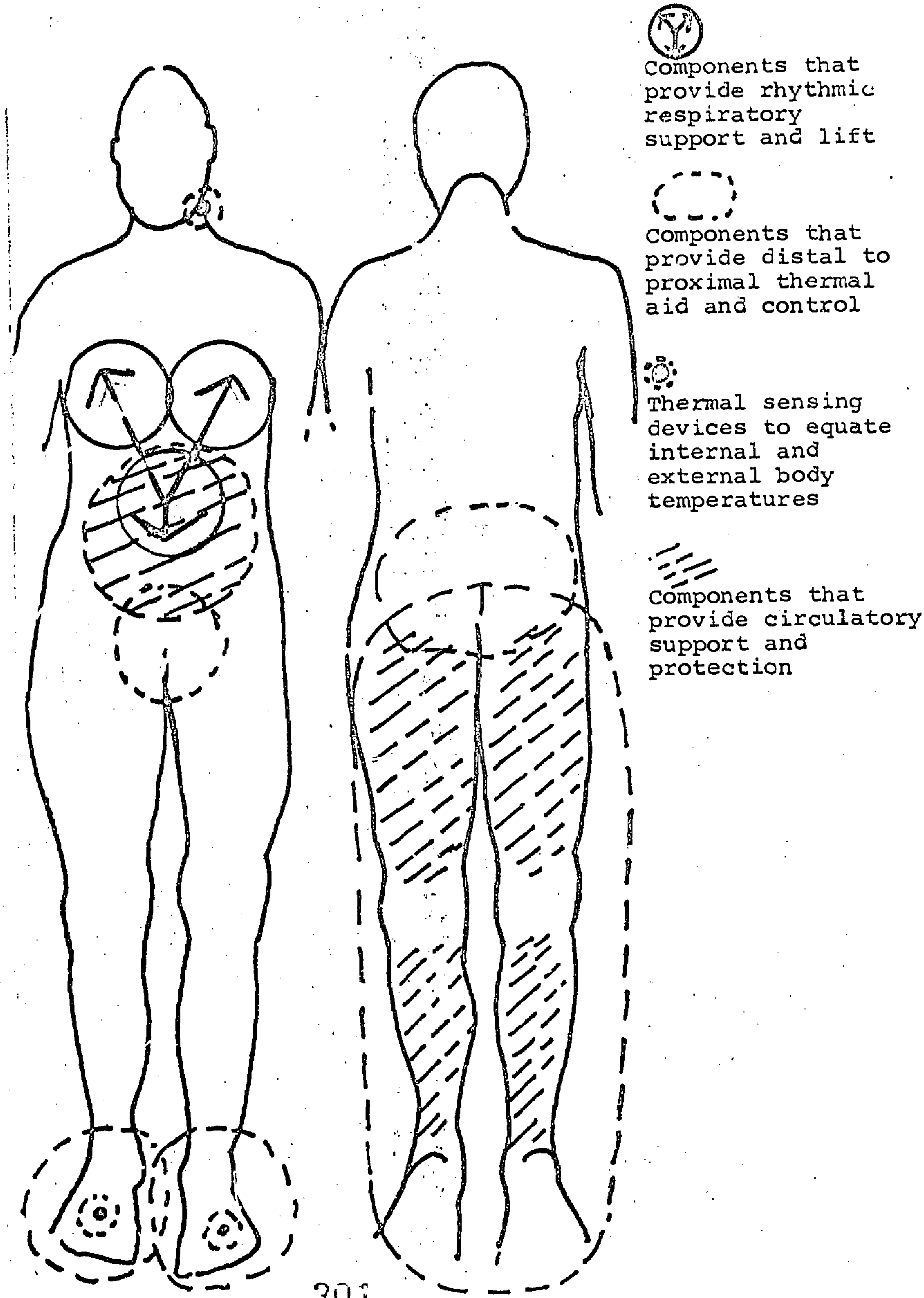
INT 67 & I 86,87,109
.Require that ankles not be locked during dynamic mass movement, due to awkwardness, yet require that ankles be locked during static and dynamic postures for stability

CS1
Modular Design Proposal

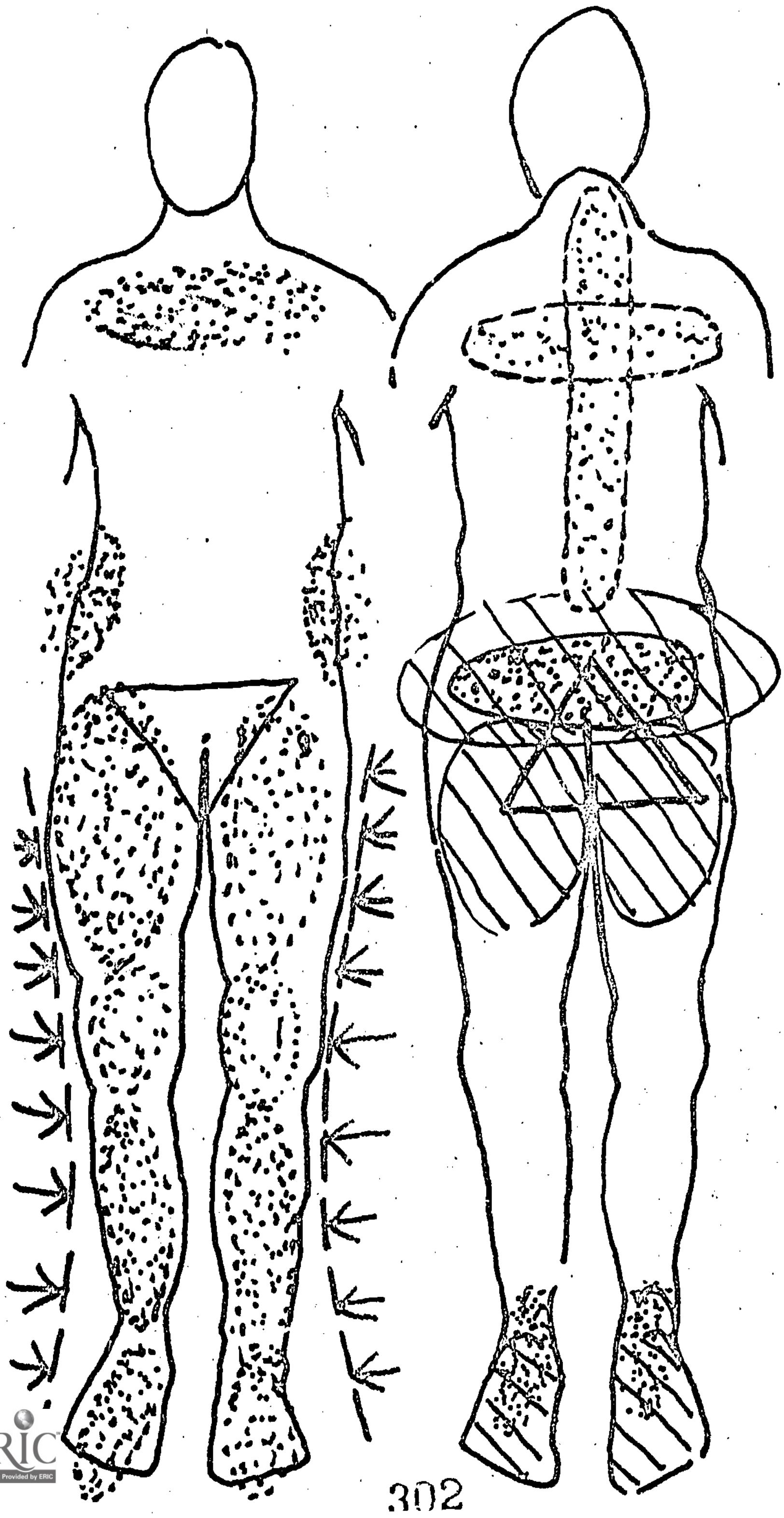
Proper integration of component and material needs is very important and a necessity if a unified dynamic artificial aid is to be designed. Careful marriage or overlapping of materials and components functioning have been found with particular requirement commonalities and action qualities. An interesting change regarding design needs has been found to occur as the amount of biologic deficiency changes. As the amount of biologic deficiency increases the amount of components to provide performance action decreases and components to maintain safe interaction increases and vice a versa. Thus design needs do not change to much in amount as deficiency changes but only as to kinds of needs that are to be met. As an example, all N.A. will require basically the same support below their hip joints, however component and material needs will vary as the performance and interfacing needs change with the varying levels of deficiency. The idea of having modular components that would be the same and based on biologic differences could be most efficient as only necessary amounts of action and interfacing sub-component would need to be substituted for. Whether or not a system of modular components which would change in character by adding or taking away subcomponents is yet to be fully determined. However it does seem most ideal with regards to the criteria provided in this study.

In summary I believe the presented data has the potential to be used as a basis to develop an overall dynamic system made up of modular action and interfacing components and materials which could simply meet all N.A.'s performance needs.

CS1
Schematic diagram of major interfacing design requirements (Continued)



CS1
Schematic diagram of major interfacing design requirements



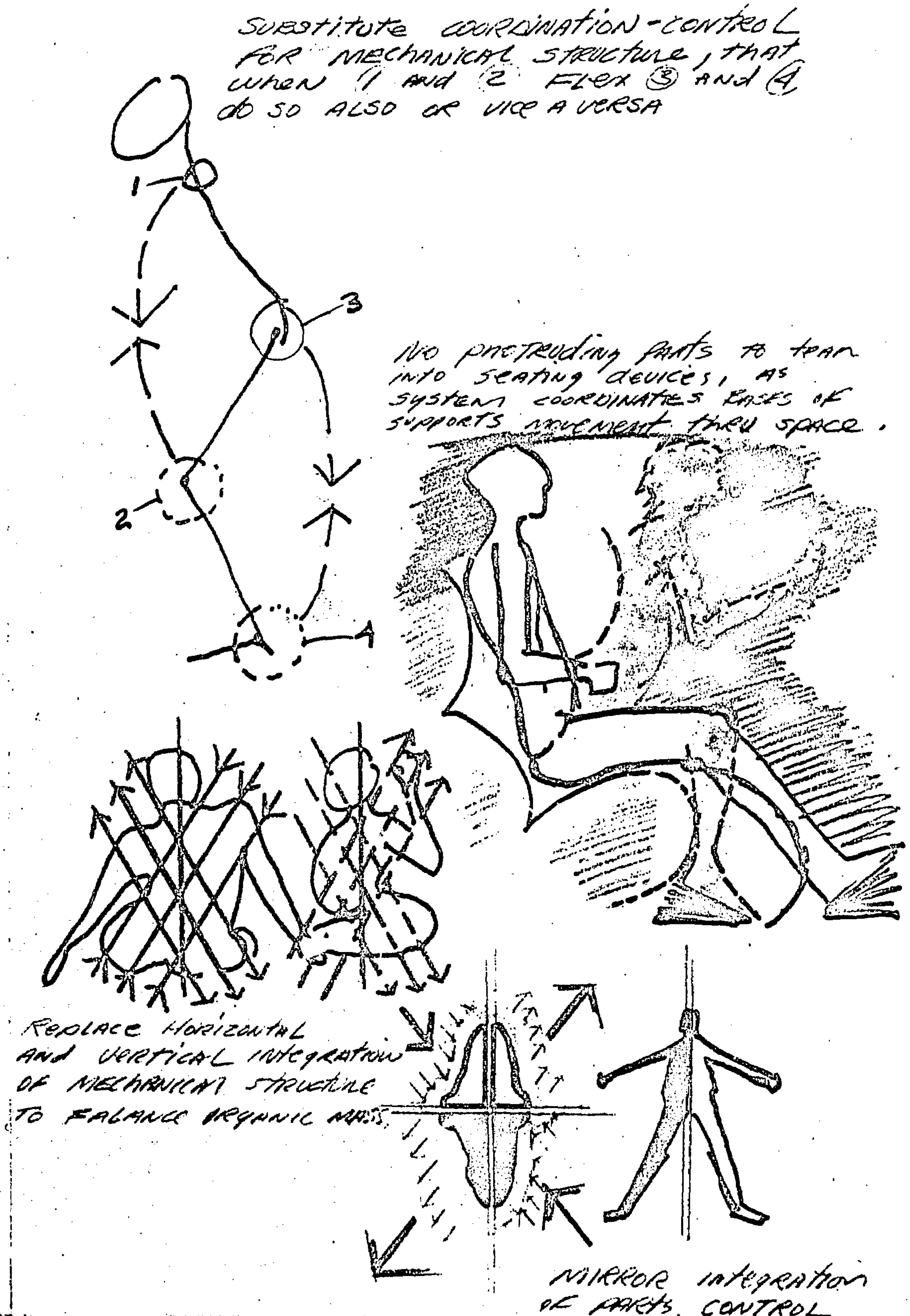
Provide components to protect tissue and body prominences

Components that provide a high degree of tissue stimulation and weight distribution in these areas

Components that provide and maintain easy access during the system's usage

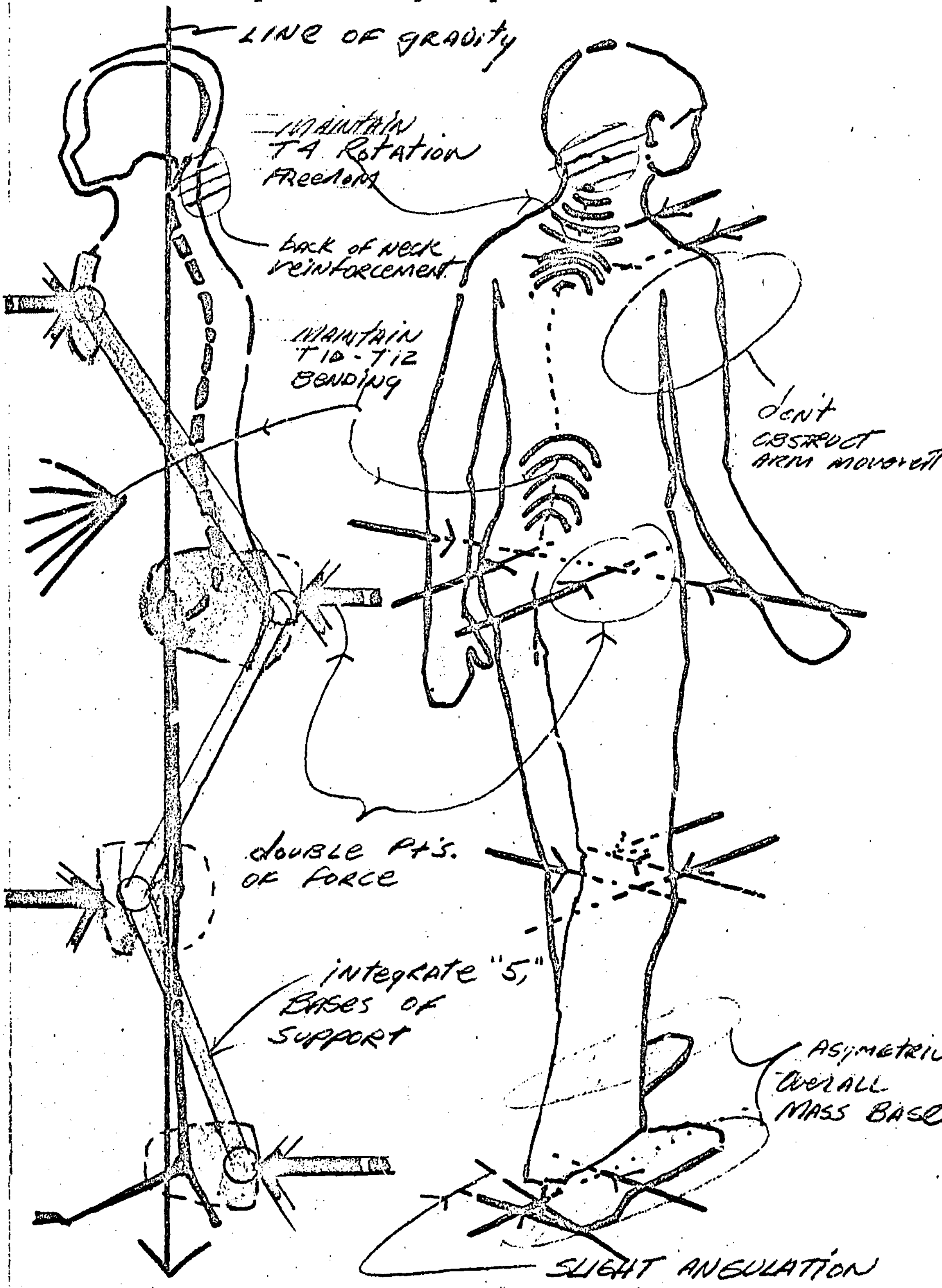
Components that provide a high degree of outside impact protection

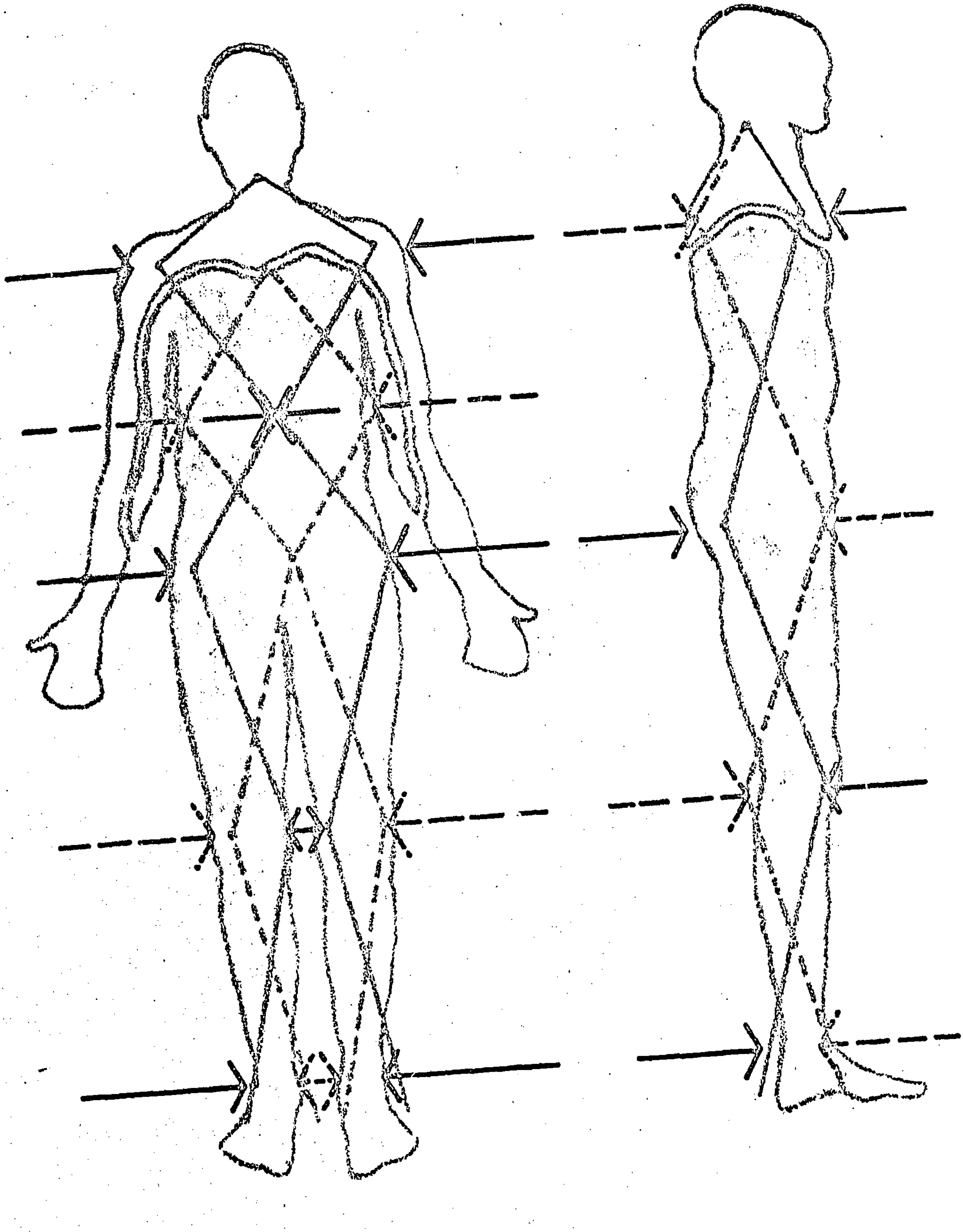
CS1
Schematic of Physical Design Requirements



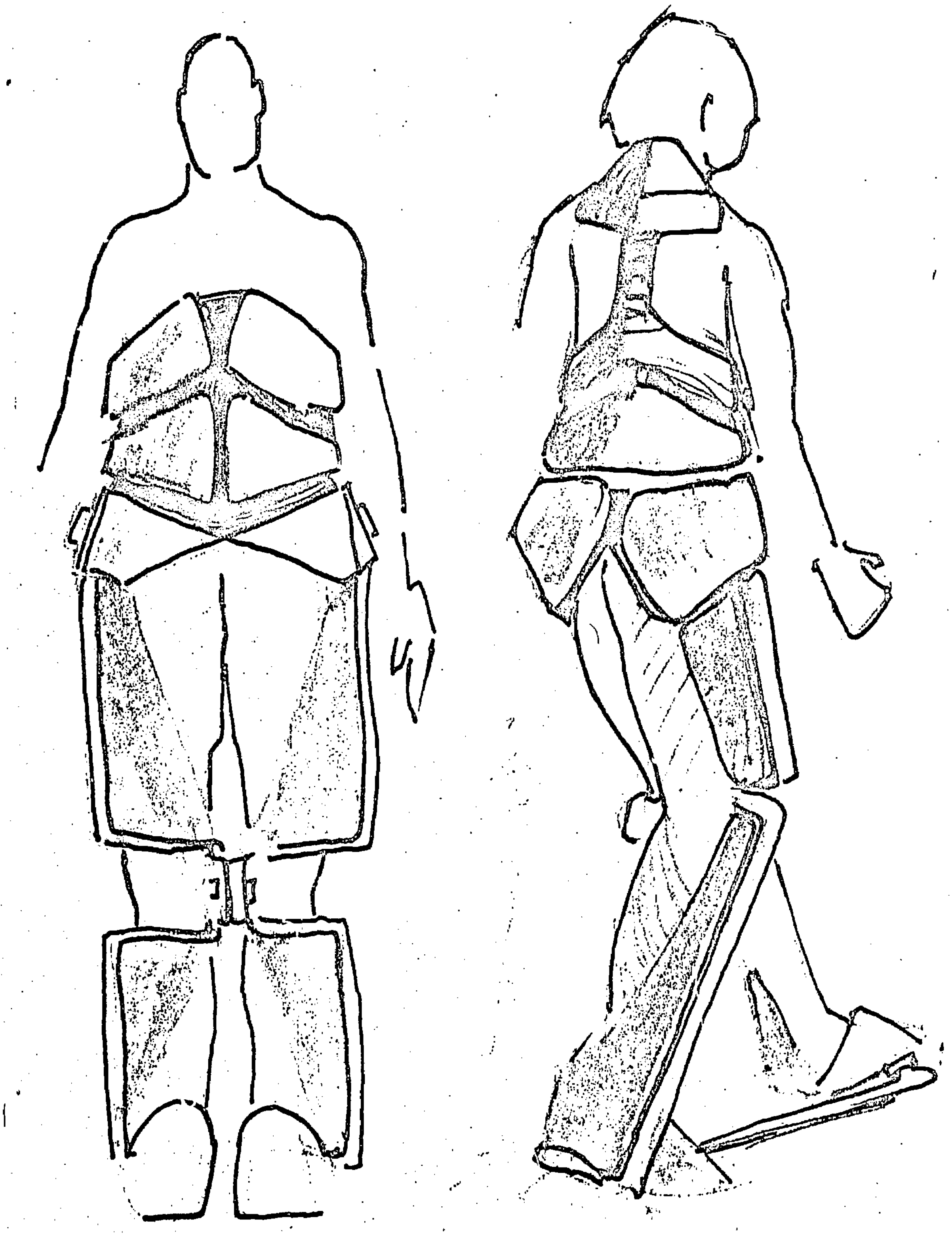
CS1

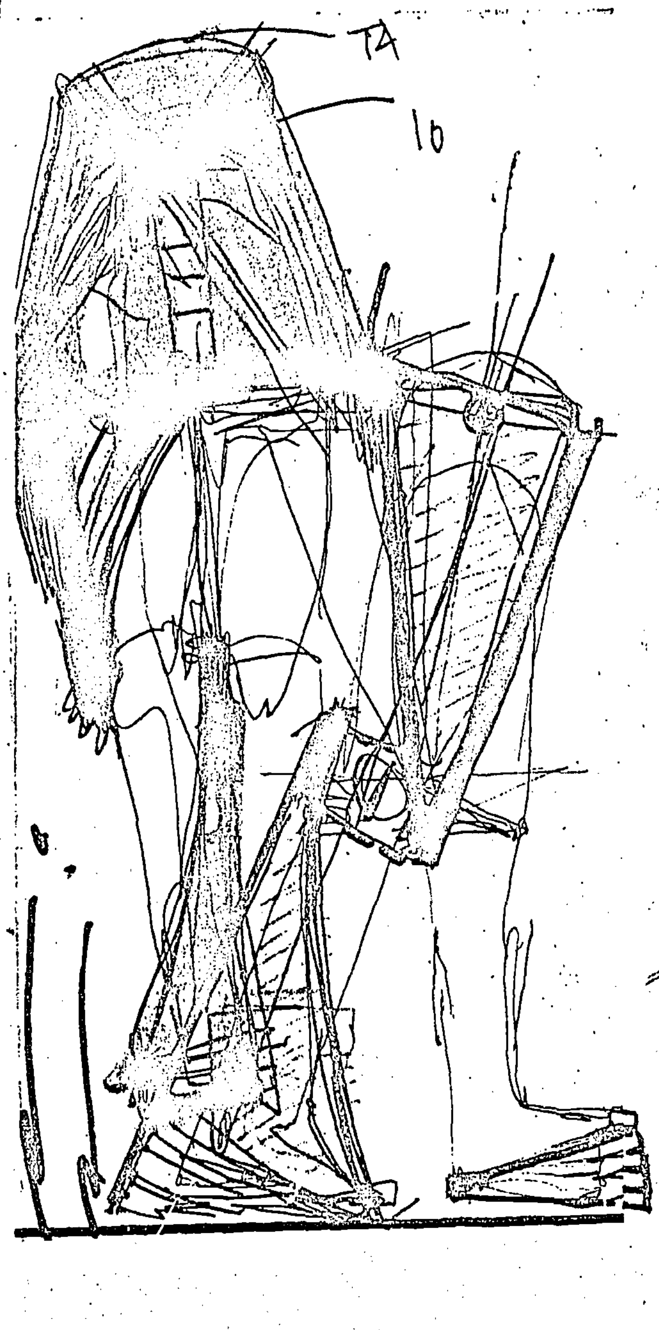
Schematic of Physical Design Requirements





CS1
Modular Design Proposal

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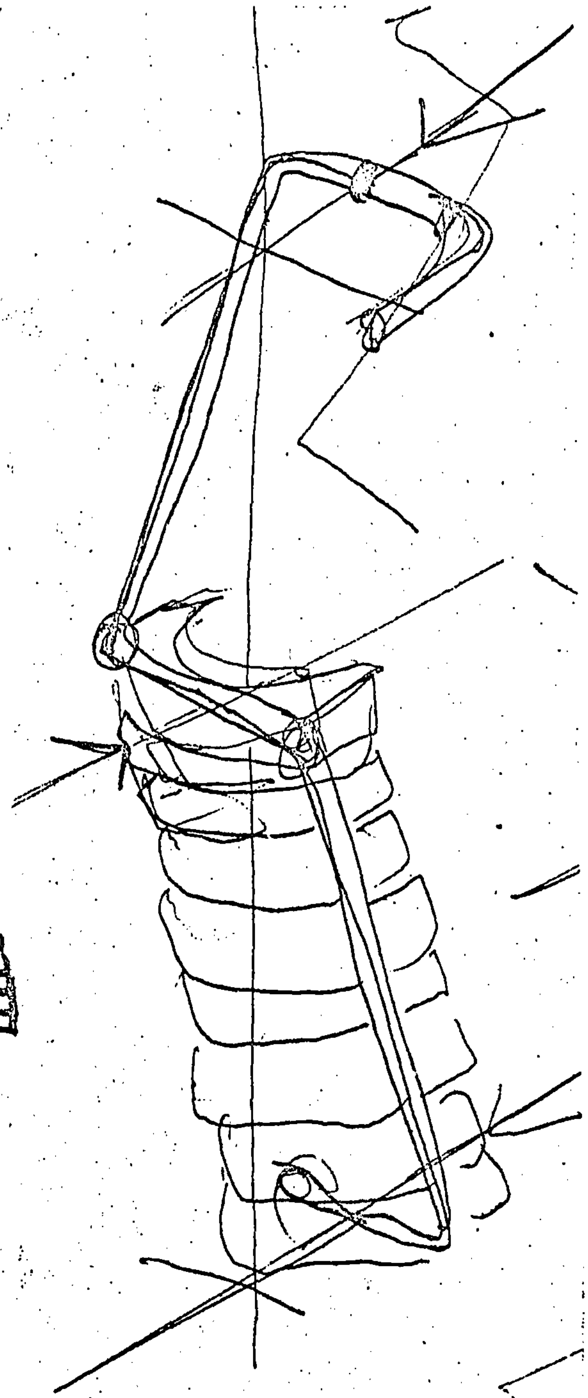
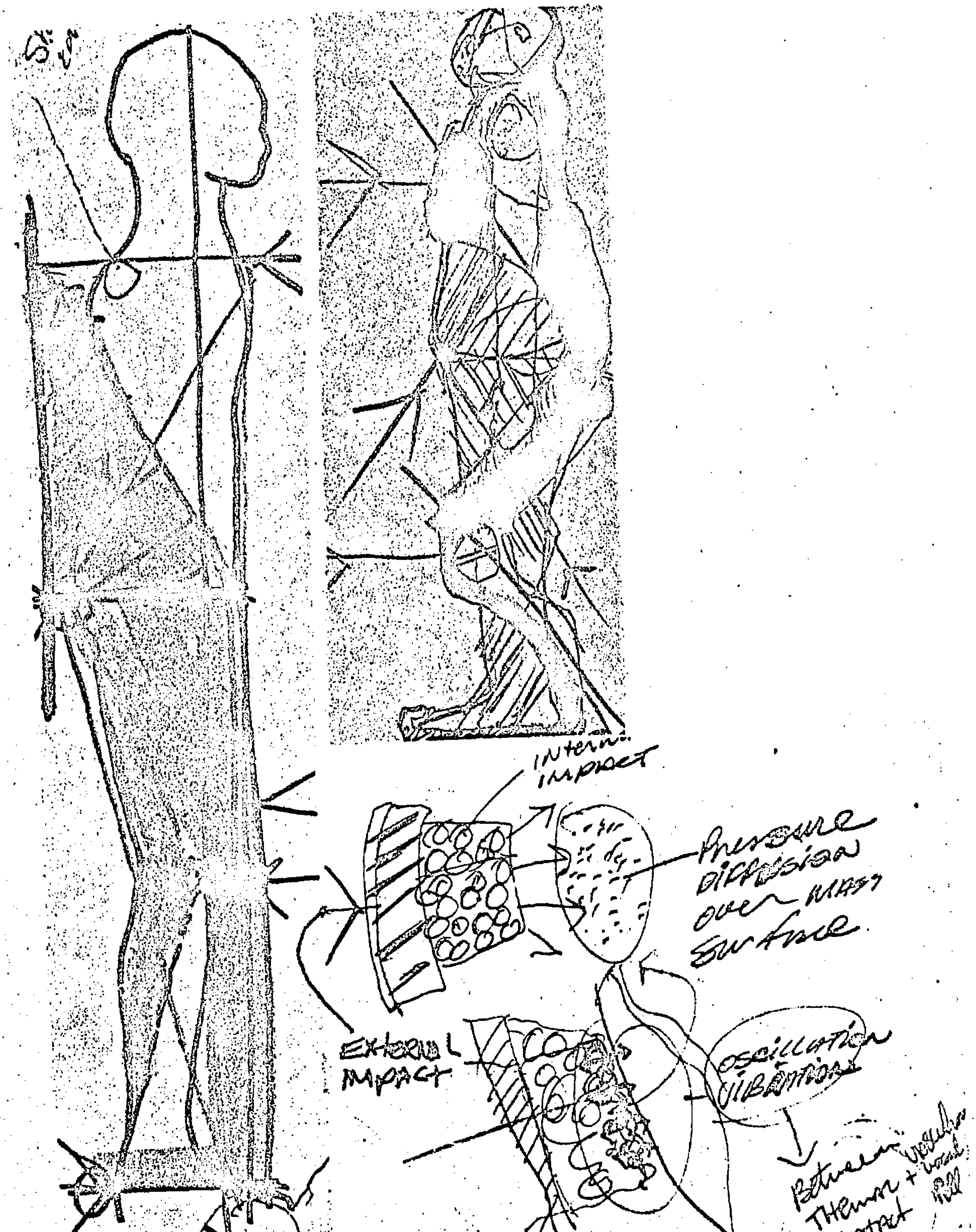
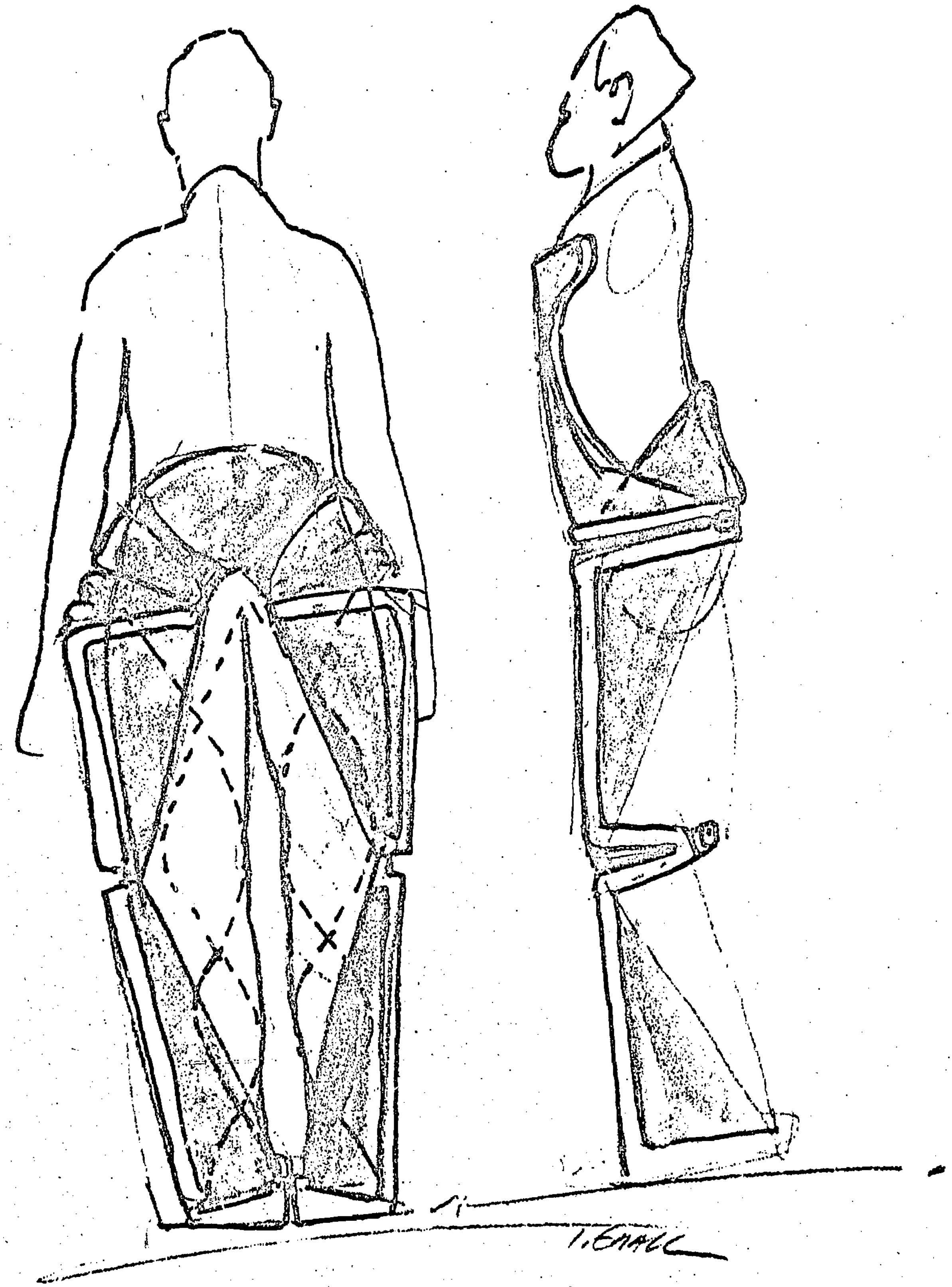
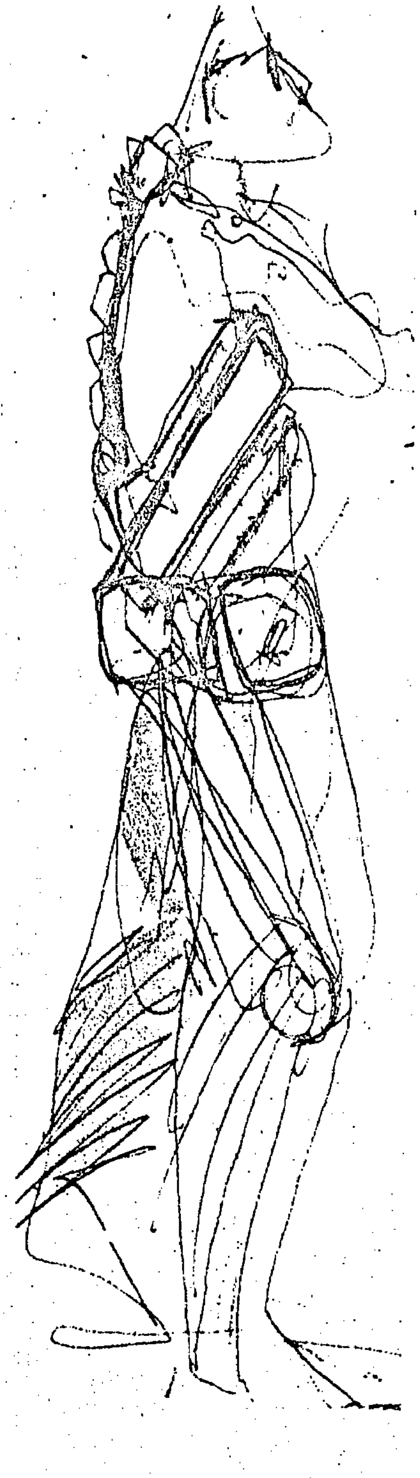
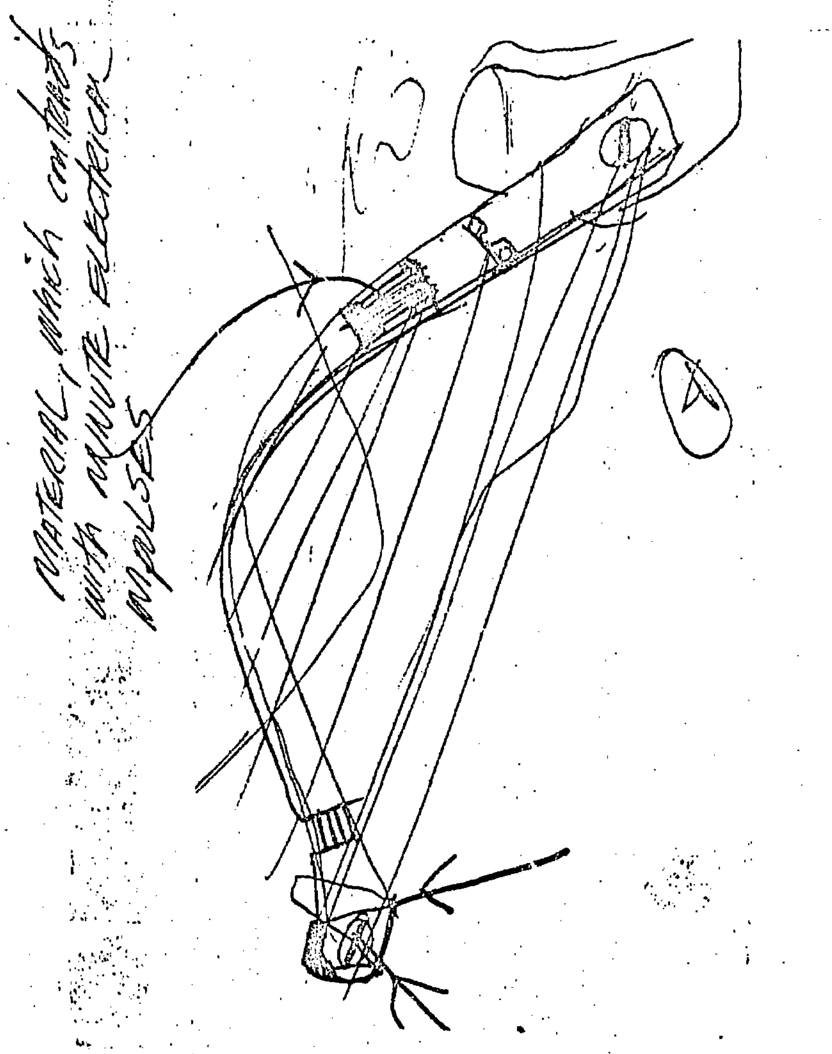


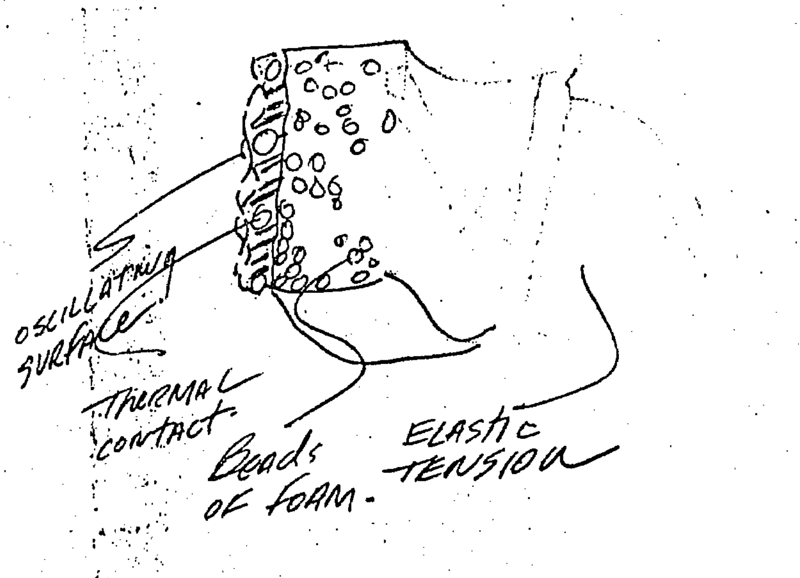

INTERNAL IMPACT
PRESSURE DIFFUSION OVER MASS SURFACE
EXTERNAL IMPACT
OSCILLATION VIBRATION

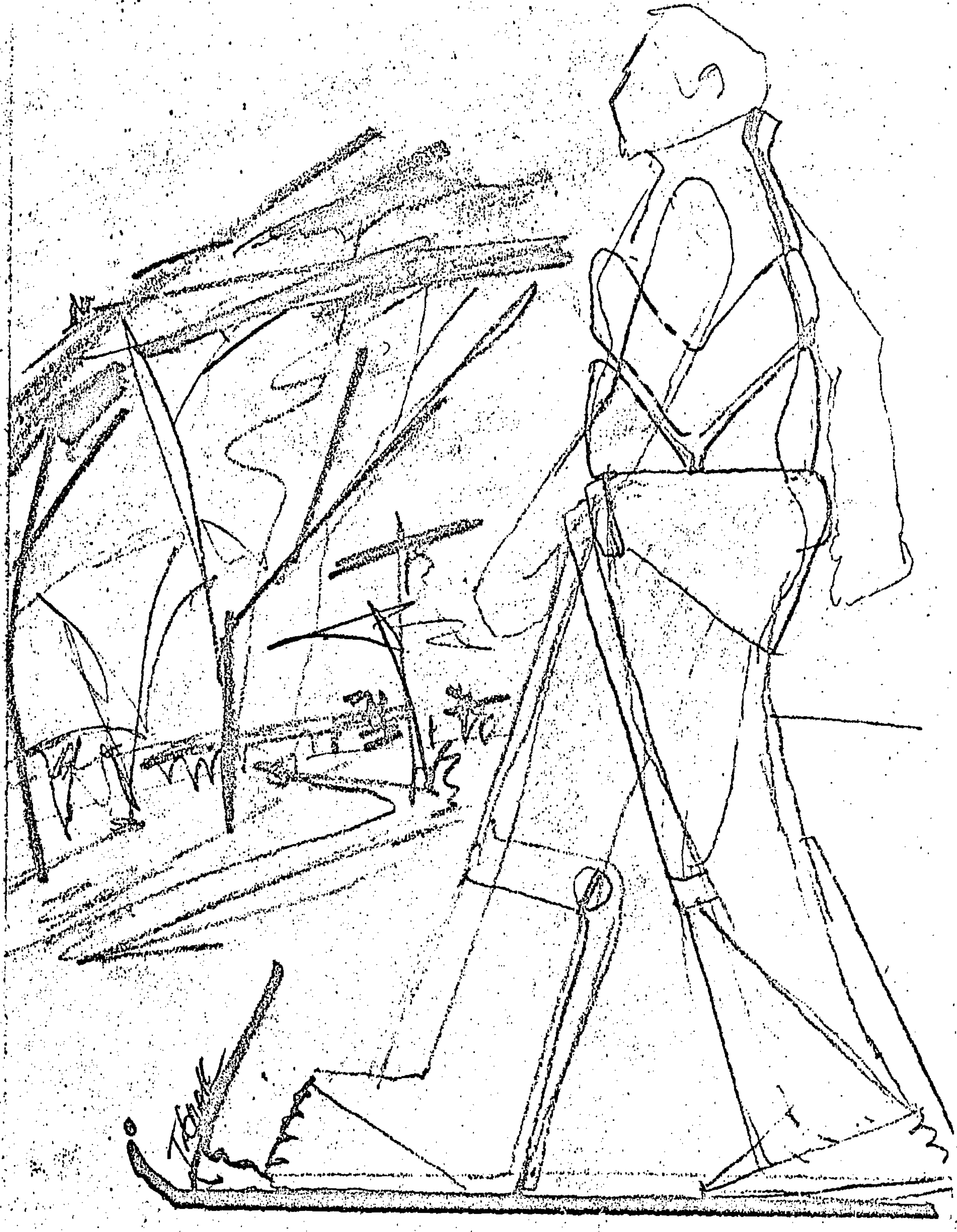
CS1
Modular Design Proposal






MATERIAL, which contracts
with minute ELECTRICAL
IMPULSES


OSCILLATING
SURFACE
THERMAL
CONTACT.
Beads
OF FOAM.
ELASTIC
TENSION



REFERENCES

The given reference listing is a select sampling of the actual six hundred and twenty-four literature sources which were reviewed in the course of this study. A full annotated bibliographic listing entitled "Artificial Locomotor Support for the Non-Ambulatory Human Organism" is on file at the Environmental Design Department Library and by the author.

The following entries are provided in hopes of indicating the broad breadth of knowledge which I feel needs to be accounted for. Because of the study's nature, most of the information and discussion provided throughout this entire study or with any of the references cited are the present writer's own and not those of the original writers. Users or readers of this study should read the references in their entirety in order to be familiar with the original writers context and overall material being interpreted, cited or quoted by the present writer. The given entries are asterisks* to identify each entry's major topical concern and how it related to the overall study.

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